



PAUL STEPHEN WALKER

A thesis submitted in
partial fulfilment of the
requirements of the degree of
DOCTOR OF PHILOSOPHY
in
ECONOMICS
in the
University of Canterbury
Christchurch, New Zealand

September 2011

A THEORY OF THE HUMAN-CAPITAL BASED ENTERPRISE

**THE FIRM IN THE KNOWLEDGE
ECONOMY**

“Ideas are everywhere, but knowledge is rare.”
„Ídées s̄le ealglaw̄re; r̄lf̄ k̄ow̄leq̄e s̄ rare.“

Thomas Sowell—*Knowledge & Decisions* (1980)

“It is a cliché that we live today in a knowledge economy.”
„Íf̄ s̄ a c̄l̄ch̄e f̄r̄at̄ w̄ē íl̄ē t̄oq̄al̄ ín̄ ā k̄ow̄leq̄ē ēōnōm̄í.“

John Kay—*Culture and Prosperity* (2005)

“Knowledge is our most powerful engine of production.”
„K̄ow̄leq̄ē s̄ ōn̄ íōst̄ p̄ow̄er̄f̄ul̄ ēn̄ḡí̄n̄ē ōf̄ p̄rōdūct̄íōn̄.“

Alfred Marshall—*Principles of Economics* (1890)

“... the boundaries of the firm are likely to be knowledge boundaries.”
„... f̄r̄ē r̄ōm̄p̄ar̄í̄es̄ ōf̄ f̄r̄ē f̄í̄m̄ s̄lē íl̄í̄k̄el̄ȳ t̄ō b̄ē k̄ow̄leq̄ē r̄ōm̄p̄ar̄í̄es̄.“

Kling—*Unchecked and Unbalanced* (2010)

“Information and knowledge are at the heart of organizational design ...”
„Í̄n̄f̄ōr̄m̄at̄íōn̄ s̄nd̄ k̄ow̄leq̄ē s̄lē āt̄ f̄r̄ē p̄ēar̄t̄ ōf̄ ōr̄ḡan̄íz̄at̄íōn̄al̄ d̄ēs̄í̄gn̄ ...“

Holmström and Roberts—*The Boundaries of the Firm Revisited* (1998)

Senior Supervisor



Professor Les Oxley
Λεσ Οξλεϋ

Supervisory team

Associate Supervisor



Associate Professor Alan Woodfield
Αλαν Ξοοδφιλδ

Acknowledgements

Thanks to my supervisory team of Les Oxley and Alan Woodfield. Thanks also to Andrea Menclova and Philip Gunby for (over)use of their whiteboards and to Andrea for the soon to be famous “Andrea Arrow”. Thanks are also owed to Vladimir Mencl and Stephen Hickson for the numerical evaluations in Appendix 3.

In addition thanks are due to Glenda Park who read and commented on Chapters 1 and 2 and improved the thesis in the process; despite hating it and to Ira for being “All Done”.

But most of all I thank the long suffering and much abused New Zealand taxpayer who had their money taken from them and given to me without their consent or knowledge. They may justifiably ask what they got, if anything, in exchange.

Published material

Section 1.1 and Appendix 1.A draw on material from Carlaw, Oxley, Walker, Thorns and Nuth (2006) and Oxley, Walker, Thorns and Wang (2008). A revised version of Chapter 2 appeared as Walker (2010).

A note on the method of numbering Tables and Figures

The system is to use two numbers $x.y$ where the first number, x , is the page on which the Table or Figure appears while the second number, y , is the number of the Table or Figure on that page. As an example, Figure 111.3 would be the third figure on page 111.

Abstract

The focus of the thesis is on the firm in the “knowledge economy”. A significant issue for the firm is the increasing importance of human capital in the knowledge economy and thus we examine the theory of the human-capital based firm. In the first section of the Introduction three questions are asked, What is a knowledge economy? How can we measure such an economy? and Can we know if we are in a new economy?, but only the last of them can be answered and only positively for the U.S. After this a brief survey of the theory of the firm literature is given. Chapter 2 argues that the current mainstream approaches to firm do not deal well with the human-capital based firm. Chapter 3 looks in more detail at the two extensions of the Grossman Hart Moore approach to modelling the human-capital based firm. The discussion centres on Brynjolfsson (1994) and Rabin (1993). An error in one of Rabin’s proofs is noted. As these papers are the mainstay of the orthodoxy approach to the human-capital based firm we discuss them in detail as a spring-board to developing a more satisfactory model of the human-capital based firm in the following chapters. Chapter 4 turns to a discussion of the more recent “reference point” approach to the firm. Chapter 5 attempts to apply the reference point approach to the human-capital based firm. Two models are developed. The first suggests that heterogeneity of preferences matters in determining the outcome when choosing between the use of independent contractors and employees. When preferences are homogeneous, the first best and the optimal level of co-ordination can be achieved. Here the scope of the firm is clear. In some cases the activities of the firm are undertaken in-house while in others an independent contractor is utilised. Heterogeneity of preferences results in outcomes, which include deadweight losses, being determined by both the sign and the size of the change in the benefits to the agents. Both under and over levels of co-ordination can occur. The scope of the firm is inconclusive. This suggests that the organisation of a human capital based firm depends on the “types” of human capital in the firm. Having a homogeneous group of human capital involved in a firm may well lead to a different organisational form than that found in a firm which involves a heterogeneous group of human capital. This issue is examined in the following section of the chapter. A model is developed in which the optimal organisational form is determined by two conditions: 1) a “Make-or-Buy” constraint which picks an independent contractor contract or an employment contract depending on which contractual type results in the optimal of two widgets being chosen and 2) if an employment contract is chosen then the owner of the integrated firm is whoever has the highest “aggrievement level”, and thus will “shade” the most. Some of the conclusions give conditions under which more than one of the possible organisational forms result in the efficient outcome. What the results of Chapter 5 suggest is that a human-capital only firm with heterogeneous human capital is likely to be unstable and thus a long lasting human-capital only firm will consist of homogeneous human capital. A firm which involves heterogeneous human capital will require some “glue”, in the form of non-human capital of some kind, to remain viable. Given the importance of this glue to the firm ownership of the firm by the owner of the non-human capital is likely. Chapter 6 is the conclusion.

JEL Classifications: D23, D86, L22.

Keywords: Theory of the firm, Contract theory, Reference point, Knowledge economy, New economy, Information economy, Human capital.

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Chapter 1

Introduction¹

“Capital consists in a great part of knowledge and organization; and of this some part is private property and other part is not. Knowledge is our most powerful engine of production; it enables us to subdue Nature and force her to satisfy our wants. Organization aids knowledge; it has many forms, e.g. that of a single business, that of various businesses in the same trade, that of various trades relatively to one another, and that of the State providing security for all and help for many. The distinction between public and private property in knowledge and organization is of great and growing importance: in some respects of more importance than that between public and private property in material things; and partly for that reason it seems best sometimes to reckon Organization apart as a distinct agent of production.”

Marshall (1920b) Book IV Chapter 1 page 115.

As Alfred Marshall makes clear, knowledge and organisation are important, interrelated, inputs to production. In fact, “[k]nowledge is our most powerful engine of production”. An engine which is aided by organisation. The aim of this thesis is to inquire into the relationship between knowledge and organisation. This inquiry will revolve around questions such as: What does the fact that we live in a ‘knowledge economy’ mean for business organisation? What does the ‘knowledge economy’ mean for the importance of human capital? How does human capital affect organisation?

In this Introduction we give short overviews of the literature on the knowledge economy and the theory of the firm as background to, and to give a context for, the rest of the thesis. We open with a survey of aspects of the literature on the knowledge economy in which two main questions are asked: What is a knowledge/information/new economy? and How can we measure such an economy? A third question, How can we know if we are in a new economy? is also briefly considered. The survey of the theory of the firm concentrates on the relevant aspects of the post-1970 literature on the firm since it was, roughly, 1970 when the currently dominate Coaseian approach to the theory of the firm began to take hold.² The most obvious exception to this rule

¹Section 1.1 and Appendix 1.A draw on material from Carlaw, Oxley, Walker, Thorns and Nuth (2006) and Oxley, Walker, Thorns and Wang (2008).

²This concentration on the post-1970 literature means a concentration on a literature which has a focus markedly different from that of the earlier mainstream theory. The theory of the firm for Ronald Coase, Oliver Williamson or Oliver Hart is a very different thing from that of Arthur Pigou, Lionel Robbins, Jacob Viner, Joan Robinson or Edward Chamberlin. To get a sense of the change that has occurred compare the survey article by Boulding (1942) with that of, for example, Holmström and Tirole (1989). The questions asked of the theory have changed from being about how the firm acts in the market, how it prices its outputs or how it combines its inputs,

is Appendix 1.B which reviews the two most important founding works for the current theory of the firm literature, Knight (1921b) and Coase (1937). The last section of the Introduction is an outline of the rest of the thesis.

1.1 the knowledge/information/new economy

John Kay makes the point that “[i]t is a cliché that we live today in a knowledge economy” (Kay 2005: 266).³ In recent years it has become common for politicians and commentators to argue that changes in technology, in particular information and communication technology (ICT), have become the major driver of economic growth.⁴ In the U.S. the then Assistant to the President for Science and Technology, Neal Lane, said in April 1999 that

“[t]he digital economy—defined by the changing characteristics of information, computing, and communications—is now the preeminent driver of economic growth and social change.” (Quoted in Brynjolfsson and Kahin 2000: 1).

In New Zealand the then Minister of Finance told the 2006 Association of University Staff (AUS) conference that his government’s aim was “a high income, knowledge based economy, which is both innovative and creative and provides a unique quality of life to all New Zealanders”. He went on to say, “the innovation that drives higher productivity comes from investment in science and technology; it comes from research and higher skill levels.” (Cullen 2006).

Many commentators argue that the effects of ICTs are so pervasive throughout the economy that we are now in a “new economy”. Alcaly (2003: 4), for example, argues that

“[. . .] much is new about this new economy, particularly its signature information technology, the broad combination of technical equipment and know-now that enables

to questions about the firm’s existence, boundaries and internal organisation. That is, there has been a movement away from the theory of the firm being seen as developing a component of price theory, namely issues to do with firm behaviour, to the theory being concerned with the firm as a subject in its own right. 1970 is a convenient, if not entirely accurate, break point between the two literatures since the modern (Coaseian) approach to the firm got under way with works such as Williamson (1971, 1973 and 1975), Alchian and Demsetz (1972), Jensen and Meckling (1976) and Klein, Crawford and Alchian (1978).

³Sometimes also called the new economy, the information economy, the digital economy or the weightless economy. See Appendix 1.A for a sample of definitions and characterisations of terminology frequently found in the knowledge economy literature.

⁴The effects of information technology on economic growth go back much further than our recent experience with ICTs. Dittmar (2010) looks at the effects of information technology, in the form of the printing press, on growth in 15th century Europe. He finds that, between 1500 and 1600, cities which adopted the printing press in late 1400s grew 60 percent faster than similar cities that did not.

us to process, store, and transmit information more efficiently. There have also been significant changes in the ways businesses operate, in the extent of trade and economic integration among nation—globalization—an in the influence and inventiveness of financial markets, including the stock and junk-bond markets.”

For Alcaly the new economy developed in response to pressures from the application of information technologies in conjunction with increased global competition, deregulation and financial innovation.

But what exactly have these pressures resulted in? What is this new economy? What is the knowledge economy? Or the information economy? How do they differ, if at all. Once we know what the new economy is we can ask the question, How do we measure it? The problem here is that there are at least as many answers to these questions as there are authors writing on them. Economists have presented a wide ranging set of definitions/characteristics of what they believe constitutes a knowledge economy and what drives it. Appendix 1.A outlines some examples of the multitude of characterisations of the “knowledge economy” and related terms. Clearly there is no coherent, generally accepted definition or characterisation of any of the terms commonly found in this literature. Smith (2002: 6-7) summarises succinctly the problem one faces with such attempts at definition:

“[w]hat does it mean to speak of the ‘knowledge economy’ however? At the outset, it must be said that *there is no coherent definition, let alone theoretical concept, of this term*: it is at best a widely-used metaphor, rather than a clear concept. The OECD has spoken of knowledge-based economies in very general terms, as meaning ‘those which are directly based on the production, distribution and use of knowledge and information’. This definition is a good example of the problems of the term, for it seems to cover everything and nothing: all economies are in some way based on knowledge, but it is hard to think that any are directly based on knowledge, if that means the production and distribution of knowledge and information products.”
(Emphasis added).

The idea that the industrial manufacturing society was starting to be transformed into an ‘information society’ was initiated by among others Peter Drucker (1959, 1969, 1994), Fritz

Machlup (1962), Daniel Bell (1973), Machlup and Kagann (1978) and Alvin Toffler (1980) and was part of a debate about the role of information and service workers within the changing economy of the time. In discussing Daniel Bell's 1973 book *The Coming of the Post-Industrial Society*, Rajan and Zingales (2003: 90) write,

“[h]e argued that the then incipient trend in developed economies of jobs moving from manufacturing to services would continue and that sectors like health care, education, and government, with skilled professional and technical workers, would displace sectors like manufacturing, with largely unskilled workers. All this has come to pass.”

By the 1970s the understanding of the changes taking place started to shift from information alone to a greater emphasis on knowledge. This occurred in the 1980s and 1990s at a time when the institutional environment was one of deregulation and liberalisation that encouraged government to dismantle border controls and other forms of economic regulation. The focus for economists was on the idea of Knowledge Based Economies (KBEs) which could be seen as concentrating on the changing role of knowledge in economic activity. For example the OECD defined a KBE as

“[e]conomies which are directly based on the production, distribution and use of knowledge and information.” (OECD 1996).

In the Asia-Pacific Economic Co-operation (APEC 2000) definition this is broadened somewhat to talk about how in such an economy all sectors are being reconstituted around a higher input of ‘knowledge’.

In a series of papers Quah (1999, 2002a, b) and Coyle and Quah (2002) suggest thinking of the new economy as a *weightless economy*. This terminology has not resulted in widespread adoption even though it has more concreteness than several other commonly used characterisations:

“[b]y the weightless economy, I mean that part of the economy comprising the following four categories:

1. Information and communications technology (ICT), including the Internet.
2. Intellectual property including not only patents and copyrights but more broadly, namebrands, trademarks, advertising, financial and consulting services, health

care (medical knowledge), and education.

3. Electronic libraries and databases, including new media, video entertainment, and broadcasting.
4. Biotechnology, which includes carbon-based libraries and databases, as well as pharmaceuticals.” (Quah 1999: 40-1).

For at least some of the authors on the new economy the central issue is the importance of digital technologies, the Internet, computers, information and the globalised networks such technologies enable. For Talero and Gaudette (1996),

“[. . .] the information economy is emerging where trade and investment are global and firms compete with knowledge, networking and agility on a global basis. A corresponding new society is also emerging with pervasive information capabilities that make it substantially different from an industrial society: much more competitive, more democratic, less centralized, less stable, better able to address individual needs, and friendlier to the environment.”

Widening the scope of what gets included is also being suggested, as in the recent work of the U.S. Progressive Policy Institute where they say

“[. . .] the New Economy is about the transformation of all industries and the overall economy. As such, the New Economy represents a complex array of forces. These include the reorganization of firms, more efficient and dynamic capital markets, more economic “churning” and entrepreneurial dynamism, relentless globalization, continuing economic competition, and increasingly volatile labor markets.” (Atkinson 2003: 4).

Given this lack of agreement on even the most basic of definitions, a question that arises is, How does all this help us in our attempt to understand what the knowledge economy is and whether it is fundamentally different from the past? Are we in any more of a knowledge society now than we were during Neolithic times, the Agricultural Revolution, the Renaissance or the Industrial Revolution?⁵ In the range of definitions highlighted in Appendix 1.A the majority ex-

⁵Moore and Lewis (1999: 17) write, “[o]ver the last twenty years a plethora of academics, management gurus and executives have proclaimed the dawning of a new economic age, a global knowledge economy. [. . .] Proponents of

explicitly or implicitly have a significant role for 'knowledge' in economic activity. But what should be noted is that historically this role for 'knowledge' is not fundamentally 'new'. Knowledge has played an important role in the 'economy' from the earliest times. When discussing the question, What happened to the Neanderthals? Tudge (1998: 25) argues

“[t]he Cro-Magnons [. . .] got to know the habits of the animals they hunted and knew where to lie in wait; and different bands shared information, so hunting parties could be forewarned of migrations days in advance.”

He goes on to say

“[m]ost importantly of all [. . .] the Cro-Magnons co-operated: that they traded tools - for which there is abundant evidence - and also traded information. Thus [. . .] the age of trade (and of information) is exceedingly ancient.” (Tudge 1998: 26).

In his discussion of the Gravettian culture which lasted in Upper Palaeolithic Europe from at least 29,000 years ago to around 21,000 years ago Finlayson (2009: 165) writes,

“[n]aturally people had to find ways of moving around without having to carry heavy loads; they also had to find ways of reading the land and of communicating with each other with precision. The Gravettians had entered the information age.”

He also notes the importance of information build-up and its relationship to population growth,

“[o]verall, Ancestors were displaying the adaptability and range of behaviours that has characterized their pre-glacial ancestors and also the Neanderthals. The main difference, and one that was to become increasingly evident as time went by, was that as populations increased in size and information networks became more sophisticated, these people had a corpus of accumulated knowledge that they could draw from. This process of information build-up became less vulnerable to loss as populations grew but at this stage was still not foolproof; the extinction of the knowledge and skills of the painters of western Europe shows us how precarious it remained.” (Finlayson 2009: 196).

this emerging new economy present this as an entirely new and modern phenomena. But is this the case? In this book we will argue that much of today's economic structures existed in prototype forms several thousand years ago.”

When discussing the economic and geographic expansion of the Upper Paleolithic population Ofek (2001: 173) writes

“Upper Paleolithic people apparently used local resources more efficiently than their predecessors - or their Neanderthal neighbors - if the latter still existed as a separate entity at the time (Klein, 1989). Such a sudden increase in the “wealth” of populations suggests a corresponding improvement in the allocation of resources in society, most likely, in my opinion, through the mechanisms of division of labor, exchange, and investment in the most consequential resource of all: *Human Capital* [...].” (Emphasis in the original).

So the argument that the knowledge economy is new, in a historical time sense, is not entirely convincing. Thus it can be asked, Is there anything ‘new’ in the new economy?

Foss (2002: 48) argues that there is:

“[w]hatever we think of this journalistic concept [of the Knowledge Economy], it arguably does capture real tendencies and complementary changes.”

What might these ‘new’ tendencies be?

“We define the knowledge economy as production and services based on knowledge-intensive activities that contribute to an accelerated pace of technical and scientific advance, as well as rapid obsolescence. The key component of a knowledge economy is a greater reliance on intellectual capabilities than on physical inputs or natural resources, combined with efforts to integrate improvements in every stage of the production process, from the R&D lab to the factory floor to the interface with customers.” (Powell and Snellman 2004: 201).

For Rooney et al., (2003: 16)

“[...] the term knowledge economy [is taken] to mean that part of the economy that creates wealth essentially through intellectual activity [...]”

Harris (2001: 22) argues

“[...] that economic wealth is created through the creation, production, distribution and consumption of knowledge and knowledge-based products.”

For David and Foray (2002: 21)

“[t]he crux of the issue lies in the accelerating (and unprecedented) speed at which knowledge is created, accumulated and, most probably, will depreciate. This trend has resulted inter alia in intense scientific and technological progress.”

Here the ‘modern’ emphasis seems to be on ‘knowledge’, ‘accelerated technical and scientific advance’ and ‘greater reliance on intellectual capabilities than physical inputs or natural resources’. Under this interpretation the ‘knowledge economy’ is primarily concerned with knowledge as an input to production and the value of intellectual labour in the creation of wealth. This point about the growing reliance on intellectual labour as the creator of wealth is important for the theory of the firm in the knowledge economy. It is this that makes the human capital based firm increasingly important for the modern economy.⁶ In a knowledge economy the wealth of a company is increasingly embodied in its creativity and information and thus human capital is replacing inanimate assets as the most important source of corporate capabilities and value.

However this is not the only possible interpretation of the knowledge economy. As Appendix 1.A makes clear there are many, sometimes conflicting, definitions of a knowledge economy. One problem that follows from this lack of an agreed upon characterisation of a knowledge economy is that it is not clear how to measure such an economy.

This lack of a commonly accepted definition is just one of the substantial challenges to be overcome in any attempt to measure the knowledge economy. These are at both the theoretical and the method level. A more consistent set of definitions are required as are more robust measures that are derived from theory rather than from whatever data is currently or conveniently available. In order to identify the size and composition of the knowledge based economy one inevitably faces the issue of quantifying its extent and composition. Economists and national statistical organisations are naturally drawn to the workhorse of the ‘System of National Accounts’ as a source of such data. Introduced during World War II as a measure of wartime production capacity, the change in (real) Gross Domestic Product (GDP) has become widely used as a measure of economic growth. However, GDP has significant difficulties in interpreta-

⁶Not that human capital has not been important in the past. For example, Meisenzahl and Mokyr (2011) discuss why the industrial revolution began in the U.K. and argue that one advantage the British had was a supply of highly skilled, mechanically able craftsmen who were able to adapt, implement, improve, and tweak new technologies and who provided the micro inventions necessary to make macro inventions highly productive and remunerative.

tion and usage (especially as a measure of wellbeing) which has led to the development of both ‘satellite accounts’ - additions to the original system to handle issues such as the ‘tourism sector’; ‘transitional economies’ and the ‘not-for-profit sector’ - and alternative measures, for example, the Human Development Index⁷ and Gross National Happiness⁸. GDP is simply a gross tally of products and services bought and sold, with no distinctions between transactions that add to wellbeing, and those that diminish it. It assumes that every monetary transaction adds to wellbeing, by definition. Organisations like the Australian Bureau of Statistics and the OECD have adopted certain implicit/explicit definitions, typically of the Information Economy-type, and mapped these ideas into a strong emphasis on impacts and consequences of ICTs. The website (<http://www.oecd.org/sti/information-economy>) for the OECD’s Information Economy Unit states that it:

“[...] examines the economic and social implications of the development, diffusion and use of ICTs, the Internet and e-business. It analyses ICT policy frameworks shaping economic growth productivity, employment and business performance. In particular, the Working Party on the Information Economy (WPIE) focuses on digital content, ICT diffusion to business, global value chains, ICT-enabled off shoring, ICT skills and employment and the publication of the OECD Information Technology Outlook.”

Furthermore, the OECD’s Working Party on Indicators for the Information Society has

“[...] agreed on a number of standards for measuring ICT. They cover the definition of industries producing ICT goods and services (the “ICT sector”), a classification for ICT goods, the definitions of electronic commerce and Internet transactions, and model questionnaires and methodologies for measuring ICT use and e-commerce by businesses, households and individuals. All the standards have been brought together in the 2005 publication, Guide to Measuring the Information Society [...]” (http://www.oecd.org/document/22/0,3343,en_2649_201185_34508886_1_1_1_1,00.html).

⁷See <http://hdr.undp.org/en/statistics/hdi/>.

⁸See <http://www.grossnationalhappiness.com/>.

The whole emphasis is on ICTs. For example, the OECD's "Guide to Measuring the Information Society" has chapter headings that show that their major concern is with ICTs. Chapter 2 covers ICT products; Chapter 3 deals with ICT infrastructure; Chapter 4 concerns ICT supply; Chapter 5 looks at ICT demand by businesses; while Chapter 6 covers ICT demand by households and individuals.

As will be shown below several authors have discussed the requirements for, and problems with, the measurement of the knowledge/information economy. As noted above most of the data on which the measures of the knowledge economy are based comes from the national accounts of the various countries involved. This does raise the question as to whether or not the said accounts are suitably designed for this purpose. There are a number of authors who suggest that in fact the national accounts are not the appropriate vehicle for this task. Peter Howitt argues that:

"[...] the theoretical foundation on which national income accounting is based is one in which knowledge is fixed and common, where only prices and quantities of commodities need to be measured. Likewise, we have no generally accepted empirical measures of such key theoretical concepts as the stock of technological knowledge, human capital, the resource cost of knowledge acquisition, the rate of innovation or the rate of obsolescence of old knowledge." (Howitt 1996: 10).

Howitt goes on to make the case that because we can not measure correctly the input to and the output of, the creation and use of knowledge, our traditional measure of GDP and productivity give a misleading picture of the state of the economy. Howitt further claims that the failure to develop a separate investment account for knowledge, in much the same manner as we do for physical capital, results in much of the economy's output being missed by the national income accounts.

In Carter (1996) six problems in measuring the knowledge economy are identified:

1. The properties of knowledge itself make measuring it difficult,
2. Qualitative changes in conventional goods: the knowledge component of a good or service can change making it difficult to evaluate their 'levels of output' over time,

3. Changing boundaries of producing units: for firms within a knowledge economy, the boundaries between firms and markets are becoming harder to distinguish,
4. Changing externalities and the externalities of change: spillovers are increasingly important in an knowledge economy,
5. Distinguishing ‘meta-investments’ from the current account: some investments are general purpose investments in the sense that they allow all employees to be more efficient,
6. Creative destruction and the ‘useful life’ of capital: knowledge can become obsolete very quickly and as it does so the value of the old stock drops to zero.

Carter argues that these issues result in it being problematic to measure knowledge at the level of the individual firm. This results in it being difficult to measure knowledge at the national level as well since the individual firms’ accounts are the basis for the aggregate statistics and thus any inaccuracies in the firms’ accounts will compromise the national accounts.

Haltiwanger and Jarmin (2000) examine the data requirements for the better measurement of the information economy. They point out that changes are needed in the statistical accounts which countries use if we are to deal with the information/knowledge economy. They begin by noting that improved measurement of many “traditional” items in the national accounts is crucial if we are to understand fully Information Technology’s (IT’s) impact on the economy. It is only by relating changes in traditional measures such as productivity and wages to the quality and use of IT that a comprehensive assessment of IT’s economic impact can be made. For them, three main areas related to the information economy require attention:

1. The investigation of the impact of IT on key indicators of aggregate activity, such as productivity and living standards,
2. The impact of IT on labour markets and income distribution and
3. The impact of IT on firm and on industry structures.

Haltiwanger and Jarmin outline five areas where good data are needed:

1. Measures of the IT infrastructure,
2. Measures of e-commerce,

3. Measures of firm and industry organisation,
4. Demographic and labour market characteristics of individuals using IT, and
5. Price behaviour.

In Moulton (2000) the question is asked as to what improvements we can make to the measurement of the information economy. In Moulton's view additional effort is needed on price indices and better concepts and measures of output are needed for financial and insurance services and other "hard-to-measure" services. Just as serious are the problems of measuring changes in real output and prices of the industries that intensively use computer services. In some cases output, even if defined, is not directly priced and sold but takes the form of implicit services which at best have to be indirectly measured and valued. How to do so is not obvious. In the information economy, additional problems arise. The provision of information is a service which in some situations is provided at little or no cost via media such as the web. Thus on the web there may be less of a connection between information provision and business sales. The dividing line between goods and services becomes fuzzier in the case of e-commerce. When Internet prices differ from those of brick-and-mortar stores do we need different price indices for the different outlets? Also the information economy may affect the growth of Business-to-Consumer sales, new business formation and in cross-border trade. Standard government surveys may not fully capture these phenomena. Meanwhile the availability of IT hardware and software results in the variety and nature of products being provided changing rapidly. Moulton also argues that the measures of the capital stock used need to be strengthened, especially for high-tech equipment. He notes that one issue with measuring the effects of IT on the economy is that IT enters the production process often in the form of capital equipment. Much of the data entering inventory and cost calculations are rather meagre and needs to be expanded to improve capital stock estimates. Yet another issue with the capital stock measure is that a number of the components of capital are not completely captured by current methods, an obvious example being intellectual property. Also research and development and other intellectual property should be treated as capital investment though they currently are not. In addition to all this Moulton argues that the increased importance of electronic commerce means that the economic surveys used to capture its effects need to be expanded and updated.

In Peter Howitt's view there are four main measurement problems for the knowledge economy:⁹

1. The "knowledge-input problem". That is, the resources devoted to the creation of knowledge are underestimated by standard measures.
2. The "knowledge-investment problem". The output of knowledge resulting from formal and informal R&D activities is typically not measured.
3. The "quality improvement problem". Quality improvements go unmeasured.
4. The "obsolescence problem". No account is taken of the depreciation of the stock of knowledge (and physical capital) due to the creation of new knowledge.

To deal with these problems Howitt makes a call for better data. But it's not clear that better data alone is the answer, to both Howitt's problems and the other issues outlined here. Without a better theory of what the "knowledge economy" is and the use of this theory to guide changes to the whole national accounting framework, it is far from obvious that much improvement can be expected in the current situation.

One simple question is, To which industry or industries and/or sector or sectors of the economy can we tie knowledge/information production? When considering this question several problems arise. One is that the "technology" of information creation, transmission and communication pervades all human activities so cannot fit easily into the national accounts categories. It is language, art, shared thought, and so on. It is not just production of a given quantifiable commodity. Another issue is that because ICT exists along several different quantitative and qualitative dimensions production can not be added up. In addition if much of the knowledge in society is tacit, known only to individuals, then it may not be possible to measure in any meaningful way. Also if knowledge is embedded in an organisation via organisational routines¹⁰ then again it may not be measurable. Organisational routines may allow the knowledge of individual agents to be efficiently aggregated, much like markets aggregate information, even though no one person has a detailed understanding of the entire operation. In this sense, the organisation "possesses" knowledge which may not exist at the level of the individual member

⁹See Howitt (1996).

¹⁰See Becker (2004) for a review of this literature.

of the organisation. Indeed if, as Hayek can be interpreted as saying, much of the individual knowledge used by the organisation is tacit, it may not even be possible for one person to obtain the knowledge embodied in a large corporation.¹¹

As noted above Carter (1996) emphasises that it is problematic to measure knowledge at the national level in part because it is difficult to measure knowledge at the level of the individual firm. Part of the reason for this is that none of the orthodox theories of the firm offer us a theory of the “knowledge firm” which is needed to guide our measurement. This inability of orthodox theories of the firm to provide a theory of the “knowledge firm” will be discussed in detail in Chapter 2.

A question that arises from the fact that we can not define or measure the new economy is, Despite this can we know that we are in a new economy? Alcala (2003: 20) says yes:

“[w]hatever else we might wish it were, a new economy is one that has changed significantly through the adoption of innovative new technologies and business practices, leading to a meaningful and sustainable increase in the rate of productivity growth.”

Productivity seems to be the key. Robert Solow famously quipped in a 1987 review of the book “Manufacturing Matters: The Myth of the Post-Industrial Economy” that: “[y]ou can see the computer everywhere but in the productivity statistics” (Solow 1987: 36),¹² a remark that has given rise to what is often called the “Solow productivity paradox”. Post-1995 the effects of computers finally showed up in the U.S. productivity statistics. For the U.S. the paradox seemed resolved.¹³

¹¹Consider Hayek (1937, 1945).

¹²Dittmar (2010) also suggests that technological innovation can take time to affect productivity but over time this effect can be large. The conclusion to the paper reads: “Economists have found no evidence that the printing press was associated with increases in productivity at the macroeconomic level. Some have concluded that the economic impact of the printing press was limited. This paper exploits city level data on the diffusion and adoption of the printing press to examine the technology’s impact from a new perspective. The estimates presented here show that cities that adopted the printing press in the late 1400s [the technology was developed around 1450] enjoyed no growth advantages prior to adoption, but grew at least 20 percentage points – and as much as 80 percentage points – more than similar cities that did not over the period 1500-1600. These estimates imply that the impact of printing accounted for at least 18 and as much as 80 percent of European city growth between 1500 and 1600. Cities that were early adopters of the printing press maintained a substantial growth advantage even over the three hundred years running 1500-1800. Even 1500-1800, print accounted for somewhere between 5 and 45 percent of city growth.

Between 1500 and 1800, European cities were seedbeds of the ideas, activities, and social groups that launched modern, capitalist economic growth. The findings in this paper suggest that movable type print technologies had very substantial effects in European economic history through their impact on cities.” (Dittmar 2010: 28).

¹³For discussions of the reasons for the growth in productivity in the late 1990s in the U.S. see Baily (2002), *The Economic Report of the President* (Council of Economic Advisers, 2001), Oliner and Sichel (2000) and Jorgenson and Stiroh (2000). For a retrospective look at U.S. productivity growth see Jorgenson, Ho and Stiroh (2008).

“It [productivity growth in the United States] finally began to pick up after 1995, rising over the next five years at a rate of more than 2.5 percent a year, almost twice as fast as its pace between 1973 and 1995 and within striking distance of the rates achieved during the golden age of 1948-1973. The surge during the last half of the 1990s raised the average growth rates of productivity and living standards for the entire decade to roughly 2 percent a year, about the same as for the century as a whole.” (Alcaly 2003: 37-8)

FIGURE 2. U.S. Productivity Growth, January 1948 Through September 2002

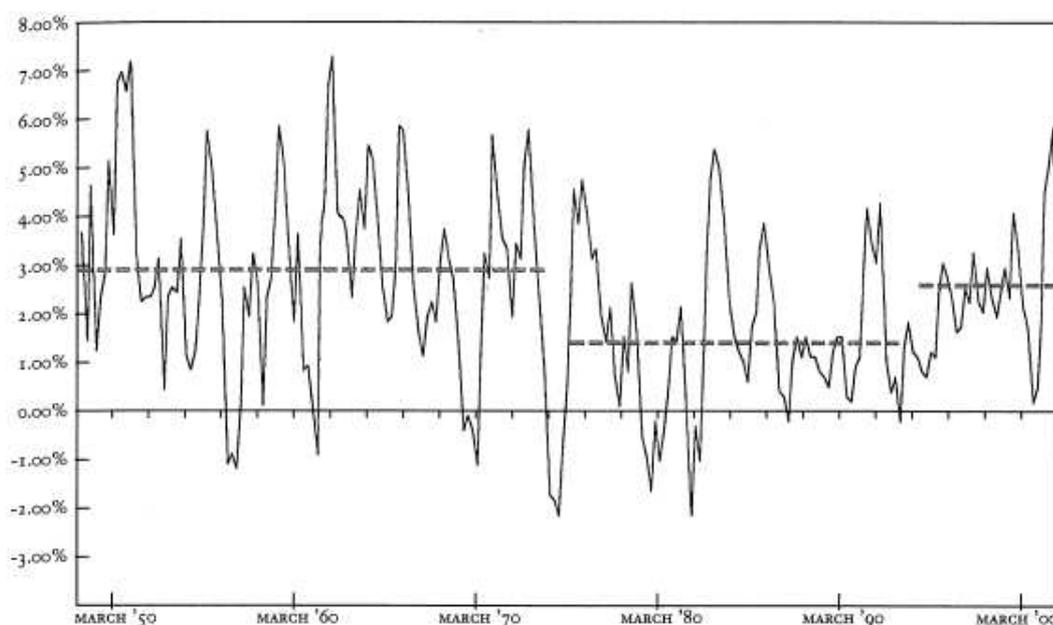


Figure 2, which is reproduced above, is taken from Alcaly (2003: 39) and it shows U.S. productivity growth for the period January 1948 through September 2002. For each quarter of a year Figure 2 shows the annual percentage change in output per hour from the corresponding quarter of a year earlier with the average rates of productivity growth (horizontal lines) shown for the subperiods 1948-73 (2.9 percent), 1974-1995 (1.4 percent) and 1996 to the third quarter of 2002 (2.6 percent). Coyle (2001: 27) explains that “[...] the improvement [in U.S. productivity growth in the late 1990s] came mainly from greater use of information technology and greater efficiency in its production. Average U.S. growth climbed from 2.75 percent in 1991-95 to 4.82

percent in 1996-99. Of this two-point improvement, 0.5 point come from growth in the input of information-technology capital, 0.9 from other capital and labor input, and 0.6 from increased growth in total factor productivity. The contribution to growth from this measure of technical progress shot up from 0.48 percent a year in the early 1990s to 1.16 percent in the second half of the decade.” So around two-thirds of the mid-to-late-90s acceleration in productivity growth was due to investment in computers, software, networks infrastructure etc along with efficiency gains in the production of computer equipment and semiconductors. By 1996 the new economy had finally arrived. For the U.S. at least.¹⁴

But wherever the acceptance of the new economy went scepticism about the causes of the productivity increases was soon to follow. Robert Gordon is one who argues that by themselves computers could not match the effects of the innovations of the past which involved a cluster of new technologies being developed contemporaneously. As an example he points to the combination of innovations which occurred over the period 1860-1900 and resulted in developments such as electricity, air and motor transport, radio and movies and indoor plumbing.¹⁵

As to the reasons for the apparently small effects and slow appearance of the new economy, in the aggregate data, Coyle (2007: 60-1) offers three observations:¹⁶

“[t]here are several responses to the argument that computers have not been very important for growth. One is that measuring the impact of steam or electricity in exactly the same way as the impact of computers is measured (using the growth accounting described above), you find that steam and electricity look pretty small too: a “small” percentage point difference in growth rates is the statistical footprint of a large economic and social change (Crafts 2004). [. . .] A second is that any radical innovation takes a long time to have measurable aggregate impact because people take many years to adjust: perhaps new infrastructure must be built, new skills

¹⁴The productivity surge is not worldwide. As Robert Gordon notes Europe has not followed the U.S. in having a post 1995 productivity increase, “[. . .] since 1995 Europe has experienced a productivity growth slowdown while the United States has experienced a marked acceleration. As a result, just in the past eight years, Europe has already lost about one-fifth of its previous 1950-95 gain in output per hour relative to the United States. Starting from 71 percent of the U. S. level of productivity in 1870, Europe fell back to 44 percent in 1950, caught up to 94 percent in 1995, and has now fallen back to 85 percent.” (Gordon 2007: 176). van Ark, O’Mahony, and Timmer (2008) see the growing productivity gap resulting from the slower emergence of the knowledge economy in Europe compared to the U.S. Bartelsman, Gautier and de Wind (2010) argues that part of the reason for the lower uptake of ICTs in Europe is due to its stricter employment protection legislation.

¹⁵See Gordon (1999, 2000). Also see Coyle (2001: 28-34).

¹⁶Also see Box 1, Pilat (2004b: 43-4).

learned, workplaces reorganized (David 1991). Indeed, many people have an incentive to resist innovations. As Niccolò Machiavelli put it in *The Prince*, “Innovation makes enemies of all those who prospered under the old regime, and only lukewarm support is forthcoming from those who would prosper under the new.” And, lastly, although popular attention has focused on computers, there *is* a cluster of new technologies today, including biotechnology, new materials, and nanotechnology. Their combined impact on our well-being is likely to be just as profound as the cluster of technologies introduced around the start of the twentieth century.”

Interestingly, unlike the macro-level data, micro-level data provides little evidence in support of Solow’s productivity paradox.¹⁷ Pilat (2004a: 11) explains “[s]tudies with firm-level data often find the strongest evidence for economic impacts of ICT.” Recent research on the productivity paradox based on firm-level data suggests that ICT use is beneficial to firm performance and productivity, even for industries and countries where there is no evidence at the more aggregate levels. This result holds for all countries in which micro-level studies have been carried out. For example, Hempell, Van Leeuwen and Van Der Wiel (2004) found that ICT capital deepening increased labour productivity in services firms in Germany and the Netherlands. A close correlation between labour productivity and ICT use was found for Swiss firms by Arvanitis (2004). Maliranta and Rouvinen (2004) looked at ICT use in Finland and concluded there are productivity-enhancing effects associated with ICTs. Baldwin, Sabourin and Smith (2004) found that greater use of ICTs was associated with higher labour productivity growth in the nineties for Canada. Clayton et al (2004) analysed U.K. data and found a positive effect on labour productivity and multi-factor productivity associated with the exploration of computer networks for trading. U.S. data was used by Atrostic and Nguyen (2002) to demonstrate that average labour productivity was higher in plants with computer networks with labour productivity being around 5 percent higher for such plants.

But the evidence also suggests that turning investment in ICT into higher productivity is not a forgone conclusion and that to do so requires complementary investments and changes in areas such as human capital, organisational change and innovation. Countries which better support a

¹⁷See Pilat (2004b) for greater discussion of the results of micro data studies relevant to the productivity paradox.

process of creative destruction, with successful firm growing and failing firm disappearing, are better able to seize the advantages of ICTs.

Pilat (2004b: 56-8) argues there are six reasons why we find a productivity paradox in the aggregate data but do not see it in the micro-level data:¹⁸

“[f]irst, aggregation across firms and industries, as well as the effects of other economic changes, may disguise the impacts of ICT in sectoral and aggregate analysis. This is also because the impacts of ICT depend on other factors and policy changes, which may differ across industries. The size of the aggregate effects over time depends on the rate of development of ICT, their diffusion, lags, complementary changes, adjustment costs and the productivity-enhancing potential of ICT in different industries (Gretton et al., 2004). Disentangling such factors at the aggregate or industry level is not straightforward.

Second, the firm-level benefits of ICT in many OECD countries may not yet be large enough to translate into better outcomes at the aggregate level. The firm-level benefits may be larger in the United States (and possible also in Australia) than in other OECD countries, and thus show up more clearly in aggregate and sectoral evidence. For example, Haltiwanger et al. (2003) suggest that the impacts of ICT are smaller in Germany than in the United States. Given the more extensive diffusion of ICT in the United States, and its early start, this interpretation should not be surprising. This is particularly the case if it takes time before the benefits from ICT become apparent, e.g. because of high costs of adjustment to the new technology. Moreover, the conditions under which ICT is beneficial to firm performance, such as having sufficient scope for organisational change or process innovation, might be more firmly established in the United States than in many other OECD countries. Small firm-level benefits in most OECD countries might thus lead to relatively small productivity benefits at the aggregate level.

Third, firms that are successful in implementing ICT may be better able to gain market share and grow in a competitive market such as the United States than in less competitive markets. This would contribute to greater overall impacts of ICT

¹⁸See also Pilat (2004a: 14-5).

in the United States. For example, some of pick-up in US productivity growth over the second half of the 1990s can be attributed to the growth in market share of Wal-Mart, a company that replaced many less efficient retailers, partly owing to its effective use of ICT throughout the value chain. If the most efficient firms in Europe find it difficult to expand and gain market share, even if they do benefit from ICT, the overall impacts on productivity might be more limited than in the United States.

Fourth, measurement may play a role. The impacts of ICT may be insufficiently picked up in macroeconomic and sectoral data outside the United States, due to differences in the measurement of output. For example, the United States is one of the few countries that have changed the measurement of banking output to reflect the convenience of automated teller machines. Since services sectors are the main users of ICT, inadequate measurement of service output might be a considerable problem.

Fifth, countries outside the United States may not yet have benefited from spill-over effects that could create a wedge between the impacts observed for individual firms and those at the macroeconomic level. The discussion above has already suggested that the impacts of ICT may be larger than the direct returns flowing to firms using ICT. For example, ICT may lower transaction costs, that can improve the functioning of markets (by improving the matching process), and make new markets possible. Another effect that can create a gap between firm-level returns and aggregate returns is ICTs impact on knowledge creation and innovation. ICT enables more data and information to be processed at a higher speed and can thus increase the productivity of the process of knowledge creation. A greater use of ICT may thus gradually improve the functioning of the economy. Such spill-over effects may already have shown up in the aggregate statistics in the United States, but not yet in other countries.

Finally, the state of competition may also play a role in the size of spill-over effects. In a large and highly competitive market, such as the United States, firms using ICT may not be the largest beneficiaries of investment in ICT. Consumers may extract a large part of the benefits, in the form of lower prices, better quality, improved convenience, and so on. In other cases, firms that are upstream or downstream in the

value chain from the firms using ICT might benefit from greater efficiency in other parts of the value chain. In countries with a low level of competition, firms might be able to extract a greater part of the returns, and spill-over effects might thus be more limited.”

1.1.1 summary

Of the three questions asked above, What is a knowledge economy? How can we measure such an economy? and How can we know if we are in a new economy?, only one of them can be answered with any degree of reliability. The aggregate U.S. productivity data do suggest that something changed in the mid-1990s as the U.S. finally saw ‘the computer everywhere *including* the productivity statistics’. This does raise the issue as to why we can answer the third question without answering the first two. The third question is an empirical one for which data is available. However while this macro level data can tell us that something has changed, it can not tell us what changed and why. The productivity data is the aggregated result of changes at the micro level, in this case at the level of the firm. Such changes require a microeconomic explanation. Without an understanding of the firm level effects of changes in the importance of knowledge/information in the production process we will be unable to fully characterise the knowledge economy and thus will be unable to measure it correctly.

In light of the issues discussed in the previous section, it would seem that a necessary first step along the path towards the correct measurement of the knowledge economy would entail the development of a theory of the knowledge economy. Such a theory would tell us, among other things, what the knowledge economy is, how it changes and grows, and what its important measurable characteristics are. Based on this, a measurement framework could be developed to deal with, at least some of, the problems outlined above.

The inability to characterise the knowledge economy and the inability to measure it are the two sides of the same coin. To measure the knowledge economy we first require a theory of the knowledge economy to guide the measurement. Without such a theory we are in a world of ‘measurement without theory’ as Koopmans put it.¹⁹ Much of what currently passes for measurement of the knowledge economy is based not on a rigorous theory of the knowledge

¹⁹See for example Koopmans (1947).

economy, which determines what should be measured and how it should be measured, but more on whatever data is convenient and available. This approach greatly limits the value of research on the knowledge economy, of any conclusions it might reach, as well as offering little in the way of guidance to policy makers. It has led to a debate which is characterised by confusing definitions and underdeveloped theorising. This debate has failed to adequately distinguish between the changing role of information within contemporary economies associated with the rise of new communication technologies, the place of knowledge as a component within economic production linked to the shift to human capital as the key cause of innovation and change, and the effect of this on the ‘knowledge firm’.

1.2 the firm²⁰

While the theory of the firm has existed for only 70-80 years, in practice ‘firms’ have existed for several thousand years.^{21,22} Silver (1995: 50) notes that

²⁰For much more complete surveys of the literature on the theory of the firm see, in chronological order, Boulding (1942), Papandreou (1952), Cyert and March (1963: chapter 2), Machlup (1967), Cyert and Hedrick (1972), Milgrom and Roberts (1988), Tirole (1988: 15-61), Hart (1989), Holmström and Tirole (1989), Borland and Garvey (1994), Holmström and Roberts (1998), Foss (2000), Foss, Lando and Thomsen (2000), Khachatryan (2003), Gibbons (2005), Mahoney (2005), Menard (2005), Foss and Klein (2008), Aghion and Holden (2011), Hart (2011b) and Zenger, Felin and Bigelow (2011). For surveys of the empirical literature see Joskow (1988), Shelanski and Klein (1995), Vannoni (2002), Klein (2005), Lafontaine and Slade (2007) and Hubbard (2008). One approach to the firm largely missing from these surveys is the Austrian approach to the firm. Since the 1990s there has emerged a small Austrian literature on the firm, see for example Dulbecco and Garrouste (1999), Ioannides (1999), Witt (1999), Yu (1999), Lewin and Phelan (2000), Sautet (2000), Bylund (forthcoming) and Jankovic (2010). For general discussions of this literature see Foss (1994, 1997b), Langlois (2007), Foss and Klein (2009, 2010) and Klein (2010). A topic ignored here is the multinational firm. For an overview see Barba Navaretti et al (2004). On the relationship between the theory of the firm and entrepreneurship see Foss, Klein and Bylund (2011). For an overview of research into the growth of firms see Coad (2007, 2009). From business history comes Alfred D. Chandler’s classic works on the origins of the modern large-scale business enterprise, Chandler (1962, 1977, 1990). Another issue ignored here is corporate finance. On this see Tirole (2006).

²¹Spulber (2008: 5, footnote 8) gives the origin of the word ‘firm’ as “[t]he word ‘firm’ derives from the Latin word ‘firmare’ referring to a signature that confirmed an agreement by designating the name of the business.”

²²The first existence of a firm becomes especially problematic if we consider a farm to be a firm. Farming is an ancient human activity. “The first clear evidence for activities that can be recognized as farming is commonly identified by scholars as at about 12,000 years ago [...]” (Barker 2006: 1). Tudge (1998: 3) writes “I want to argue that from at least 40,000 years ago – the late Palaeolithic – people were managing their environments to such an extent that they can properly be called ‘proto-farmers.’” At what historical point did the farm first become a firm? If we accept production for others as an important characteristic of the firm then farms can be seen (at least partially) as firms from a very early stage. Ofek (2001: chapter 13) argues that agriculture developed with a symbiotic relationship with exchange/trade. There is a conflict between the fact that we specialise in production but diversify in consumption. This conflict is reconciled by redistribution, i.e. via exchange/trade. Ridley (2010: 127-30) argues there would be no farming without trade, that trade was a precursor to farming. “One of the intriguing things about the first farming settlement is that they also seem to be trading towns. [...] it is a reasonable guess that one of the pressures to invent agriculture was to feed and profit from wealthy traders – to generate surplus that could be exchanged for obsidian, shells or other more perishable goods. Trade come first.” (Ridley 2010: 127). Spulber (2009: 103) argues that the early farms were not firms. He writes that farms “from the earliest times to the eighteenth century are precursors to the contemporary firms. What distinguishes these economic actors from firms in that their enterprises tended to be integrated with the personal economic

“[p]rivate firms (*bītātu*) were prominent in late-third-millennium Akkad (the region south of Baghdad), in the Old Assyrian trade with Cappadocia [. . .] and, somewhat later, at Nippur. In the mid-second millennium the firm of Tehip-tilla played a major role in the real estate transactions and other business activities at Nuzi. A list of about the same time from Alalakh in northwest Syria refers to sixty-four firms participating in leatherworking, jewelry, and carpentry.”

Sobel (1999: 21) points out that during the Roman Republic contracting out of economic activities to private firms was the norm:

“[t]he republican Senate left virtually all economic activities to private individuals and companies, known collectively as the *publicani*. Tax collection, supplying the army, providing for religious sacrifices and ceremonies, building construction and repair, mining, and so on were all contracted out. There was even a contract for summoning the assembly in session and one for feeding the sacred geese.”

Micklethwait and Wooldridge (2003b: 4) also note the private nature of tax collection in Rome, pointing out that companies were formed for this, and other purposes:²³

“[t]he *societates* of Rome, particularly those organized by tax farming *publicani*, were slightly more ambitious affairs. To begin with, tax collecting was entrusted to individual Roman knights; but as the empire grew, the levies became more than any one noble could guarantee, and by the Second Punic War (218-202 b.c.), they began to form companies – *societates* – in which each partner had a share. These firms also found a role as the commercial arm of conquest, grinding out shields and swords for the legions. Lower down the social scale, craftsmen and merchants gathered together to form guilds (*collegia* or *corpora*) that elected their own managers and were supposed to be licensed.”

And some of these ancient firms were of reasonable size. Silver (1995: 66-7) notes,

affairs of the entrepreneur. There was no separation between the owner’s commercial activities and their personal consumption activities.”. See footnote 46, page 39, for more on Spulber’s approach to the firm.

²³For a brief discussion of the forms that firms could take in ancient Rome see Hansmann, Kraakman and Squire (2006: 1356-64).

“[w]e may note here that during the Ur III period a new mill at Girsu required the services of 679 women and 86 men (Maekawa 1980: 98).”

and

“[a] number of cities possessed large workshops employing hundreds of women in spinning and weaving. For example, a late-third-millennium text from Eshnunna lists 585 female and 105 male employees in a weaving house.” (Silver 1995: 143).

Ancient firms also diversified their activities.

“Large commercial houses flourished in Babylonia from the seventh to the fourth century. The House of Egibi, for example, bought and sold houses, fields, and slaves, took part in domestic and international trade, and participated in a wide variety of banking activities.

[...]

Earlier, in the late third-millennium Sumer, the rulers and governors controlled vertically integrated firms that used wool of the sheep they raised in their weaving workshops. At the same time, an Umma businessman (- bureaucrat?) named Ur-e-e busied himself with manifold operations, including raising livestock; transactions involving cheese, oil, leather, carcasses, wool; the weaving and finishing of cloth; shipments by boat of fish and grain; and even the construction of boats.” (Silver 1995: 67).

The firm, it appears, is such an old and obvious feature of the economic landscape that it has tended to be overlooked by economic theorists. The dichotomy between theory and practice could not be more stark.

This does raise the obvious question as to why economists ignored the firm for so long.²⁴ One reason for the firm to be overlooked is that for a long time economists saw the internal workings of the firm to be outside the competence of economists. Arthur Pigou wrote:

²⁴As to why the firm was ignored in Austrian economics Witt (1999: 108) writes, “[t]he neglect of the firm as the organizational form of an entrepreneurial venture has a tradition in Austrian economics. It may be traced back to a characteristic of the scientific community in the German language countries. There, economic theory (Volkswirtschaftslehre) and business economics (Betriebswirtschaftslehre) were institutionally segregated as early as at the turn of the century to a degree still unknown today in the Anglo Saxon world. As Lachmann once conjectured, Austrian writers therefore considered the organizational form of entrepreneurial activities to be a topic best left to their business economics fellows.”

“[. . .] it is not the business of economists to teach woollen manufacturers to make and sell wool, or brewers how to make and sell beer, or any other business men how to do their job. If that was what we were out for, we should, I imagine, immediately quit our desks and get somebody - doubtless at a heavy premium, for we should be thoroughly inefficient - to take us into his woollen mill or his brewery.” (Pigou 1922: 463-4).

Lord Robbins argued similarly, in that

“[t]he technical arts of production are simply to be grouped among the *given* factors influencing the relative scarcity of different economic goods. The technique of cotton manufacture [. . .] is no part of the subject-matter of Economics [. . .]” (Robbins 1935: 33).

Foss and Klein (2005: 6-7) argue that there is the possibility of an empirical reason for the neglect of the firm; the relative unimportance of the firm. Until relatively recently firms were simply not a large part of the economy. But they also point out that such an explanation is not wholly convincing. Large firms²⁵ have existed since at least the time of Adam Smith and the classical economists knew this. A more precise, and more defensible, version of the argument

²⁵Mokyr (2002: 122-3) summarises manufacturing in the U.K. before the Industrial Revolution by noting that “[. . .] large plants were not entirely unknown before the Industrial Revolution. For instance, Pollard (1968) in his classic work on the rise of the factory, mentions three large British plants, each employing more than 500 employees before 1750. Perhaps the most “modern” of all industries was silk throwing. The silk mills in Derby built by Thomas Lombe in 1718 employed 300 workers and were located in a five-story building. After Lombe’s patent expired, large mills patterned after his were built in other places as well. Equally famous was the Crowley ironworks, established in 1682 in Stourbridge in the Midlands (not far from Birmingham), which at its peak employed 800 employees. [. . .] In textiles, supervised workshops production could be found before 1770 in the Devon woollen industry and in calico printing (Chapman 1974).” The development of factories and firms during the industrial revolution is discussed in Mokyr (2009: chapter 15). Also chartered companies were well known as witnessed by Adam Smith’s negative assessment of chartered companies in general and the East India Company in particular, contained in the *Wealth of Nations*. Jones and Ville (1996a: 898) note that “Adam Smith, no friend of chartered companies, argued that this separation of ownership from control contributed to gross administrative inefficiency, inattention to detail, and the pursuit of managerial goals, which raised prices to consumers and reduced returns to shareholders. He believed that only the extraction of monopoly rents ensured the success and continuance of such companies.” See Smith (1776: Book V, Chapter 1, Part e, pages 731-58). Smith’s view of chartered companies is discussed in Kennedy (2010: 143-7). On the issue of whether the joint-stock chartered trading companies were an efficient institutional response to long-distance trade or were inefficient, rent-seeking monopolists see Carlos and Nicholas (1996) and Jones and Ville (1996a,b). A general history of the chartered companies is given in Cawston and Keane (1896), Griffiths (1974) and Ekelund and Tollison (1997: chapters 6 and 7). An important development for the modern large firm, following on from the chartered companies, was the introduction of limited liability. See Copp (2008) for a discussion of the reasons for the introduction of limited liability in the U.K. Limited liability protects investors from claims of the corporation, organisational law also does the converse. The assets of the corporation are protected from claims by investors. Hansmann, and Kraakman (2000a,b) and Hansmann, Kraakman and Squire (2005) emphasise the importance of this “asset separation” to the development of the firm. Hansmann, Kraakman and Squire (2006) traces the history of the emergence of entity shielding.

would be that the large, vertically integrated and diversified firm was not empirically important until recently. Thus analysing anonymous “firms” may not have been a bad approximation to the empirical realities of the time.²⁶ But the evidence presented above on the size and diversified nature of ancient firms as well as the size of some pre-industrial revolution firms (see footnote 25, page 24) should give us cause for reflection before accepting this conclusion without some reservations.

For whatever reason it is only in more recent times that the firm has attracted attention as an important part of the economic system. As Foss, Lando and Thomsen (2000: 632) note:

“[i]t is only relatively recently, in other words, that economists have felt the need for an economic theory addressing the reasons for the existence of the institution known as the (multi-person) business firm, its boundaries relative to the market, and its internal organization - to mention the issues that are generally seen as the main ones in the modern economics of organization [. . .]”.

Many would date the beginning of a genuine theory of the firm as recently as Knight (1921b) or Coase (1937), rather than to either the classical school or the neoclassical revolution.²⁷ Before

²⁶As an approximation to “anonymous firm” production - that is, fully price-decentralised production - consider the case of rifle manufacture in Birmingham, England in the 1860s,

“[o]f the 5800 people engaged in this manufacture within the borough’s boundaries in 1861 the majority worked within a small district round St Mary’s Church. . . . The reason for the high degree of localization is not difficult to discover. The manufacture of guns, as of jewellery, was carried on by a large number of makers who specialized on particular processes, and this method of organization involved the frequent transport of parts from one workshop to another.

The master gun-maker-the entrepreneur-seldom possessed a factory or workshop. . . . Usually he owned merely a warehouse in the gun quarter, and his function was to acquire semi-finished parts and to give these out to specialized craftsmen, who undertook the assembly and finishing of the gun. He purchased materials from the barrel-makers, lock-makers, sight-stampers, trigger-makers, ramrod-forgers, gun-furniture makers, and, if he were engaged in the military branch, from bayonet-forgers. All of these were independent manufacturers executing the orders of several master gun-makers. . . . Once the parts had been purchased from the “material-makers,” as they were called, the next task was to hand them out to a long succession of “setters-up,” each of whom performed a specific operation in connection with the assembly and finishing of the gun. To name only a few, there were those who pre-pared the front sight and lump end of the barrels; the jiggers, who attended to the breech end; the stockers, who let in the barrel and lock and shaped the stock; the barrel-strippers, who prepared the gun for rifling and proof; the hardeners, polishers, borers and riflers, engravers, browners, and finally the lock-freers, who adjusted the working parts.” (Allen (1929: 56-7 and 116-7), quoted in Stigler (1951: 192-3).)

Such a method of production would be a guide to the way production would take place under a functioning version of the neoclassical model of the “firm”. It could be argued that this form of production isn’t neoclassical since it is not clear that the neoclassical separation theorem is satisfied.

²⁷O’Brien (1984: 25) takes a contrary position: “[s]erious discussion of the history of the theory of the firm has to start with Alfred Marshall.” O’Brien’s argument is based, in the main, on Marshall (1920a). O’Brien also argues that developments subsequent to Marshall have resulted in many of Marshall’s insights being lost to succeeding generations of economists. We would therefore argue that Marshall has left little in the way of a legacy in terms

the contributions of Knight and Coase we had discussions of pin factories, but the discussion was about the importance of the division of labour rather than being ‘an enquiry into the nature and causes of the firm’. When discussing Adam Smith’s approach to the division of labour McNulty (1984: 237-8) comments

“[h]aving conceptualized division of labor in terms of the organization of work within the enterprise, however, Smith subsequently failed to develop or even pursue systematically that line of analysis. His ideas on the division of labor could, for example, have led him towards an analysis of task assignment, management, or organization”. Such an approach would have foreshadowed the much later—indeed, quite recent—effects in this direction by Herbert Simon, Oliver Williamson, Harvey Leibenstein, and others, a body of work which Leibenstein calls “micro-micro economics”. [...] But, instead, Smith quickly turned his attention away from the internal organization of the enterprise, and outward toward the market and the realm of exchange, perhaps because he found therein both the source of division of labour, in the “propensity in human nature [...] to truck, barter and exchange” and its effective limits.”

As has been pointed out by Demsetz (1982, 1988a and 1995) before Knight and Coase – and it could be added for much of the period after them – the fundamental preoccupation of economists was with the market and the price system and hence little, or no, attention was paid to either the firm or the consumer as separate, significant, economic entities. Firms (and consumers) existed as handmaidens to the price system.

The interest in the price system, culminating in the “perfect competition” model, has its intellectual origins in the eighteenth-century debate between free traders and mercantilists. Butler (2007: 25-6) briefly sums up mercantilism in the following way:²⁸

“[...] it measured national wealth in terms of a country’s stock of gold and silver. Importing goods from abroad was seen as damaging because it meant that this supposed wealth must be given up to pay for them; exporting goods was seen as

of the mainstream theory of the firm. In addition to his views on Marshall’s work and later developments O’Brien also argues that any “attempt to construct a pre-Marshallian theory from the materials available is likely to be unsuccessful.” See, however, Williams (1978) for such an attempt. On the neglect of Marshall’s ‘Industry and Trade’ (Marshall 1920a) see also Liebhafsky (1955). The development of the “theory of the firm” from Marshall to Robinson and Chamberlin is also dealt with in Moss (1984).

²⁸For a detailed discussion of mercantilism see Heckscher (1934) and Ekelund and Tollison (1997).

good because these precious metals came back. Trade benefited only the seller, not the buyer; and one nation could get richer only if others got poorer. On the basis of this view, a vast edifice of controls was erected in order to prevent the nation's wealth draining away - taxes on imports, subsidies to exporters and protection for domestic industries. [...] Indeed, all commerce was looked upon with suspicion and the culture of protectionism pervaded the domestic economy too. Cities prevented artisans from other towns moving in to ply their trade; manufacturers and merchants petitioned the king for protective monopolies; labour saving devices such as the new stocking-frame were banned as a threat to existing producers.”

The free trade versus mercantilism debate was, to a large degree, about the proper scope of government in the economy and the model it gave rise to reflects this. The question implicitly at the centre of the debate was, Is central planning necessary to avoid the problems of a chaotic economic system? Adam Smith famously answered “no”.²⁹ Smith

“[...] realised that social harmony would emerge naturally as human beings struggled to find ways to live and work with each other. Freedom and self-interest need not lead to chaos, but – as if guided by an ‘invisible hand’ – would produce order and concord. They would also bring about the most efficient possible use of resources. As free people struck bargains with others – solely in order to better their own condition – the nation's land, capital, skills, knowledge, time, enterprise and inventiveness would be drawn automatically and inevitably to the ends and purposes that people valued most highly. Thus the maintenance of a prospering social order did not require the continued supervision of kings and ministers. It would grow organically as a product of human nature.” (Butler 2007: 27-8).

²⁹According to Smith the government has three duties: “[t]he first duty of the sovereign, that of protecting the society from the violence and invasion of other independent societies [...]”. Smith (1776: Book V, Chapter 1, Part First, page 689). “The second duty of the sovereign, that of protecting, as far as possible, every member of the society from injustice or oppression of every other member of it, or the duty of establishing an exact administration of justice, [...]”. Smith (1776: Book V, Chapter 1, Part II, page 709). “The third and last duty of the sovereign or commonwealth is that of erecting and maintaining those public institutions and those public works, which, though they may be in the highest degree advantageous to a great society, are, however, of such a nature that the profit could never repay the expense to any individual or small number of individuals, and which it therefore cannot be expected that any individual or small number of individuals should erect or maintain” Smith (1776: Book V, Chapter 1, Part III, page 723). For book length discussions of Smith's thought see, for example, Evensky (2005), Kennedy (2005, 2010) and Otteson (2002, 2011).

For Smith, markets are the most prominent mechanism for solving the problems of coordination and motivation that arise with interdependencies of specialisation and the division of labour. Market institutions leave individuals free to pursue self-interested behaviour, but guide their choices by the prices they pay and receive. For economists, the 200 years following Smith involved a search for conditions under which the price system would not descend into chaos.

The formal (neoclassical) model that arose from this search is one which abstracts completely from any form of centralised control in the economy.³⁰ It is a model delineated by “perfect decentralisation”.³¹ Authority, be it in the form of a government or a firm or a household, plays no role in coordinating resources.³² The only parameters guiding decision making are those given

³⁰For Adam Smith this would be an abstraction too far. Smith knew of the importance of institutions to the proper functioning of the market economy. Mark Blaug points out that “[...] Smith’s faith in the benefits of ‘the invisible hand’ has absolutely nothing whatever to do with allocative efficiency in circumstances where competition is perfect à la Walras and Pareto; the effort in modern textbooks to enlist Adam Smith in support of what is now known as the ‘fundamental theorems of welfare economics’ is a historical travesty of major proportions. For one thing, Smith’s conception of competition was, as we have seen, a process conception, not an end-state conception. For another society, a decentralised competitive price system was held to be desirable because of its dynamic effects in widening the scope of the market and extending the advantages of the division of labour - in short, because it was a powerful engine for promoting the accumulation of capital and the growth of income.” (Blaug 1996: 60-1).

³¹The neoclassical model is often described as one of “perfect competition” and one reason that the emphasis on the firm diminished as the model developed was that the neoclassicals placed a growing emphasis on the concept of market competition and thus less emphasis was given to the firm. As McNulty (1984: 240) explains “[t]he ‘perfection’ of the concept of competition, beginning with the work of A. A. Cournot and ending with that of Frank Knight, which was at the heart of the development of economics as a science during the nineteenth and early twentieth centuries, led on the one hand to an increasingly rigorous analytical treatment of market processes and on the other hand to an increasingly passive role for the firm.” For Knight “[p]erfect competition is conditioned by the existence of a set of assumptions, the most important of which are the following: (1) “a perfect market for productive services [...], that is, uniform prices over the whole field” (1921[a], 316); (2) complete rationality and perfect knowledge by free and independent individuals; (3) “perfect mobility in all economic adjustments, no cost involved in movements or changes” (1921[b], 77); (4) “virtually instantaneous and costless” exchange of commodities (1921[b], 78); (5) “perfect, continuous, costless intercommunication between all individual members of the society” (1921[b], 78); (6) perfect divisibility of commodities; and (7) “an indefinitely large number of competing organizations, each of the most efficient size” (1921[a], 316).” (Marchionatti 2003: 58).

³²The household in the neoclassical model is as lacking in substance as the firm. Kenneth Boulding made the point that “[t]his type of analysis [the theory of the firm] is exactly analogous to the analysis of the reactions of a consumer by means of indifference curves. Indeed, a consumer is merely a “firm” whose product is “utility.” The indifference curves are analogous to the isoquants, or product contours, the only difference being that they cannot be assigned definite quantities of utility. The utility surface, whose contours form the system of indifference curves, is a “mountain” whose shape we theoretically know, but whose height at any point probably cannot be known; by contrast, we can assume that both shape and height of the production surface are known. The “substitution effect” and the “scale effect” are likewise known in consumption theory, where the scale effect is usually called the “income effect.” Thus, a rise in the price of a single object of consumption will have a substitution effect tending to reduce the consumption of that object as cheaper alternatives are substituted for it. There will also be an “income effect” tending to reduce all consumption, as the higher price makes the consumer poorer. The effect of a given rise in price, therefore-i.e., the elasticity of demand-depends first on the substitutability of the commodity concerned, and, secondly, on its importance in the total expenditure. This is true either of a consumption good or of a factor of production.” (Boulding 1942: 799). Fritz Machlup argues that the household is not the subject of study in the theory of the consumer: “[t]he “household” in price theory is not an object of study; it serves only as a theoretical link between changes in prices and changes in labor services supplied and in consumer goods demanded. The hypothetical reactions of an imaginary decision-maker on the basis of assumed, internally consistent preference functions serve as the simplest and heuristically satisfactory explanation of empirical relationships between changes in prices and changes in quantities. In other words, the household in price theory is not an object of study.” (Machlup 1967, footnote 4, page 9).

within the model – tastes and technologies – and those determined impersonally on markets – prices. All parameters are outside the control of any of the economic agents and this effectively deprives all forms of authority a role in allocation. This includes, of course, the firm. It doesn't matter whether it is the general equilibrium version of the neoclassical model, characterised by Walras's auctioneer, or the partial equilibrium version, characterised by Marshall's representative firm, there is no serious consideration given to the firm as a problem solving institution.³³

In fact the exact role of the theory of the firm in price theory has been the subject of some confusion. Fritz Machlup has argued:

“[m]y charge that there is widespread confusion regarding the purposes of the “theory of the firm” as used in traditional price theory refers to this: The model of the firm in that theory is not, as so many writers believe, designed to serve to explain and predict the behavior of real firms; instead, it is designed to explain and predict changes in observed prices (quoted, paid, received) as effects of particular changes in conditions (wage rates, interest rates, import duties, excise taxes, technology, etc.). In this causal connection the firm is only a theoretical link, a mental construct helping to explain how one gets from the cause to the effect. This is altogether different from explaining the behavior of a firm. As the philosopher of science warns, we ought not to confuse

³³About the partial equilibrium approach to the firm Klein (1996: 5) writes, “[i]n neoclassical economic theory, the firm as such does not exist at all. The “firm” is a production function or production possibilities set, a means of transforming inputs into outputs. Given the available technology, a vector of input prices, and a demand schedule, the firm maximizes money profits subject to the constraint that its production plans must be technologically feasible. That is all there is to it. The firm is modeled as a single actor, facing a series of relatively uncomplicated decisions: what level of output to produce, how much of each factor to hire, and so on. These “decisions,” of course, are not really decisions at all; they are trivial mathematical calculations, implicit in the underlying data. In the long run, the firm may also choose an optimal size and output mix, but even these are determined by the characteristics of the production function (economies of scale, scope, and sequence). In short: the firm is a set of cost curves, and the “theory of the firm” is a calculus problem.” The high water mark for neoclassical general equilibrium approach is arguably Debreu (1959). For Debreu there are no firms, in the normal sense of the word, there are just “producers”: “[...] when one abstracts from legal forms of organization (corporations, sole proprietorships, partnerships, ...) and types of activity (Agriculture, Mining, Construction, Manufacturing, Transportation, Services, ...) one obtains the concept of a producer, i.e., an economic agent whose role is to choose (and carry out) a production plan.” (Debreu 1959: 37). It is also clear from the context that the agent referred to is a person. The only role for the agent is to pick the profit maximising production plan from the set of available plans. Langlois (1981: 5) explains that “[...] the interesting feature of the general-equilibrium formulation is not so much that it takes as given the mix of market and internal transactions; rather, it is that the assumptions of general-equilibrium theory themselves actually suggest that there need be no internal activity whatsoever. If all commodities are predetermined for all time and the techniques for producing them are given and fully known in all details, then one could easily conceive of a situation where every separate part of the production process would be in the nature of a market transaction”. On Debreu's influence today Till Düppe writes, “[f]rom the point of view of today Debreu's influence on the body of economics could be called zero, in that general equilibrium theory (GET) is the economics of yesterday.” (Düppe 2010: 2-3). For more on the neoclassical model see Section 2.2.

the explanans with the explanandum.” (Machlup 1967: 9).

Despite the pioneering efforts of Knight (1921b) and Coase (1937), the neoclassical model held sway, in mainstream economics, up until the 1970s.³⁴ It was only then that serious attention began to be paid to the firm. Work by Oliver Williamson (see, for example, Williamson 1971, 1973, 1975), Alchian and Demsetz (1972) and Jensen and Meckling (1976) were among the main driving forces behind this upswing in interest.

Foss, Lando and Thomsen (2000: 634) classify the mainstream post-1970 economics literature on the theory of the firm into two general groups:

1. Principal-agent type models where agents can write comprehensive contracts characterised by ex ante incentive alignment under the constraints imposed by the presence of asymmetric information.
2. Incomplete contracts models which are based on the idea that it is costly to write contracts and thus contracts will have holes, and therefore there is a need for ex post governance.

This division can be seen as resulting from the breaking of two different assumptions embedded in the general equilibrium (Arrow-Debreu) version of the neoclassical model.³⁵ The first group corresponds to the breaking of the assumption that there are no asymmetries of information between parties and thus no principal-agent problems, of either the adverse selection or moral hazard kind. The second grouping results from breaking the assumption that agents can foresee all future contingencies and can costlessly contract on all such eventualities. We discuss each group in turn.

Within the principal-agent classification Foss, Lando and Thomsen (2000: 636-8) identify three sub-groups: 1) the nexus of contracts view, 2) the firm as a solution to moral hazard in teams approach and 3) the firms as an incentive system view.

³⁴As Aghion and Holden (2011: 181) note, “[u]ntil the 1970s, the dominant theory of the firm was the neoclassical theory: namely, there are economies of scale (or scope) which justify that production activities up to some efficient scale (or up to efficient variety) be concentrated within one firm rather than scattered across multiple producers.”

³⁵The Arrow-Debreu framework was not originally conceived as a theory of contracting per se, but rather it was seen as an analytical apparatus for modelling competitive equilibrium. But the efficiency properties associated with trade involving complete contingent claims contracts - that is, contracts specifying the price, date, location and physical characteristics of a commodity for every future state of nature - made such contracts the standard against which other, more realistic, contracts are compared.

The nexus of contracts view was developed in papers by Alchian and Demsetz (1972), Jensen and Meckling (1976), Barzel (1997), Fama (1980) and Cheung (1983). The important innovation here was to see that it is difficult to draw a line between firms and markets, firms are seen as a special type of market contracting. What distinguishes firms from other forms of market contract is the continuity of the relationship between input owners.

Most famously in the Alchian and Demsetz version of this approach, they argue that the authority relationship between the employer and employee is in no way the defining characteristic of a firm.³⁶ The employer has no more authority over an employee than a customer has over his grocer. “Firing”, of either the employee or grocer, is the ultimate punishment that either the employer or customer can use in cases of “disobedience”. Alchian and Demsetz argue that, in economic terms, the customer “firing” his grocer is no different from the employer firing his employee. In both cases one party stops dealing with the other, terminating the “contract” between them. In this approach the firm is seen as little more than a nexus of contracts, special in its legal standing and characterised by long term nature of the relationship between the input owners. In this approach it is not generally useful to talk about firms as distinctive entities, a nexus of contracts could be called more firm-like if, for example, the residual claimants belong to a concentrated group but the term “firm” has little meaning beyond this.

Roberts (2004: 104) responds to this line of argument:

“[w]hile there are several objections to this argument, we focus on one. It is that, when a customer “fires” a butcher, the butcher keeps the inventory, tools, shop, and other customers she had previously. When an employee leaves a firm, in contrast, she is typically denied access to the firm’s resources. The employee cannot conduct business using the firm’s name; she cannot use its machines or patents; and she probably has limited access to the people and networks in the firm, certainly for commercial purposes and perhaps even socially.”

The second grouping, the “firm as a solution to moral hazard in teams approach”, was developed by Alchian and Demsetz (1972) and Holmström (1982). Alchian and Demsetz (1972) extend their discussion, outlined above, by noting that the firm is more than just a special legal

³⁶In later work Alchian has stated that this assertion is incorrect (Alchian 1984: 38) while Demsetz (1995: 37) claims the idea “is a mere aside” in their paper.

arrangement, it is also characterised by team production. The problem that arises here is that with team production, the marginal products of the individual members of the team are hard to measure. This means that free-rider behaviour is now possible since team production can act as a cover for shirking. The Alchian and Demsetz solution is to give the right to hire and fire the members of the team to a monitor who observes the employees and their marginal products. To ensure that the efficient amount of monitoring takes place, the monitor is given the rights to the residual income of the team.

Holmström (1982) looks at the incentive problems to do with monitoring and identifies possible solutions.³⁷ Holmström assumes that the members of the team each take actions which are unobservable to the monitor but the overall result of the combined actions is observable. What Holmström shows is that it is only under very restrictive assumptions that the monitor can ensure that efficient effort levels will be provided by each team member. The way the monitor would ensure this is to design a sophisticated incentive scheme. But Holmström shows that given unobservable effort levels, the requirements of the incentive scheme being a Nash equilibrium, budget balancing and Pareto optimality, can not be met.³⁸ More specifically, a budget-balancing incentive scheme can not reconcile Nash equilibrium and Pareto optimality. This is because each team member will equalise the costs and benefits of extra effort: that is, if the team revenue is increased by the efforts of a single member, that member should receive that revenue to ensure that they are properly motivated. But as the monitor only knows that team revenue has increased and not the effort levels of each individual member, all members of the team would have to each receive the extra revenue to ensure that the hard working member is rewarded for his efforts. But this will, obviously, violate the balanced budget condition. This suggests that there is an advantage, in terms of incentives, in the team not having to balance their budget.³⁹

Clearly the role of the “monitor” in the Alchian and Demsetz model is very different to their role in the Holmström model. For Alchian and Demsetz, the monitor oversees the behaviour of the team members, in the Holmström model, the monitor injects the capital needed so that the team members do not have to balance their budget.

³⁷Importantly Holmström ignores team synergies by assuming an additive production function.

³⁸Budget balancing means that the incentive scheme has to fully distribute the revenues among the team members.

³⁹See also footnote 11 on page 117.

The third subgroup is the “firms as an incentive system view”. Early contributors to this approach were Holmström and Milgrom (1991, 1994). In Holmström and Milgrom (1994) it is stressed that the firm should be viewed as ‘a system’, that it is a set of contractual relationships which endeavour to mitigate incentive problems. In their view the firm is characterised by a number of factors: 1) the employees do not own the non-human assets of the firm; 2) the employees are subject to a ‘low-powered incentive scheme’ (see below); and 3) the employer has authority over the employee.

Holmström and Milgrom (1991) make two observations. First, they note that there are a number of ways that an employee can spend their time, many of which can be of value to an employer. But if these multiple activities compete for the worker’s attention then the incentives offered for each of the activities must be comparable. Otherwise, the employee will put most effort into those things that are most well compensated and put less effort into the others activities. The second observation relates to the provision of strong incentives to a risk-averse employee. Providing strong financial incentives is costly because it loads extra risk into the worker’s pay. In addition, the cost is greater the more difficult it is to measure performance. This means that, other things being equal, tasks where performance is hard to measure should not be given as intense incentives as ones that are more accurately observed. But having low-powered incentives means that the employer needs to be able to exercise authority over the use of the employee’s time, since the employee will not have the proper incentives to be productive.

This logic suggests that, conversely, an independent contractor should face the opposite combination of instruments. The choice between having an employee or using an independent contractor depends on the ability of the principal to measure each dimension of the agent’s contribution. Thus, in the Holmström and Milgrom approach, measurability of performance is one important determinant of the boundaries of the firm. In addition their approach incorporates the importance of the allocation of property rights to the physical assets in determining incentives via determination of bargaining positions as is the case with the Williamson and Grossman-Hart-Moore approaches, both of which are discussed below.

In the incomplete contracting theories group Foss, Lando and Thomsen (2000: 638-43) identify five subgroups: 1) the authority view, 2) the firm as a governance mechanism, 3) the firm as an ownership unit, 4) implicit contracts and 5) the firm as a communication-hierarchy.

In the authority view, the firm is seen as being defined as an employment relation. This view is most closely associated with Coase (1937) and Simon (1951). For Coase a firm will arise when it is cheaper to carry out a transaction in a firm than it is to do so over the market. Given it costs something to enter into a market contract, that is, there are transaction costs, firms will emerge to carry out what would otherwise be a market transaction when it is cheaper for the firm to handle that transaction. The size of the firm (the boundaries of the firm) will be determined when the cost of organising a transaction within the firm equals the cost of using the market. Coase notes that within the firm contracts are not eliminated but are greatly reduced and the nature of the contract changes. When a factor of production is employed within the firm the contract controlling it is incomplete. The factor (or its owner) agrees, for remuneration, to obey the directions of the manager of the firm, within certain limits. In the last section of Coase (1937), it is noted that the relationship that constitute the firm corresponds closely to the legal concept of the relationship between the employer and employee. Coase explains that “direction” is the essence of the legal concept of the employment relationship, just as it is for the concept of the firm that he developed.⁴⁰

For Simon (1951) the issue is a comparison of an employment contract against a contract between two autonomous agents. A contract between autonomous agents specifies an action to be taken in the future along with its price while an employment contract specifies a set of acceptable instructions that the employee has to accept if asked to carry them out by the employer. The advantage of the employment contract is its flexibility, the employer does not have to pre-commit to an action and can adapt the choice of action to the state of the world that occurs.

A more modern approach to these issues is Wernerfeld (1997). He compares three alternative governance structures (game forms) for situations where a buyer needs a sequence of human asset services: 1) the hierarchy game form, 2) the price list game form and 3) the negotiation-as-needed game form.⁴¹ An employee is defined as someone who sells his services in a specific game form

⁴⁰See Appendix 1.B gives more detailed discussion of this paper.

⁴¹Wernerfeld (1997: 490) introduces the game forms with three simple examples:

1. As a typical day unfolds, you learn that you will need several services from your secretary. In principle, the two of you could contract over the provision of each service as its nature becomes clear. However, under such an arrangement you would spend a lot of time negotiating. We therefore have the institution normally called the employment relationship under which the secretary has agreed to supply ex ante unspecified services for a certain number of hours.
2. Consider what happens if a general contractor remodels your house. You may change your mind during construction, but because these adaptations are infrequent they are typically handled through negotiation on an as-needed basis.

characterised by the absence of bargaining over adaptations to changing circumstances. The firm is seen as consisting of the buyer of human asset services, along with a set of sellers, provided that the human services are traded in the “employment relationship” or “hierarchy” game form. The hierarchy game form is defined as the situation in which the parties engage in once-and-for-all wage negotiation, the manager describes desired services sequentially, and either party may terminate the relationship at will. In this model, the boundaries of the firm are given by the set of agents employed by the buyer. Whether one uses the employment relationship or an alternative game form depends on the nature of the expected adaptations. If many diverse and frequent adjustments are needed, the employment relationship involves lower adjustment costs than any of the other governance structures. The price list game form is better when the list of possible adjustments is small and the negotiation-as-needed game form is better when adjustments are needed infrequently.

The ‘firm as a governance mechanism’ approach is most commonly associated with the work of Oliver Williamson (see, for example, Williamson 1971, 1973, 1975, 1985 and 1996).⁴² Williamson’s work is based on the twin notions of bounded rationality, which results in contractual incompleteness, and opportunism, thought of as ‘self-interest with guile’. An upshot of these ideas is that contractual agreements need various kinds of safeguards built into them. For example, contractual agreements could involve ‘hostages’, that is, one party may post a bond with the other. The contractual arrangements and their associated safeguards are referred to as ‘governance structures’ by Williamson. This basic idea is that transactions can be assigned to governance structures on the basis of their transaction properties.

For Williamson, a central player in determining governance structures is asset specificity. Assets are specific to a transaction when they have greater value within the context of a particular transaction but little value outside it. This leads to the possibility of opportunism. Insofar as contracts are incomplete, as uncertainty unfolds the contract will need to be renegotiated and if one party has made a sunk investment in developing assets specific to the relationship then the

3. Suppose next that you are at H & R Block getting help with your tax return. While at the store, you may realize that you need additional services: there may be more schedules to file or you may want to prepay part of next year’s taxes. In this case you know the price of each adaptation *ex ante* and no new negotiation is needed. Since the number of possible adjustments is small, the price list governs adaptation cheaply.

⁴²See Section 2.3 for more discussion.

other party could attempt to opportunistically appropriate an undue part of the payoffs to the investment by threatening to withdraw from the relationship.

Williamson argues that vertical integration can help counter such problems by removing the incentive for opportunism. The relative advantage of a firm in dispute resolution come from the fact that between firm disputes often involve the expensive use of third party arbitrators or decision makers, such as courts, whereas firms can make decisions by fiat.

What Foss, Lando and Thomsen refer to as the ‘firm as an ownership unit’ approach to the firm is the property rights theory or incomplete contracts theory of the firm due to Grossman and Hart (1986), Hart and Moore (1990) and Hart (1995).⁴³ The central idea in the property rights approach is that as contracts are incomplete the allocation of control rights affects the incentives that people face and thus their behaviour and the allocation of resources. This theory defines ownership of an asset as the possession of the *residual* control rights over that asset.⁴⁴ A firm is defined as a collection of jointly-owned assets. This means that the distinction between an independent contractor and an employee turns on who owns the non-human assets with which the agent works. An independent contractor owns his own tools while an employee does not.

The importance of ownership is that if a non-contractible, specific to an asset, investment is undertaken then a non-owner risks being held-up by the owner. Thus the property rights theory would say that whoever makes the most important, non-contractible, asset-specific investment should be the owner of the asset. The optimal size of a firm must balance two opposing forces: hiring an employee means hiring someone who lacks optimal incentives since they risk being held up by the firm because they can be fired, thereby separating them from the assets they need to be productive, versus using an independent contractor who could hold-up the firm by threatening to quit the relationship and taking his assets with him.

This trade-off gives a theory which can determine the boundaries of the firm.

In many cases it is difficult, if not impossible, to write complete state-contingent contracts. In such circumstances people will often rely on what has been referred to as ‘unwritten codes of conduct’, that is, implicit contracts. The underlying idea in the implicit contract theory of the firm is that there are differences in the way implicit contracts function between firms (‘rational

⁴³See Section 2.5 for an expanded discussion.

⁴⁴Residual control rights are those rights associated with being able to use the asset under conditions not specified in the contract.

contracting') and within firms (an employment agreement).

Baker, Gibbons and Murphy (2002) (BGM) make this point that implicit contracts occur both within and between firms and argue that the difference between them lies in what happens if the implicit contract breaks down. An independent contractor can leave the relationship and take the assets belonging to it with him. This an employee can not do. In BGM an independent contractor can, if he wants, sell the finished product elsewhere while an employee does not own the finished product and thus can not leave the relationship with the asset or the product. The strength of the threat to discontinue the relationship determines the implementability of implicit contracts. As an example consider the situation where the market for the good is highly volatile. In this case a relational contract may be unworkable since the supplier has an incentive to violate the implicit contract when the market price is high. If the supplier is part of the firm such an option does not exist and the implicit contract that holds the internal transfer 'price' constant may be self-enforcing.⁴⁵ The implicit contracting theory can be seen as being related to Williamson's idea that the resolution of disputes is more easily achieved within firms than between firms in the sense that mechanisms for dispute resolution can be seen as a feature of a system of self-enforcing implicit contracting within the firm.

The last of the subgroups identified by Foss, Lando and Thomsen is the 'the firms as a communication-hierarchy' subgroup. Here the firm is viewed as a communications network designed to minimise both the cost of processing new information and the costs associated with the dispersing information among the members of the firm. Clearly communication is costly in that it takes time for people to absorb new information that they have been sent. But this time can be reduced by having particular agents specialising in the processing of particular types of information. In the model from Bolton and Dewatripont (1994), for example, each agent handles a particular type of information with the different types being aggregated via the communications network. Teams, firm-like structures, arise when the benefits to specialisation are greater than the costs of communication.

The major problem with this approach to the firm is that it can't explain the boundaries of the firm. The theory does not explain why communication hierarchies can exist within firms but not between firms.

⁴⁵Self-enforcing here means that each party lives up to the other party's expectation in fear of retaliation and the breaking down of cooperation.

1.2.1 Demsetz and the neoclassical model

As noted above the neoclassical model held sway in mainstream economics up until 1970s and even today is still the one model of the ‘firm’ that every economist knows. In fact it’s likely to be the only model of the firm they do know. As will be explained in Section 2.2 the standard interpretation of the neoclassical model is one in which firms, in the Coaseian sense, do not exist. The model is one of zero transaction costs in which agents interact with each other only via the price mechanism and elaborate (complete) contracts. Harold Demsetz is one author who disagrees with this interpretation of the neoclassical model. For him the ‘firm’ in the neoclassical model is a specialised production unit, specialised in the sense that it produces only for those outside the firm.

Demsetz (1995: First commentary) argues that the neo-classical model offers both a definition of the firm and a rationalisation for the existence of firms, but he admits that these are mostly implicit. Demsetz starts by noting that the problem that the neoclassical model tackles is to see how the price system works and how it is able to deal with the interdependencies of the modern economy. The theory sets out to do this by envisioning a hypothetical economy within which people must depend on others. Demsetz (1995: 7) explains,

“[t]he construction depends on two characteristics of economic activity: extreme decentralization and extreme interdependency. Extreme decentralization deprives all firms and households of influence over price. So they do not set price; the system does. This aspect of neoclassical theory is well understood. The need for interdependency is not.”

The opposite of interdependency is self-sufficiency, by which Demsetz means production for one’s own consumption. Robinson Crusoe stranded alone on an island must be self-sufficient; there is no one else to depend on. The neoclassical economy is one in which there is no self-sufficiency so that all people in this hypothetical economy are dependent on all other people in the economy. That is, there is extreme interdependency. Demsetz argues that

“[t]his is accomplished with the aid of two “black boxes”: the household and the firm. The household sells its services to others and buys goods from others. It does not self-employ resources to produce goods for its own members; it offers its resources

to firms. Firms buy or rent these resources, and they produce goods that are not for consumption by their owners and employees as such, but are for exclusive sale to households. The role of prices in accommodating this high degree of interdependency is of interest, not the manner in which households and firms manage their internal affairs. The contribution made by the household and the firm in this theory is to make the price system deal with extreme interdependency and decentralization. “In-the-household” production and “on-the-job” consumption are ruled out.” (Demsetz 1995: 8).⁴⁶

The production unit in the neoclassical economy is specialised in the sense that it produces for those outside the firm, so that the firm is not just a black box, it is a specialised black box. There is no discussion of the managing of production. The role of the firm in the neoclassical theory is to separate production from consumption so that there is no self-sufficiency. The coordination of production and consumption is achieved via two factors: first, impersonally determined market prices and second, personally defined tastes. The neoclassical model lays out the nature of the interactions between these components. Thus the perfectly competitive firm is one important ingredient in a scenario in which the price system is the only coordination mechanism for harmonising production and consumption.

Demsetz goes on to note that the internal organisation of the firm is not addressed in the neoclassical theory. The firm need not be an organisation at all, a single owner/manager/employee is all that is required. For Demsetz the neoclassical firm is no more or less than a specialised unit of production. The important criterion for the neoclassical firm is that it separates production from consumption with production being exclusively for consumption by those outside the firm.

In the neoclassical world in which everyone possesses perfect information about prices and technologies, each owner of resources can manage their own resources, placing them in their

⁴⁶This separation between the household and firm is also noted by Hicks (1946: 79): “[...] the enterprise (the conversion of factors into products) may be regarded as a separate economic unit, detached from the private account of the entrepreneur. It acquires factors, and sells products; its aim is to maximize the difference between their value.” Spulber (2009: 125) calls this separation of the firm’s objectives and the consumer’s objectives the “neoclassical separation theorem”, which he says makes three assertions: “(1) firms maximise profits, (2) firms generate gains from trade compared to autarky, and (3) firm decisions are separate from consumer decisions.” For expanded discussion see Spulber (2009: 127-32). For Spulber the firm “is defined to be a transaction institution whose objectives differ from those of its owners.” (Spulber 2009: 63). The importance of this separation is noted by Mas-Colell et al (1995: 153) when they observe “[i]f prices may depend on the production of the firm, the objective of the owners may depend on their tastes as consumers.” This implies that the objective of profits maximisation by the firm may be lost. For criticisms of Spulber’s approach to the firm see Hart (2011: 108-11).

highest value uses in response to the prices that they face. These resource owners can write any contracts needed to coordinate their relationships.

Demsetz then makes the point that this view of the firm is very different from that of either Knight or Coase or from the modern theory of the firm literature, which follows, in the main, from Coase. In the Coaseian literature markets and firms are seen as substitutes, in that as transaction costs fall the market is used more and firms do less. In the limit as transaction costs go to zero the firm ceases to exist and all activities take place via markets. In the Demsetz framework the relationship between firms and markets is complementary. As transaction costs fall, the costs to specialisation fall as the use of the market becomes cheaper and more specialisation takes place and thus more firms are created. As transaction costs increase, the use of the market becomes more expensive and thus it is used less, self-sufficiency become more common and the number of firms falls.

Demsetz sums up the specialisation theory of the firm as,

“[t]he bottom line of specialization theory is that *firms exist because producing for others, as compared to self-sufficiency, is efficient; this efficiency is due to economies of scale, to specialized activity, and to the prevalence of low, not high, transaction costs.*” (Demsetz 1995: 11).

One interesting implication of the specialisation theory is that it guarantees profit maximisation. Given that firms only produce for sale to those outside the firm, there can be no on-the-job consumption and thus the owner of the firm maximises utility by maximising profits. As there can be no utility gained from on-the-job consumption the owner maximises utility by having the firm maximise profit and then saving or consuming this profit in his role as consumer.

1.2.2 summary

While in practice firms may be as old as farming, in theory an explanation of the reasons for and organisation of firms only goes back to the 1920s or 1930s, while the current mainstream approach to the theory of the firm is even more recent having been developed only since the 1970s. This post-1970 literature can be seen as being derived from the breaking of two assumptions in the standard general equilibrium model. One group of theories corresponds to the breaking of the

assumption that there are no asymmetries in the information available to contracting parties and thus no principal-agent type problems. The second group of theories violates the assumption that agents can costlessly write contracts.

The first group of theories have given rise to principal-agent based theories of the firm which can be divided into three sub-groups: 1) the nexus of contracts view, 2) the firm as a solution to moral hazard in teams approach and 3) the firms as an incentive system view. The second groups of incomplete contracting models can be divided into five subgroups: 1) the authority view, 2) the firm as a governance mechanism, 3) the firm as an ownership unit, 4) implicit contracts and 5) the firm as a communication-hierarchy.

The two general groupings of theories take a Coaseian approach to explaining the firm insofar as they both take seriously Coase's basic point that firms can only exist in a world of positive transaction costs.⁴⁷ This assumption of positive transaction costs separates the current theories of the firm from the neoclassical model of the "firm" which was developed within a zero transaction cost framework. When discussing the neoclassical model of the firm Jensen and Meckling write, "[w]hile the literature of economics is replete with references to the "theory of the firm," the material generally assumed under that heading is not actually a theory of the firm but rather a theory of markets in which firms are important actors." (Jensen and Meckling 1976: 306). The movement away from a 'theory of markets with firms' to a 'theory of the firm' is one of the major hallmarks of the current approach to the theory of the firm. The questions asked today by the theory have to do with the firm's existence, boundaries and internal organisation, whereas the neoclassical theory asked questions about how the firm acts in the market. What we have seen since the 1970s is a movement away from the theory of the firm being seen as developing a component of price theory, namely issues to do with firm behaviour, to the theory being concerned with the firm as a subject in its own right.

⁴⁷The importance of positive transactions costs is the theme that links Coase's two most famous papers. As Demsetz (1996: 565) notes, " 'The Problem of Social Cost' (Coase, 1960) is R.H. Coase's most cited and most influential work. It is noted for, among other things, demonstrating the importance of incorporating transaction cost into the analysis of externalities and into the analysis of markets more generally. This theme, that markets are not free, is also found in the classic 'The Nature of the Firm' (Coase, 1937), so that, taking the perspective offered by both works, transaction cost turns out to be important whether one is analyzing allocation through the price system or through the firm."

1.3 outline of the thesis

Two related themes run through the short survey of the knowledge economy given in Section 1.1. The first being that we do not have a generally accepted theory of the knowledge economy and the second is that we can not, in part because of the first point, measure the knowledge economy. While there is no fully agreed upon theory of the knowledge economy one common, although not universal, idea that runs through the knowledge economy literature relates to the growing importance (or re-emergence in importance) of human capital to the economy. Human capital is increasingly being seen as the main creator of value in firms. This means that human capital, via firms in general and human-capital based firms in particular, will play an increasingly important role as the knowledge economy expands.

The remainder of this thesis will examine the theory of a human-capital based firm starting in Chapter 2 with an analysis as to why a new theory is needed to explain such organisations. This chapter will outline why none of the current mainstream theories of the firm fully capture the relevant aspects of the human capital based firm. Chapter 3 expands on the discussion contained in Chapter 2 with regard to the incomplete contracts or property rights approach to the theory of the human-capital based firm. The property rights approach is, as Bolton and Scharfstein (1998: 96) note, “the first complete, formal model of integration”. Much of the recent mainstream literature on the formal approach to the firm utilises a property rights framework, Hart (2011: 106) goes so far as to say “I think it is fair to say that it [the property rights approach] has become a workhorse in the literature.” This approach has been expanded, even if not in an entirely satisfactory manner, to cover the knowledge firm. While the incomplete contracts theory represents a major stream in the modern theory of the firm literature it is not without its problems. Chapter 4 considers a more recent approach to the theory of contracts, referred to here as the ‘reference point’ approach, which has been developed to deal with some of the shortcomings of the standard incomplete contracts theory and its application to the theory of the firm. Next, Chapter 5 attempts to contribute to the theory of the human-capital based firm by utilising the reference point framework to develop a simple model of the human-capital based enterprise. Chapter 6 is the conclusion.

appendix 1.A: definitions of a knowledge economy

This Appendix gives a sample of definitions and characterisations of terminology frequently found in the knowledge economy literature.

Knowledge economy

Houghton and Sheehan (2000) “In an agricultural economy land is the key resource. In an industrial economy natural resources, such as coal and iron ore, and labour are the main resources. A knowledge economy is one in which knowledge is the key resource.” (page 1)

David and Foray (2002) “the crux of the issue lies in the accelerating (and unprecedented) speed at which knowledge is created, accumulated and, most probably, will depreciate. This trend has resulted inter alia in intense scientific and technological progress.” (page 21)

Munro (2000) “the phrase ‘knowledge economy’ will be shown to be a concoction of five different approaches: information technology (usually considered to encompass computing and communication technologies); information networks, new industry processes (including innovation, research and development, and technological diffusion); the human capital approach; and a new approach to capital accumulation through the privatisation and commercialisation of knowledge.” (page 5)

Powell and Snellman (2004) “We define the knowledge economy as production and services based on knowledge-intensive activities that contribute to an accelerated pace of technical and scientific advance, as well as rapid obsolescence. The key component of a knowledge economy is a greater reliance on intellectual capabilities than on physical inputs or natural resources.” (abstract)

Rooney et al., (2003) “We take the term knowledge economy to mean that part of the economy that creates wealth essentially through intellectual activity [...]” (page 16)

Foss (2002) “Whatever we think of this journalistic concept, it arguably does capture real tendencies and complementary changes. These include, on the organization side, a shrinking of the corporate boundaries and new ways of structuring these, falling firm sizes and a flattening of internal organization; increased differentiation of tastes on the demand side; acceleration of innovation and technological development on the supply side; and changes in the composition of labour on the input side.” (page 48)

The Enterprise Development Website (2005) “For the last two hundred years, neo-classical economics has recognised only two factors of production: labour and capital. This is now changing. Information and knowledge are replacing capital and energy as the primary wealth-creating assets, just as the latter two replaced land and labour 200 years ago. In addition, technological developments in the 20th century have transformed the majority of wealth-creating work from physically-based to “knowledge-based.” Technology and knowledge are now the key factors of production. With increased mobility of information and the global work force, knowledge and expertise can be transported instantaneously around the world, and any advantage gained by one company can be eliminated by competitive improvements overnight. The only comparative advantage a company will enjoy will be its process of innovation – combining market and technology know-how with the creative talents of knowledge workers to solve a constant stream of competitive problems – and its ability to derive value from information. We are now an information society in a knowledge economy.”

Nokkala (2004) “One of the buzzwords featuring prominently in the higher education policy documents, and used to legitimise the Lisbon agenda, the Bologna process as well as committing education to the GATS agreement, is the concept of knowledge economy or knowledge society. It is often used to illustrate the shift from an economy based on the low skills industrial production to knowledge intensive production and services as the back bone of the economy, or the shift from a fordist to a post-fordist society, marked by denationalisation and transnationalisation of state regulation, transnational flow of capital and ensuing global competition. The discourse of knowledge economy emphasizes the shift to knowledge intensive high skills labour force, international circulation of brains, life long learning, transferable skills and competences and knowledge management as a key individual and organisational capacity. In the age of globalisation, the knowledge economy discourse has become a way to characterize the new relationships between the state, society and economy and rendered higher education increasingly important for the international competitiveness of the nation states through their central tasks of generation, application and dissemination of knowledge and training high skilled labour force.”

Foss (2005) “More specifically, it (the knowledge economy) is concerned with important parts of the theorizing that has emerged within the strategy and organization fields to accommodate the emergence of the knowledge economy, or, more precisely, accommodate those tendencies that we

may think of as characterizing the knowledge economy. Among these-real, alleged, and imagined-tendencies is the increasing importance of human-capital inputs, the generally increasing importance of immaterial assets and scientific knowledge in production, the increasing importance of immaterial products, the need to control in-house an increasing number of technologies (even if product portfolios are shrinking) and in general to tap an increasing number of knowledge nodes, not just internally but also through an increasing number of alliances and network relations with other firms as well as public research institutions. These tendencies-that in turn co-evolve with a host of other tendencies that may be placed under the knowledge-economy heading, such as increasing competitive pressure and an increasing extent of the market stemming from increased deregulation and internationalization, increasing technological modularity, improved methods of measurement and cost allocation, and the increasing importance of ICT - profoundly impact on economic organization and competitive advantages.” (pages 1-2)

Smith (2002) “What does it mean to speak of the ‘knowledge economy’ however? At the outset, it must be said that there is no coherent definition, let alone theoretical concept, of this term: it is at best a widely-used metaphor, rather than a clear concept. The OECD has spoken of knowledge-based economies in very general terms, as meaning “those which are directly based on the production, distribution and use of knowledge and information”. This definition is a good example of the problems of the term, for it seems to cover everything and nothing: all economies are in some way based on knowledge, but it is hard to think that any are directly based on knowledge, if that means the production and distribution of knowledge and information products.” (pages 6-7)

“Leaving aside such general definitional problems there seem to be four basic views about the changed significance of knowledge: Firstly, there are those who believe that knowledge is quantitatively and in some sense qualitatively more important than before as an input. Peter Drucker, for example, suggests that ‘Knowledge is now becoming the one factor of production, sidelining both capital and labour.’ Along the same lines, the OECD has suggested that “the role of knowledge (as compared with natural resources, physical capital and low-skill labour) has taken on greater importance. Although the pace may differ, all OECD economies are moving towards a knowledge-based economy”. Secondly, there is the idea that knowledge is in some way more important as a product than it has been hitherto - that we are seeing the rise of

new forms of activity based on the trading of knowledge products. Thirdly, there is the view that codified knowledge (as opposed to tacit, person-incorporated skills) is in some ways more significant as a component of economically relevant knowledge bases. Thus Abramowitz and David argue that ‘Perhaps the single most salient characteristic of recent economic growth has been the secularly rising reliance on codified knowledge as a basis for the organisation and conduct of economic activities’. Finally, there are those who argue that the knowledge economy rests on technological changes in ICT, since innovation in computing and communications changes both physical constraints and costs in the collection and dissemination of information. So for some, the rise of ICT technologies and the complex of ICT industries is coterminous with the move to a knowledge society. Lundvall and Foray argue a more sophisticated view: ‘Even if we should not take the ICT revolution as synonymous with the advent of the knowledge-based economy, both phenomena are strongly interrelated, the ICT system gives the knowledge-based economy a new and different technological base which radically changes the conditions for the production and distribution of knowledge as well as its coupling to the production system’.” (pages 7-8)

Knowledge-based economies

Foray (2004) “essentially, economies in which the proportion of knowledge-intensive jobs is high, the economic weight of information sectors is a determining factor, and the share of intangible capital is greater than that of tangible capital in the overall stock of real capital.” (page ix)

“a scientific development corresponding to the emergence of a new economic subdiscipline of which the research object - knowledge - poses new theoretical and empirical problems; and a historical knowledge heralding the advent of a particular period in the growth and organization of economic activities. I stress the importance of this twofold change, which some authors fail to recognize. For them, the only new development of any relevance is theoretical, and the historical period in which they are living follows earlier periods without any discontinuity whatsoever. Because one believes, on the contrary, in the dual nature of the economics of knowledge - as a discipline and as a historical period - it is naturally around that duality that this volume is organized. By convention, so as not to confuse the two phenomena, I call the discipline “the economics of knowledge” and the historical period “the knowledge-based economy.”.” (page xi)

Harris (2001) “the notion that economic wealth is created through the creation, production,

distribution and consumption of knowledge and knowledge-based products.” (page 22)

Rooney et al (2003) “[...] a knowledge-based economy to be an economy in which knowledge is the most important productive factor.” (page 16)

Australian Bureau of Statistics (2002) “The term ‘knowledge-based economy’ was coined by the OECD and defined as an economy which is ‘directly based on the production, distribution and use of knowledge and information’ (OECD 1996). The Asia-Pacific Economic Co-operation (APEC) Economic Committee extended this idea to state that in KBE ‘the production, distribution and use of knowledge is the main driver of growth, wealth creation and employment across all industries’ (APEC 2000). According to this definition, a KBE does not rely solely on a few high technology industries for growth and wealth production. Rather, all industries in the economy can be knowledge intensive, even so called ‘old economy’ industries like mining and agriculture. Further, the APEC Economic Committee states that ‘the knowledge required by a knowledge-based society is wider than purely technological knowledge; for example it includes cultural, social and managerial knowledge’.”

OECD (1996) “economies which are directly based on the production, distribution and use of knowledge and information.” (page 7)

Asia-Pacific Economic Cooperation (2000) “A Knowledge-Based Economy is an economy in which the production, distribution, and use of knowledge is the main driver of growth, wealth creation and employment across all industries. In this context, being a KBE means more than simply having a thriving “new economy” or “information economy” that is somehow separate from a stagnant “old economy”. In a truly knowledge-based economy, all sectors have become knowledge-intensive, not just those usually called “high technology”. Important features of an ideal KBE include: an openness to trade, new ideas and new enterprises; sound macroeconomic policy; the importance attached to education and lifelong learning; and the enabling role of information and telecommunications infrastructure. Note that the knowledge required by a knowledge-based society is wider than purely technological knowledge; for example, it includes cultural, social, and managerial knowledge. The knowledge possessed by an organisation is much more than the information written in its files, and includes its culture, the way in which people interact within the organisation, knowledge about the contacts they use to gain information from outside, and so on. The organisation’s knowledge consists of its capability in integrating inform-

ation with experience and expertise to take action. This assimilation is no mean feat; as one wit put it: “Today we are drowning in information but starving for knowledge”.” (page vii)

Neef (1998) “The phrase (knowledge based economy) has been used enthusiastically to describe a new interconnected economy and the positive effect of newly emerging technologies in the workplace and home. Equally, it has been used to lament the effect of downsizing on the blue-collar sectors of the labor force. For some, “knowledge-based economy” describes the ever-increasing proportion of the nation’s GNP dedicated to computerization and high-technology electronics industries. For others, it is the impetus behind “knowledge management” - adaptation of traditional organizational structures in a way that better accommodates the highly skilled “knowledge workers” who populate the high-performance workplace and provide complex problem-solving services. The knowledge-based economy is a phrase that has been used to describe both a coming age of global prosperity and a coming economic apocalypse.” (page 1)

Knowledge driven economy

Department of Trade and Industry (1998) “knowledge driven economy is one in which the generation and the exploitation of knowledge has come to play the predominant part in the creation of wealth. It is not simply about pushing back the frontiers of knowledge; it is also about the more effective use and exploitation of all types of knowledge in all manner of economic activity.”

Weightless economy

Quah (2003) “Instead, it is the weightless economy where the economic significance of knowledge achieves greatest contemporary resonance. The weightless economy, in this view, comprises four main elements: 1. Information and communications technology (ICT), the Internet. 2. Intellectual assets: Not only patents and copyrights but also, more broadly, namebrands, trademarks, advertising, financial and consulting services, and education. 3. Electronic libraries and databases: Including new media, video entertainment, and broadcasting. 4. Biotechnology: Carbon-based libraries and databases, pharmaceuticals.”

Harris (2001) “economic value seems to be increasingly concentrated in non-material objects.” (page 23)

Knowledge economy/weightless economy

Danabalan (1999) “Knowledge economy is the ability to create, distribute and exploit know-

ledge and information for increasing economic wealth and improvement in the quality of life. It is also described as the “weightless economy”, in comparison with the label “weighty economy” of the industrial era.”

Goldilocks economy

Gordon (1998) “Freed from the restraint of restrictive monetary policy that had choked earlier expansions, and with its fires stoked by the lowest medium-term and long-term nominal interest rates in three decades, the economy charged ahead and achieved a state of high growth-noninflationary bliss that some have dubbed the “Goldilocks economy” (neither too hot nor too cold, but just right).” (page 297-8)

“Thus far, I have characterized the major surprise in the Goldilocks economy as the low rate of inflation given the low rate of unemployment, and indeed, this has been the focus of the media as well.” (page 300)

“Stated another way, the real questions about the Goldilocks economy are why inflation has been so low relative to changes in wages and why the unemployment rate has declined when utilization has not increased.” (page 301)

Information economy

Harris (2001) “focuses on the important role that information and communication have come to play in the modern economy.” (page 23)

Talero and Gaudette (1996) “A new kind of economy - the information economy - is emerging where trade and investment are global and firms compete with knowledge, networking and agility on a global basis. A corresponding new society is also emerging with pervasive information capabilities that make it substantially different from an industrial society: much more competitive, more democratic, less centralized, less stable, better able to address individual needs, and friendlier to the environment.” (abstract)

“Revolutionary advances in information technology reinforce economic and social changes that are transforming business and society. From this revolution emerges a new kind of economy - the information economy - in which information is the critical resource and the basis for competition. Old ways of doing business will be challenged and sometimes defeated.” (Section 1:1. How is information shaping the economy and society?)

Digital economy

Department of Trade and Industry (1998) “The “digital economy” is shorthand for the transformational impact which information and communication technologies (ICTs) are having on every single aspect of business activity.”

New Economy

Ittner, Lambert and Larcker (2003) “Talks about new economy firms by which it means “organizations competing in the computer, software, internet, telecommunications, or networking fields”.”

Quah (2002a) “Digital goods are bitstrings, sequences of 0s and 1s, that have economic value. They are distinguished from other goods by five characteristics: digital goods are nonrival, infinitely expandible, discrete, aspatial, and recombinant. The New Economy is one where the economics of digital goods importantly influence aggregate economic performance.”

“As documented elsewhere in this Handbook (and attested to by journalistic frenzy in the late 1990s’ dotcom boom) the New Economy means different things to different observers. Possible dimensions to the New Economy range from e-commerce, e-government, the Internet, the productivity paradox, knowledge-intensive work, social mass-mobilization, and globalization, all the way through auction proliferation, electronic payment systems, venture capital financing saturation, and business restructuring. In less guarded moments, popular conception held that with the New Economy, inflation might be forever conquered, explosive income growth might be hereafter the norm, and stock markets be always stratospheric.” (page 4)

Quah (2002b) “This paper attempts to draw lessons for the New Economy from what economists know about technology dissemination and economic growth. It argues that what is most notable about the New Economy is that it is knowledge-driven, not just in the sense that knowledge now assumes increasing importance in production, thereby raising productivity. Instead, it is that consumption occurs increasingly in goods that are like knowledge-computer software, video entertainment, gene sequences, Internet-delivered goods and services-where material physicality matters little. That knowledge is aspatial and nonrival is key. Understanding the effective exchange and dissemination of such knowledge-products will matter more than resolving the so-called productivity paradox.” (abstract)

Coyle and Quah (2002) “Definitions of the ‘new economy’ tend to cluster into two main types. The first equates the new economy with ICT and its sectoral consequences; either on certain

core industry sectors, mainly professional services, or wider economic effects on all economic structures, mainly through cost reduction and networking enabling processes. The second sees the new economy as the post-industrial economy as a whole. Equal emphasis is placed on symbolic analysis and frontline services as areas for employment growth.” (page 6)

Samuelson and Varian (2001) “Some have asserted that the 1990’s witnessed the emergence of a “New Economy.” That term dates back to the 1980’s when it referred to an economy driven by services rather than manufacturing. The fear then was that the services economy would result in slow growth, rising prices, and low-wage jobs. In 1996 Michael Mandel published an article in *Business Week* called “The Triumph of the New Economy” which emphasized the development of a technology-driven, fast-growing, low-inflation economy, which he referred to as “the New Economy”. The latter connotation came to dominate popular discussion, although economists as a whole remain somewhat skeptical of the concept.”

Abramovitz and David (2001) “The term “new economy” itself acquired a variety of quite different connotations: for many commentators, it continues to refer primarily to the altered macroeconomic configuration that saw an accelerating rate of growth of real GDP and a steadily falling unemployment rate which, unexpectedly, did not give rise to inflationary pressures on wages and prices. Some connected this with evidence of the revival of labor productivity growth that became increasingly visible in the aggregate statistics for the private sector, and emphasized that as the key development heralding a permanent escape from the US economy’s poor performance record during the preceding two decades. For others, however, the productivity growth picture beneath the aggregate level was less than entirely clear, and the core of the “New Economy” was peculiarly associated with the growth of output and employment in “hi-tech” industries, particularly those involving information technologies and computer mediated telecommunications, and with the on-going restructuring of business organizations and markets that are driven by advances in the latter (ICTs). The high and rising stock market valuations of companies in this sector, and the wave of venture capital that poured into new enterprises launched after 1993 to exploit the commercial possibilities of the explosively expanding Internet, seemed for still other observers to be the very essence of what was new and positive in these developments. Indeed, in the exuberance that marked the century’s close, the Nasdaq stock market index came to be identified with the New Economy, whereas the comparatively weak performance

of the Dow-Jones index was disparaged as representative of “the Old Economy”.” (page 116)

Micklethwait and Wooldridge (2003a) “The new economy is difficult to define, largely because it encompasses three things. The first, now fortunately gone for good, had to do with the stock market in the 1990s: that it somehow justified crazy equity prices. But the other two things have survived the bubble. The second has to do with the organization of business: the idea that corporate life, particularly in America, is being transformed by the Internet and by Internet companies. This seems very hard to quarrel with. The third, most complicated debate has to do with macroeconomics and how its laws and assumptions need to be rewritten in the light of all this new technology and, to a lesser extent, globalization.” (page 107)

Progressive Policy Institute (nd) “The term New Economy refers to a set of qualitative and quantitative changes that, in the last 15 years, have transformed the structure, functioning, and rules of the economy. The New Economy is a knowledge and idea-based economy where the keys to job creation and higher standards of living are innovative ideas and technology embedded in services and manufactured products. It is an economy where risk, uncertainty, and constant change are the rule, rather than the exception.”

Notes, Harvard Law Review (2001) “The world is currently undergoing a fundamental economic transformation. A combination of technological developments - powerful personal computers, high-speed telecommunications, and the Internet - has created a new market environment variously referred to as the “information economy,” the “network economy,” the “knowledge economy,” or simply the “New Economy.” This New Economy is anchored primarily in the production, processing, and dissemination of such information goods as software, content, or expertise. To be sure, there is nothing new about the existence of information goods; music and books, for example, have existed as information goods for quite some time. What is new, however, is the dominance of information goods in the total marketplace and the present pace of major technological advances. The technological revolution impacts the cost and distribution of such goods in a way that fundamentally alters how their purveyors must operate.” (pages 1627-8)

OECD (2000) “The term “new economy” has been used extensively in recent years to describe the workings of the US economy and in particular the part of its economy that is linked to ICT. It reflects a view that something has changed and that the economy now works differently. Few studies clearly define the term “new economy” and it seems to mean different things to different

people. The three main characteristics of the new economy appear to be the following: The new economy may imply higher trend growth. Due to more efficient business practices linked to ICT use, the new economy may experience a pick-up in trend growth, due to higher MFP growth. The new economy may affect the business cycle. ICT, in combination with globalisation, may change the short-run tradeoff between inflation and unemployment and lower the NAIRU (non-accelerating inflation rate of unemployment). As a result, the economy can expand for a longer period without inflationary pressures emerging. In this view, ICT puts downward pressure on inflation, while increased global competition keeps wage inflation in check. More extreme views have argued that the new economy may mean the end of the business cycle. The sources of growth are different in the new economy. Certain parts of the new economy may benefit from increasing returns to scale, network effects and externalities. The value of communications networks and Internet applications, for instance, increases as more people are connected. This situation entails considerable spillovers, and these contribute to higher MFP growth and fuel further growth. These three characteristics are closely related and the US experience of the past decade provides some support for all, although there is no support for extreme claims about the end of the business cycle.” (page 17)

Godin (2004) “The new economy referred to data that indicated the appearance of new economies in the United States and in a number of smaller OECD countries not very “vibrant” in terms of entrepreneurship. What characterized new economies was the acceleration of trend growth and productivity. Technologies, particularly information and communication technologies (ICT), were believed to be at the hearth of the phenomenon.” (page 679)

“Today, alongside the OECD, it is the European Commission that most faithfully pursues work on productivity gaps between Europe and the United States in its annual reports on competitiveness (European Commission, 2000, 2001). The failure to close the gap appears, according to the commission, what characterizes the New Economy in the United States: higher employment rates and higher labor productivity as a consequence of investments in information and communication technologies (ICT).” (pages 667-8)

Editors, “Editors’ Summary” (2000) “The authors examine the data for “new economy” companies, defined as those engaged in the manufacture of computers or other electronics products or in software or telecommunications, and “old economy” companies; they also examine the data

by manufacturing industry.” (page xix)

““New economy” proponents credit the success to the information revolution, which they see as driving a fundamental transformation of the economy that will lead to faster productivity growth for many years. Skeptics of this view acknowledge the importance of the high rates of investment stimulated by the computer revolution, but attribute much of the economy’s success to a series of favorable but temporary shocks.” (page xx)

Thompson (2004) “Of course, in large part this depends upon how one defines the idea of a ‘new economy’. The difficulties here are legion. Just to give two examples, the US Council of Economic Advisors (2002: 58-60) restricts its analysis very much to the dominance of ICTs, whereas an analysis for the Bank of England by Wadhvani (2001: 495) includes a wider set of structural changes, including ‘globalization’, intensifying product market competition, financial market liberalization, changes in labour market flexibility and other factors. Both these argue that there is a ‘new economy’ in the USA and possibly the UK, but not elsewhere. In addition, McGuckin and van Ark (2002), for the US Conference Board, see a new economy only appearing in the USA, as US productivity figures soar away from the rest of the world.” (page 565)

Wadhvani (2001) “There is no generally accepted definition of what one means by the NE. Recall that the term NE, in the early 1980s, implied an economy that was driven by services rather than manufacturing. Then, the worry was that a service-driven economy was going to create poor, low-wage jobs. More recently, the use of the term NE has been transformed radically. Unsurprisingly, there are those who see the NE as being synonymous with an acceleration in the diffusion of Information and Communications Technology (see, e.g. Gordon (2000)). However, I regard that as a rather narrow definition. Recall that John Travers was, of course, active in the free trade movement during the mid-19th century. Indeed, much that might be different about the economy today relates not just to ICT advances, but also to the effects of globalisation, intensifying product market competition, labour market reform, financial market liberalisation and several other factors.” (pages 5-6)

Browne (2000) “My own preferred definition relates instead to features of the aggregate macro economy itself rather than to technology - three features are isolated for attention. 1. A permanently raised potential growth rate of the economy (using the 1970s, 1980s and early 1990s as a benchmark) attributable predominantly to the revolution in the Information and Commu-

nications Technologies (ICT); 2. The second feature is a permanent reduction in structural and frictional unemployment to which it is argued the ICT also contributes through a number of channels; 3. The third feature is a permanent reduction in the variation in the growth rate of output in the 1990s, and possibly to some extent in the 1980s, relative to previous decades.” (page 210)

Elmeskov (2000) “The conjunction of a number of economic developments in the United States has contributed to an impression that something fundamental may have changed in that country. These developments include: strong non-inflationary growth, coupled with high labour utilisation; the spread of information and communication technology (ICT); and microeconomic evidence of continued restructuring of production processes. Taken together, these developments have been seen as representing the emergence of a ‘New Economy’.” (page 57)

Internet Economy

Choi and Whinston (2000) “[...] the Internet economy is defined as that part of the economy that deals with information goods such as software, online contents, knowledge-based goods, the new media and supporting technology industries that provide computers and network devices.”

Multiple terms

Knowledge economy, knowledge-based economy, innovation economy, high-technology civilisation, knowledge society, information society

Makarov (2004) “The term “knowledge economy” was coined by the Austrian-American economist Fritz Machlup (1962) in reference to one of the sectors of the economy. Today this term, together with the term “knowledge-based economy,” is used to designate a type of economy in which knowledge plays a crucial role and the production of knowledge is the main source of growth. Such widely used concepts as “innovation economy,” “high-technology civilization,” “knowledge society” and “information society” are close to the knowledge economy concept.” (page 19)

Digital economy, information economy, knowledge-based economy, weightless economy, virtual economy, Internet economy, electronic commerce, e-commerce, e-economy, new economy

Piazolo (2001) “Various catchwords have been coined to capture the essence of the economy-wide consequences resulting from an increased use of processed digital information and from the application of the Internet for a wide array of services (software programming, webpage

maintenance, ticket and hotel reservations, on-line information and support, ordering facilities, publishing, indexing or abstracting etc.) as well as transactions (delivering music, movies, documents, literature or software in digital form). The following catchwords aim at different characteristics of this phenomenon but are frequently used as synonyms: “digital economy”, “information economy”, “knowledge-based economy”, “weightless economy”, “virtual economy”, “Internet economy”, “electronic commerce”, “e-commerce”, “e-conomy”, or maybe more capacious “new economy”. Some authors have tried to assign distinguishing concepts to this variety. For example, Kling and Lamb (2000) suggest to use the term “information economy” to include all informational goods and services like publishing, research, legal and insurance services, entertaining, and teaching in all of its forms, and the term “digital economy” to address (only) the goods and services whose development, production, sale, or provision is critically dependent upon digital technologies. Furthermore, the term “new economy” is associated for them to the possible consequences of the information economy and the digital economy, namely high growth, low inflation, and low unemployment. However, in many papers - including the present one - the concept of the “new economy” is wider and includes the characteristics of the “information economy” and of the “Internet economy” as subsets. In the following, the term “new economy” describes an economy where both final output and intermediate input predominantly consist of information and where the modern (digital) information and communication technologies provide world-wide access to almost any available information. These new technologies might have the potential to enable an increase in the productivity of conventional business practices, but also facilitate the establishment of new processes and products. Consequently, the evolution of the new economy should not be considered as being restricted to the information sector, but as a far reaching process that might alter and extend the products and production processes within the whole economy. This means also that the consequences of being excluded from the progress of the new economy might be rather detrimental for (developing) countries.” (page 29)

appendix 1.B: the founding works: Knight (1921b) and Coase (1937)

In this Appendix we give brief overviews of the two works most commonly cited as the founding works of the modern theory of the firm: “Risk, Uncertainty and Profit” by Frank Knight and

“The Nature of the Firm” by Ronald Coase.

“Risk, Uncertainty and Profit”: Knight (1921b)

Demsetz (1988b: 244) goes so far as to state “[...] it can be said without hesitation that Knight launched the modern theory of the firm in 1921.” However the primary motivation of Knight (1921b) wasn’t to examine the organisation of the firm or explain the existence of the firm, it was to explain the existence of profit. The theory of the firm was a byproduct of his explanation of profit. Although as Foss (2000: xix) notes “[...] the connection between his theory of profits and his theory of the firm is not entirely clear.”

The standard view of Knight’s rationale for the existence of the firm, see for example Demsetz (1995: 2-4), doesn’t depend on profit, but on risk, or more accurately, risk redistribution. The entrepreneur forms a firm as a way of specialising in risk-taking. Employees receive a stipulated income and the entrepreneur takes the residual income of the firm and thereby bears most of the risk associated with uncertainty about the future. The advantage of the firm, according to the standard view, is that there are gains to be made from this redistribution of risk between the entrepreneur and the firm’s employees. The profit and loss consequences of fluctuations in the business outcomes can be better absorbed by the entrepreneur than the employees. The entrepreneur contracts to pay a fixed wage to workers, thereby protecting them from the fluctuations in business outcomes. Knight sees this as efficient since the entrepreneur is less averse to bearing risk. Presumably, risk is not handled as well without firms.

Another view is offered by Boudreaux and Holcombe (1989).⁴⁸ They see Knight’s theory of the firm as stemming from the role of the entrepreneur as the person who decides what to produce or whether or not to introduce a new production process in a world of Knightian uncertainty. For Knight, the goods and services to be produced are not given, as in the neoclassical theory, thus entrepreneurs must make a decision as to which goods to produce. Given that the entrepreneurs face a world of uncertainty, such decisions must be made on the basis of ‘intuitive judgement’. The need for ‘judgement’ is due to the entrepreneur having to deal with uncertainty resulting from the fact that prices of the outputs are unknown when the decisions about production are made. This price uncertainty is the result of changing consumer desires and the uncertainty as to the reactions of competitors. Entrepreneurs differ from non-entrepreneurs in that entrepreneurs receive the

⁴⁸See Foss (1993) for criticism of Boudreaux and Holcombe.

return from ‘judgement’, that is, entrepreneurs receive the residual (positive or negative) left after the costs incurred at the time the production decision was made are subtracted from revenues.

For Boudreaux and Holcombe the “distinguishing characteristic of the Knightian entrepreneur [...] is that he makes decisions under uncertainty about how resources will be allocated.” (Boudreaux and Holcombe 1989: 152). The Knightian firm’s primary function is, in Boudreaux and Holcombe’s view, entrepreneurial, decisions must be made without the guidance of market prices since the market doesn’t exist yet. Entrepreneurial activity is necessary for the development of markets. New goods create new markets. For Knight, the products to be produced is a decision made within the firm. The entrepreneur is the person in the firm who makes such decisions. Thus for Boudreaux and Holcombe the Knightian theory of the firm is driven by a theory of the entrepreneur, this they claim differentiates the Knightian theory from that of Coase, who they argue puts forward a theory of management that leaves no room for genuine entrepreneurship. For Boudreaux and Holcombe, the Knightian firm exists in order to facilitate decision making in a world of true uncertainty, that is, to facilitate true entrepreneurial decision making.⁴⁹ Presumably, such decision making is not as efficient without firms.

Barzel (1987) and McManus (1975) put forward a moral hazard explanation for the Knightian firm. The firm arises here “because, for certain kinds of risks, the functions of risk taking and management are inseparable due to the prohibitively high costs of enforcing constraints that would induce one individual, the manager, to maximize the wealth of another, the risk-taker.” (McManus 1975: 348). As noted in the redistribution of risk story above, firms are one way of specialising in risk-taking. Knight was aware of contractual and insurance arrangements as alternatives to the firm as ways of specialising in risk-taking but thought, because of the moral hazard problems, they were particularly costly to enforce in the case of risks of enterprise and hence the need for the creation of a firm. Presumably monitoring the manager is easier for the risk-taker in a firm that it is on the market.

An alternative view is given by Langlois and Cosgel (1993). Here it is argued that Knight’s theory of organisation has things in common with the more recent incomplete contracts approach

⁴⁹Foss (1993: 273) conceptualises this as “the firm and vertical integration exist because entrepreneurs cannot communicate—without exorbitant information costs—their idiosyncratic ‘visions’ (innovations) to owners of assets necessary for realizing this vision; therefore, they integrate such activities”. This inability to communicate with assets owners means that it is difficult to hire assets on the market and thus the need for entrepreneurs to supply the needed assets themselves by forming a firm.

to the firm.⁵⁰ Langlois and Cosgel summarise their view of Knight's theory of organisation as

“[b]ecause of the non-mechanical nature of economic life, novel possibilities are always emerging, and these cannot be easily categorized in an intersubjective way as repeatable instances. To deal with this “uncertainty,” one must rely on judgment. Such judgment will be one of the skills in which people specialize, yielding the usual Smithian economies. Moreover, some will specialize in the judgment of other people's judgment. As the literature since Coase [1937] suggests, however, a theory of specialization is not by itself a theory of organization, since, in the absence of transaction costs, there is no reason why the division of labor could not be undertaken through markets rather than within a firm. Knight's answer is that the function of judgment is ultimately non-contractible.” (Langlois and Cosgel 1993: 462).

The non-contractibility of judgement leads to the entrepreneur's skills not being tradable on markets, thus the division of labour cannot “be undertaken through markets rather than within a firm” and hence the need for the firm.⁵¹ The optimal organisational structure that results from this has the entrepreneur being the residual claimant, and he hires the other agents for a fixed payment. Langlois and Cosgel argue that incompleteness results in the entrepreneur owning the other assets in the firm on the assumption that the entrepreneur's participation is the most important to the resulting joint product. If we compare this case with that of the standard risk redistribution case noted above, we see that the residual claimant doesn't so much insure the other agents, as in the risk redistribution story, rather it is simply that, due to the non-contractibility, the optimal arrangement is for the entrepreneur to receive the residual and the other agent to receive a fixed payment.

Thus if one wished to write Whig History, Knight's theory of the firm would be a forerunner, not of the theory of moral hazard and asymmetric information, but of the incomplete contracts approach to vertical integration. Langlois and Cosgel contend that Knight saw the causes of incompleteness in the lack of knowledge of the categories of action and the consequent need for judgement. For Knight incompleteness of contract was ultimately a matter of uncertainty.

⁵⁰See Grossman and Hart (1986), Hart and Moore (1990) and Hart (1995).

⁵¹Foss and Foss (2006: 2) note “[...] there is no market for judgment that entrepreneurs rely on, and therefore exercising judgment requires the person with judgment to start a firm”.

“The Nature of the Firm”: Coase (1937)⁵²

The importance of Coase (1937) stems from the fact that it was the major catalyst, albeit with a long delay, for the modern theory of the firm and the theory of economic organisations more generally. Coase notes “[t]he article was not an instant success.” (Coase 1988b: 23). In fact it took nearly 40 years for it to become an overnight success.

Coase opens the paper by pointing out that there has been, in economics, a failure to clearly state the assumptions on which theories are built. He notes that two questions can be asked of a set of assumptions: Are they tractable? and Do they correspond with the real world? Coase argues that it is important to have a clear definition of the word “firm” since much economic analysis starts with the individual firm rather than the industry and it is important to know the difference between the theoretic firm and the real world firm. The aim of Coase’s paper was to provide a definition of the firm that “is not only realistic in that it corresponds to what is meant by a firm in the real world, but is tractable by two of the most powerful instruments of economic analysis developed by Marshall, the idea of the margin and that of substitution, together giving the idea of substitution at the margin.” (Coase 1937: 386-7).

Coase begins his search for a definition of the firm by pointing out that the standard treatment of the economic system is one where the price mechanism provides all the coordination of resources required.⁵³ Resource allocation is dependent directly on the price mechanism. But in the firm, Coase notes, the price system does not allocate resources, authority does. The use of authority to supersede the price mechanism is, in Coase’s view, the distinguishing mark of the firm. Coase then asks, If all coordination can be done by the price mechanism, why is the firm, with its coordination by authority, necessary?

In Section II, Coase states the the task ahead is to explain why a firm would emerge in a specialised exchange economy. He first points out that it could emerge if it was desired for its own sake. It could arise if some people preferred working under the direction of others or if some people wished to control others. Also firms may arise if customers preferred goods produced in this way to goods produced by other institutional arrangements. However, Coase points out that these motivations can not explain all firms we see, hence there must be other factors involved.

The, now, most famous “other factor” is that there are costs to using the price mechanism.

⁵²For discussion of the origin, meaning and influence of “The Nature of the Firm” see Coase (1988a, b, c).

⁵³See the discussion of the neo-classical model above and in Section 2.2.

To quote Coase (1937: 390-2):

“[t]he most obvious cost of “organising” production through the price mechanism is that of discovering what the relevant prices are. [...] The costs of negotiating and concluding a separate contract for each exchange transaction which takes place on a market must also be taken into account. [...] It is true that contracts are not eliminated when there is a firm but they are greatly reduced. [...] There are, however, other disadvantages-or costs-of using the price mechanism. It may be desired to make a long-term contract for the supply of some article or service. [...] Now, owing to the difficulty of forecasting, the longer the period of the contract is for the supply of the commodity or service, the less possible, and indeed, the less desirable it is for the person purchasing to specify what the other contracting party is expected to do. [...] When the direction of resources (within the limits of the contract) becomes dependent on the buyer in this way, that relationship which I term a “firm” may be obtained. A firm is likely therefore to emerge in those cases where a very short term contract would be unsatisfactory. [...] We may sum up this section of the argument by saying that the operation of a market costs something and by forming an organisation and allowing some authority (an “entrepreneur”) to direct the resources, certain marketing costs are saved. The entrepreneur has to carry out his function at less cost, taking into account the fact that he may get factors of production at a lower price than the market transactions which he supersedes, because it is always possible to revert to the open market if he fails to do this.”

Coase also notes that the different treatment of in house and market transactions by Government and regulatory bodies could also explain why some firms exist. Having explained why a firm could exist, Coase goes on to note that a firm consists of the relationships that are brought into existence when the control of resources is dependent on an entrepreneur.

An advantage of the approach just developed, claims Coase, is that it is possible to give a meaning to a firm becoming larger or smaller. A firm becomes larger when a transaction that could be carried out in the market, is instead organised by the entrepreneur. The firm, therefore, becomes smaller when the entrepreneur gives up organising such a transaction.

Next Coase considers the question as to why, if by creating a firm, the costs of production can be reduced, are there any market transactions at all. “Why is not all production carried on by one big firm?” (Coase 1937: 394). The answer according to Coase is, first, that as a firm gets bigger there may be decreasing returns to entrepreneurial activity. That is, the cost of an additional transaction being organised within the firm may rise. Secondly, as the number of transactions which are organised in house increases, the entrepreneur may fail to place the factors of production in the uses where their value is maximised. This means the entrepreneur fails to make the best use of the available factors of production. Finally the supply price of one or more of inputs to production may increase, because the “other advantages” of a small firm are greater than those of a large firm.⁵⁴ As a result of these factors, “a firm will tend to expand until the costs of organising an extra transaction within the firm become equal to the costs of carrying out the same transaction by means of an exchange on the open market or the costs of organising in another firm.” (Coase 1937: 395).

Coase (1937: 396-7) then notes that all other things being equal, a firm will tend to be larger:

- (a) the less the costs of organising and the slower these costs rise with an increase in the transactions organised.
- (b) the less likely the entrepreneur is to make mistakes and the smaller the increase in mistakes with an increase in the transactions organised.
- (c) the greater the lowering (or the less the rise) in the supply price of factors of production to firms of larger size.

An additional reason for why efficiency will decrease as the firm grows larger is that as more transactions are controlled by an entrepreneur, these transactions are likely to be either different in kind or different in place. Mistakes in decision making are more likely as there is an increase in the spatial distribution of transactions, the dissimilarity of the transaction and in the probability

⁵⁴This point is explained by Coase in footnote 1 on page 395, which reads: “[f]or a discussion of the variation of the supply price of factors of production to firms of varying size, see E. A. G. Robinson, *The Structure of Competitive Industry*. It is sometimes said that the supply price of organising ability increases as the size of the firm increases because men prefer to be the heads of small independent businesses rather than the heads of departments in a large business. See Jones, *The Trust Problem*, p. 531, and Macgregor, *Industrial Combination*, p. 63. This is a common argument of those who advocate Rationalisation. It is said that larger units would be more efficient, but owing to the individualistic spirit of the smaller entrepreneurs, they prefer to remain independent, apparently in spite of the higher income which their increased efficiency under Rationalisation makes possible.”

of changes in prices relevant to production. Changes which lessen the spatial distribution between transactions will lead to an increase in the size of the firm, as will improvements in managerial technique.

The ideas of “combination” and “integration” can be given precise meaning using the analysis presented above. Combination is when transactions normally undertaken by two or more entrepreneurs are undertaken by one and this turns into integration when the transaction was previously carried out on the market. Firms can grow via either or both of these two ways.

In the last section of the paper Coase asks whether the concept of the firm he has developed is realistic and manageable? As to realism, he contends the best way to see what constitutes a firm in practice is to look at the legal relationship between the master and servant or employer and employee.⁵⁵ The essentials of the employer and employee relationship is given by Coase as follows:

1. The servant must be under the duty of rendering personal services to the master or to others on behalf of the master, otherwise the contract is a contract for sale of goods or the like.
2. The master must have the right to control the servant’s work, either personally or by another servant or agent. It is this right of control or interference, of being entitled to tell the servant when to work (within the hours of service) and when not to work, and what work to do and how to do it (within the terms of such service) which is the dominant characteristic in this relation and marks off the servant from an independent contractor, or from one employed merely to give to his employer the fruits of his labour. In the latter case, the contractor or performer is not under the employer’s control in doing the work or effecting the service; he has to shape and manage his work so as to give the result he has contracted to effect. (Coase 1937: 403-4).

It is noted by Coase that what distinguishes an agent from an employee is not the presence or absence of a fixed wage or the payment only of commission, but rather the freedom with

⁵⁵In a footnote Coase explains that the legal concept of employer and employee and the economic concept of a firm are not identical. He notes that the firm may imply control over another person’s property in addition to their labour. But the identity of these two concepts is sufficiently close for an examination of the legal concept to be of value in appraising the worth of the economic concept. However in Coase (1988: 37) he writes “I consider that one of the main weaknesses of my article stems from the use of the employer-employee relationship as the archetype of the firm. It gives an incomplete picture of the nature of the firm. But more important, I believe it misdirects our attention”.

which an agent may carry out his employment. Coase argues that it is the fact of direction that is the essence of the legal concept of the employer and employee relationship just as it was in the economic concept of the firm he developed. He concludes that his definition is therefore realistic. The question is then asked, Is it manageable? Again the answer is yes, the principle of marginalism works smoothly. The question is, Does it pay to organise an additional transaction under a given entrepreneur? Should the transaction be undertaken by this firm or some other firm or in the market. At the margin the cost of undertaking the transaction in any given firm will equal the cost to either another firm or in the market.

In Coase's work we see most of the main issues of the modern theory of the firm being raised together for the first time. He sets out to "discover why a firm emerges at all in a specialized exchange" – a question about the existence of the firm; he also sets out to "study the forces which determine the size of the firm" – an issue to do with the boundaries of the firm; and he inquires into the reasons for "diminishing returns to management" – issues to do with the internal organisation of the firm. It was the efforts to answer these questions that initiated the change from seeing the theory of the firm as just part of price theory to seeing it as an important topic in its own right. Coase also provides one of the main building block for answers to these issues, the "costs of using the price mechanism" or transaction costs.

Chapter 2

The (non)theory of the knowledge firm¹

“[...] one reason for the existence of a business firm is to economize on the production or application of knowledge.”

Sowell (1980: 33).

2.1 introduction

As noted above the new economy has developed in response to pressures from the application of information technologies in conjunction with increased global competition, deregulation and financial innovation. These factors have altered the whole business environment. Coyle (2001: 230) notes that,

“[t]echnology means the boundaries between what used to be different markets are more fluid, so your new competitor might be from a business you used to think of as entirely different from yours.”

Change is affecting not just markets but also firms within those markets. Coyle (2001: 43) notes that advances in technology are making human capital more important in creating value for firms,

“[f]undamental to all these descriptions of the New Capitalism, however, is the notion that the increased capacities of machines are making the contributions of human more, not less, important.”

Rajan and Zingales (2003: 80) argue,

“[i]ncreased competition, changes in technology, and widespread access to finance have reduced the advantages of the large, vertically integrated firm. We should therefore expect the largest firms to have shrunk. This is indeed the case.”

¹A revised version of this chapter appeared as Walker (2010).

They go on to point out that these same factors have also affected the relationship between physical and human capital in firms' creation of value and this is changing the organisational structure of the firm.

“Human capital is replacing inanimate assets as the most important source of corporate capabilities and value. In both their organizational structure and their promotion and compensation policies, large firms are becoming more like professional partnerships.” (Rajan and Zingales 2003: 90).

Further, Rajan and Zingales (2003: 87) argue that we are in fact seeing a new “kinder, gentler firm”. This is in response to the changing balance of power within firms following on from the increasing importance of the worker. But as Coyle (2001: 246-7) points out one drawback of this increased importance of human capital is the diminished ability of managers to (formally) control the activities of their workforce. Fewer of a knowledge workers activities can be formally contracted upon, a large proportion of their work is, by its nature, non-contractible.² As an example, How can you verify to a third party (e.g. a court) whether the failure by your R&D team to make a major breakthrough was because it really isn't feasible or because they just didn't put in enough time and effort?³ In Rajan and Zingales's view,

“[t]he single biggest challenge for the owners or top management today is to manage in an atmosphere of diminished authority. Authority has to be gained by persuading lower managers and workers that the workplace is an attractive one and one that they would hate to lose. To do this, top management has to ensure that work is enriching, that responsibilities are handed down, and rich bonds develop among workers and between themselves and workers.” (Rajan and Zingales 2003: 87).

That firms are changing matters because firms are the institutional structure within which most economic activity takes place and so as they change much of our economic lives change. Herbert Simon (1991: 27) makes this point about the importance of firms by asking us to envision a mythical visitor from Mars. This visitor approaches Earth from space equipped with a telescope

²This suggests that the reference point approach (see chapter 4) may be valuable in modelling the human capital based firm.

³Coyle (2002: 246-7) argues that individuals investing in acquiring a reputation is a response to this problem. Reputation as to the quality of human capital has increased economic value when human capital itself is valuable.

which reveals social structures. What our visitor's telescope would display is, according to Simon, that firms are the "dominant feature of the landscape". For Simon the view that our visitor would get of the developed world or parts of the old Soviet Union or areas of urban China or urban India is one where most of the economic activity takes place, not within markets or self-sufficient households, but within the framework of firms.⁴ But despite the obvious empirical importance of the firm, when our visitor turns its attention to an overview of the theory that purports to explain this "dominant feature of the landscape", its survey would reveal a somewhat peculiar looking theoretical terrain. As Oliver Hart has written,⁵

"[a]n outsider to the field of economics would probably take it for granted that economists have a highly developed theory of the firm. After all, firms are the engines of growth of modern capitalistic economies, and so economists must surely have fairly sophisticated views of how they behave. In fact, little could be further from the truth. Most formal models of the firm are extremely rudimentary, capable only of portraying hypothetical firms that bear little relation to the complex organizations we see in the world. Furthermore, theories that attempt to incorporate real world features of corporations, partnerships and the like often lack precision and rigor, and have therefore failed, by and large, to be accepted by the theoretical mainstream."

(Hart 1989: 1757).

While Hart's point is made with reference to the orthodox view of the theory of the physical capital based firm it applies with even greater vengeance when we consider the human capital based firm relevant to the knowledge or information economy. None of the textbook (neoclassical) model, the transaction cost model, the incentive-system approach and the Grossman Hart Moore (GHM) approach to the firm is able to fully capture the changes to the firm that the movement

⁴Roberts (2004: 77-8) explains that "[i]n fact, John McMillan (2002: 168-9) estimates that less than a third of all the transactions in the U.S. economy occur through markets, and instead over 70 percent are within firms." Lafontaine and Slade (2007: 629) state "[d]ata on value added, for example, reveal that, in the United States, transactions that occur in firms are roughly equal in value to those that occur in markets."

⁵In personal correspondence (November 2008 - used here with permission), Professor Hart said of the 1989 quote "The language of 1989 is strong, and I'd probably tone it down a bit now. There's been a lot of work in the last twenty years, and some progress. However, we are still not at the point where we have good models of the internal organization of large firms."

A catalogue of the progress referred to would include Aghion and Tirole (1997), Alonso, Dessein and Matouschek (2008), Bolton and Dewatripont (1994), Cremer, Garicano and Prat (2007), de Meza and Lockwood (1998), Dessein (2002), Dessein and Santos (2003), Garicano (2000), Hart (2009), Hart and Holmström (2010), Hart and Moore (2007), Holmström (1999), Holmström and Milgrom (1991), Holmström and Milgrom (1994), Rajan and Zingales (1998), Roberts (2004), Spulber (2009), Van den Steen (2010) and Wernerfelt (1997).

towards a knowledge economy entails. As knowledge becomes more important in the economy, human capital becomes more important to the firm and physical capital relatively less so. The major asset of a knowledge firm is its workers' human capital. Crucially, this increases the workers' importance and thus improves their outside options and changes the power relationships within the firm. Firms' organisational structures are changing to reflect this new reality. On the other hand the orthodox theories of the firm are, in the main, silent about the changes that this increase in the importance of human capital is bringing about. This chapter will examine these theories in an attempt to delineate the reasons for this silence.

2.2 the neoclassical theory of the firm

The most deafening silence comes from the neoclassical model. And for good reason. The model of the "firm" found in most microeconomic textbooks does not incorporate knowledge – individual or institutional – it can't since it isn't a "theory of the firm" in any meaningful sense.⁶ The output side of the standard neoclassical model is a theory of supply rather than a true theory of the firm. In neoclassical theory, the firm is a 'black box' there to explain how changes in inputs lead to changes in outputs.⁷ The firm is a conceptualisation that represents, formally, the actions of the owners of inputs who place their inputs in the highest value uses, and makes sure that production is separated from consumption. The firm produces only for outsiders, there is no on-the-job or internal consumption, no self-sufficiency. In fact there are no managers or employees to indulge in on the job consumption and as production is separated from consumption, no self-sufficiency. Production for outsiders is, according to Demsetz (1995), the definition of a firm in the neoclassical model:

“[w]hat is needed is a concept of the firm in which production is exclusively for sale to those formally outside the firm. This requirement defines the firm (for neoclassical theory), but it has little to do with the management of some by others. The firm in

⁶For an example of an approximation to what production could look like in a neoclassical world see footnote 26, page 25.

⁷It is a black box in the sense that inputs go in and outputs come out, without any explanation of how one gets turned into the other. The firm is taken as given; no attention is paid to how it came into existence, the nature of its internal organisation, where the boundary between one firm and another is or between a firm and the market; or whether anything would change if two firms merged and called themselves a single firm.

neoclassical theory is no more or less than a specialized unit of production, but it can be a one-person unit.” (Demsetz 1995: 9).

As inputs are combined in the optimal fashion by the actions of independent owners of inputs motivated solely by market prices, there is no need for ‘management of some by others’, there is no role for managers or employees. Also note that as competition assures the absence of profits and losses in equilibrium, there is no need to have a residual claimant. This means that, in one sense at least, there are no owners of the firm.⁸ As there are no physical assets controlled by the firm, there are no (residual) control rights over these assets to allocate. This implies there are no owners of the firm in the Grossman Hart Moore sense.

The neoclassical production function is a way of representing the (efficient) black box conversion of inputs into outputs but tells us little about the inner workings of the black box. The production function is independent of the institutional framework of output creation. It can be given two interpretations: it can represent the production method of a single firm, of which all known firms are just divisions or, equally, it could represent the outcome of a series of purely market based transactions which give rise to the observed outputs.

Thus it represents the ‘firm’ without explaining the ‘firm’. The boundaries of the firm is an issue described by Williamson (1993: 4) as one of

“[. . .] make-or-buy. What is it that determines which transactions are executed how? That posed a deep puzzle for which the firm-as-production function approach had little to contribute.”

Hart (1995: 17) criticises the neoclassical model based on three characteristics of the theory. First, he notes that the theory completely ignores incentive problems within the firm. The firm is a perfectly efficient ‘black box’. Second, the theory has nothing to say about the internal organisation of the firm. Nothing is said about the hierarchical structure, how decisions are made, who has authority within a firm. Third, the theory tells us nothing about how to pin

⁸Hansmann (1996), for example, states “[a] firm’s “owners,” as the term is conventionally used and as it will be used here, are those persons who share two formal rights: the right to control the firm and the right to appropriate the firm’s profits, or residual earnings (that is, the net earnings that remain with the firm after it has made all payments to which it is contractually committed, such as wages, interest payments, and prices for supplies).” (page 11) He later adds “[n]ot all firms have owners. In nonprofit firms, in particular, the persons who have control are barred from receiving residual earnings.” (page 12).

down the boundaries of the firm. The theory is as much a theory of plant or division size as firm size. As Hart points out

“[t]o put it in stark terms . . . neoclassical theory is consistent with there being one huge firm in the world, with every existing firm . . . being a division of this firm. It is also consistent with every plant and division of an existing firm becoming a separate and independent firm.” (Hart 1995: 17).

Cyert and Hedrick (1972) addressed similar points. They argue that in the neoclassical system the firm doesn't exist, that no real world problems of firms are considered, that there are no organisational problems or any internal decision-making process at all.

“In one sense the controversy over the theory of the firm has arisen over a non-existent entity. The crux of microeconomics is the competitive system. Within the competitive model there is a hypothetical construct called the firm. This construct consists of a single decision criterion and an ability to get information from an external world, called the “market” [8, Cyert and March, 1963, pp. 4-16]. The information received from the market enables the firm to apply its decision criterion, and the competitive system then proceeds to allocate resources and produce output. The market information determines the behavior of the so called firm. None of the problems of real firms can find a home within this special construct. There are no organizational problems nor is there any room for analysis of the internal decision-making process.” (Cyert and Hedrick 1972: 398).

Thus within the neoclassical model of the price system, the firm's only role is to allow input owners to convert inputs into outputs in response to market prices. Firms have no internal organisation since they have no need of one, they have no owners since there is nothing to own. Questions about the existence, definition and boundaries of the firm are to a large degree meaningless within this framework since firms, by any meaningful definition of that term, do not really exist. As Foss, Lando and Thomsen (2000: 632) summarise it:

“[t]he pure analysis of the market institution leaves almost no room for the firm (Debreu 1959). Under the assumption of a perfect set of contingent markets, as well

as certain other restrictive assumptions, the model describes how markets may produce efficient outcomes. The question how organizations should be structured does not arise, because market-contracting perfectly solves all incentive and coordination issues. By assumption, firm behaviour (profit maximization) is invariant to institutional form (e.g. ownership structure). The whole economy can operate efficiently as one great system of markets, in which autonomous agents enter into very elaborate contracts with each other. However, by treating the firm itself as a black box, where internal structure, contracts, etc. disappear from the picture, there are many other issues that the theory cannot address. For example, the theory does not tell us why firms exist.”

Given there is no serious modelling of the firm, there is no way to deal with the knowledge firm within this framework. There are no organisational problems or any internal decision-making process, in fact, there is no organisational structure at all and thus the advent of the knowledge economy can not alter this nonexistent structure. As there is no role for managers or employees there can be no knowledge workers in the firm. But the growth in knowledge workers is one of the most important aspects in the development of the knowledge society. And their advent will change the way we think about firms.

2.3 the transaction cost approach

The recognition that writing a contract is costly lies at the heart of the large and growing literature on the transaction cost approach to the firm. This literature has been developed by, among others, Williamson (1975, 1985, 1996) and Klein, Crawford and Alchian (1978). Coase (1937) started the transaction cost approach by making a simple, but important point, there are costs to carrying out market transactions. Costs, which today, are called transaction costs.⁹ Coase describes such costs as:

“[w]hat the prices are have to be discovered. There are negotiations to be undertaken,

⁹Coase (1937) does not use the term ‘transaction costs’. According to Backhouse (2002: 317) “[t]he term ‘transaction cost’ was first used by Marschak in 1950, [...]” while Hardt (2009: 30) claims “[...] in 1940, Tibor Scitovsky introduced the label of transaction costs into the economic vocabulary (Hardt 2006).” Hardt (2006: 11-2) discusses the relationship between what Scitovsky and Marschak said.

contracts have to be drawn up, inspections have to be made, arrangements have to be made to settle disputes, and so on.” (Coase 1992: 715).

Roberts (2004: 90) defines transaction costs as

“[...] the costs of finding and qualifying trading partners, of establishing specifications and prices, of negotiating and drafting contracts, and of monitoring and enforcing agreements. They are also the opportunity costs of lost benefits that are occasioned by the difficulties of developing complete, enforceable agreements between separate parties.”

Transaction cost economics is based on the ideas of bounded rationality – intendedly rational, but only limitedly so – and opportunism – self-interest with guile. Two consequences of these assumptions are that contracts will be incomplete and contracts may not be honoured. Hart (1995: 23) argues that in transaction cost economics contracts are incomplete for three reasons, all of which are, in his view, forms of bounded rationality.

“First, in a complex and highly unpredictable world, it is hard for people to think very far ahead and to plan for all the various contingencies that may arise. Second, even if individual plans can be made, it is hard for the contracting parties to negotiate about these plans, not least because they have to find a common language to describe states of the world and actions with respect to which prior experience may not provide much of a guide. Third, even if the parties can plan and negotiate about the future, it may be very difficult for them to write their plans down in such a way that, in the event of a dispute, an outside authority – a court, say – can figure out what these plans mean and enforce them. In other words, the parties must be able to communicate not only with each other, but also with outsiders who may have little knowledge about the environment in which the contracting parties operate.”

But why do incomplete contracts matter? If parties to a contract can renegotiate the contract, and thus fill in any gaps, why is contractual incompleteness an issue? First, there may be costs to haggling over the terms and conditions of the new contract. Haggling over the division of surpluses is inefficient in that it is time-consuming and wastes resources while serving no

productive purpose. Second, informational asymmetries may prevent the parties from reaching an efficient outcome. Assume the buyer of an input does not know the actual cost of the input but only knows the probability distribution from which the costs are drawn. The seller of the input knows the true cost. Supply of the input can be ensured by a high price offer from the buyer. If the buyer wants to cover the seller's costs with probability one then this could be an expensive option as the buyer will be overpaying in the low cost states of the world. If a low price offer is made then the seller will not supply in the high cost states of the world and so profit maximising behaviour by the buyer may lead to profitable trades not taking place.¹⁰ An important point here is that if switching to a new trading partner at the renegotiation stage was easy then neither of these two costs would be significant. Thus for these costs to be high there must be something preventing the switching to a new trading partner. That 'something' is normally taken to be ex ante relationship-specific investment. In other words, a prior investment whose value is greatest when the contracting parties relationship extends over time but for which little or no value is created if the parties relationship breaks down. Such investments are normally thought of as investments in physical capital but as Roberts (2004: 91) points out,

“[f]irm-specific human capital—knowledge that is only (or especially) valuable in the context of employment with a particular firm—is another example.”

Relationship-specific investments result in there being a third cost of incomplete contracts. It may be that because contracts are incomplete parties are deterred from making efficient relationship-specific investments. In a comprehensive contracts world, relationship-specific investments could be protected by enforceable contracts. In an incomplete contracts world this may not be possible. Parties will recognise that any long-term contract between them will be incomplete. This could be because of problems such as being unable to specify far in advance the quality and quantity of the goods traded. This incompleteness will mean the contract will be subject to renegotiation. Even in a situation where problems of haggling and asymmetric information do not arise the gains from trade will have to be divided and this division will depend on the ex post bargaining strengths

¹⁰Assume the buyer values the input at 1. The seller's costs are $\frac{1}{2}$ or 1, each with probability $\frac{1}{2}$. An offer by the buyer of 1 ensures supply in all states of the world but results in zero profits for the buyer. An offer of $\frac{1}{2}$ results in non-supply in the high cost states of the world but profits of $1 - \frac{1}{2} = \frac{1}{2}$ in the low cost states of the world. Thus the low price, trade only $\frac{1}{2}$ the time offer is more profitable than the high price, trade at all times offer and therefore profitable trades do not take place.

of the parties rather than on what is written in the contract or on the grounds of economic efficiency. This raises the fear that one party could be exploited by another. For example, an input supplier, who has made (sunk) relationship specific investments, may worry that the buyer will take advantage of these investments to drive the price he pays for the input down to around variable cost, so there is little or no contribution to covering the investment costs. But it is still not worthwhile for the supplier to stop supplying the buyer. This is simply because the sunk investment costs have to be paid whether or not supply takes place, and the asset has no other profitable use. This exploitation of a quasi-rent – returns greater than what is required to keep asset in its current use once it has been created – is the classic “hold-up” problem.

Realising that such exploitation could occur, may result in the supplier being unwilling to undertake the investment in the first place. Thus the buyer, if he wants the input supplied at all, may have to produce it himself. The buyer could purchase the supplier, i.e. vertically integrate with the supplier, thereby making the supplier part of the buyer’s firm. This eliminates the hold-up problem since the quasi-rents now accrue to the buyer. Use of the investment asset is now directly under the control of the buyer and all costs of and benefits from investment have been internalised. The investment decision is now just part of the buyer’s profit maximisation problem.

This argument that vertical integration deals with the hold-up problem is strongest when the assets involved are physical. The argument is less applicable to relationship-specific investments in human capital. As human capital can not be owned, by anyone other than the particular individual acquiring it, the potential for opportunistic behaviour still exists even after vertical integration. The buyer does not have control over the human capital in the way he does over the physical capital. The individual who invests in the relationship-specific human capital still controls that capital even after becoming part of the buyer’s firm and thus they can still hold-up the buyer. Thus the explanation for the existence of firms as the answer to hold-up problems, related to relationship-specific investments, doesn’t hold for the case of a human capital only firm.

This point has been commented upon by Klein (1988: 204) in his discussion of the (in)famous case of the vertical integration of General Motors with Fisher Body.¹¹ It is noted that vertical

¹¹For more viewing of the soap opera that is the literature on the General Motors-Fisher Body integration, see Baird (2003), Casadesus-Masanell and Spulber (2000), Coase (2000), Coase (2006), Freeland (2000), Goldberg (2008), Klein (1988), Klein (1996), Klein (2000), Klein (2007), Klein (2008), Klein, Crawford and Alchian (1978) and Nicita (2004).

integration did not eliminate the Fisher brothers, they just went from being an independent contractor to being employees of General Motors. Given that human capital can not be owned, Klein asks “[...] how did the vertical integration of General Motors with Fisher reduce the hold-up problem?” (Klein 1988: 206). He argues that even post integration the Fisher brothers could still hold up General Motors, in this case for their human capital specific investments.

2.4 the incentive-system theory

This approach to the theory of the firm was developed by Holmström and Milgrom (1991, 1994); Holmström and Tirole (1991) and Holmström (1999) and has been described by Gibbons (2005: 206) as an “accidental theory of the firm”. The reason for Gibbon’s description is that focus of these papers was not on the make-or-buy problem of the transaction cost or Grossman Hart Moore approaches but rather on a multi-task, multi-instrument principal-agent problem and its application to the firm was an “accidental” outcome of this endeavour.

To analyse the application of this theory to the knowledge firm we will take advantage of Gibbons (2005: 210-2) “stick-figure rendition” of the theory. In the simple Gibbon’s model there is a technology of production which is a linear combination of the Agent’s actions: $y = f_1a_1 + f_2a_2 + \varepsilon$ where the a_i s are actions chosen by the Agent and ε is a noise term. Evaluation of performance by the Agent is based upon the indicator p which is a different linear combination of the Agent’s actions: $p = g_1a_1 + g_2a_2 + \phi$, where ϕ is another noise term. Gibbons assumes that both parties are risk-neutral, ω is the total compensation paid by the Principal to the Agent and $c(a_1, a_2)$ represents the Agent’s cost function. Gibbons makes the assumption that,

$$c(a_1, a_2) = \frac{1}{2}a_1^2 + \frac{1}{2}a_2^2.$$

In addition Gibbons assumes that the Principal and the Agent sign a linear contract, $\omega = s + bp$, based upon the performance indicator p .

To provide a theory of the firm, this model has to be extended to include physical capital, a machine, which is used by the Agent during the production of y . Post production this capital has a value determined by a third linear combination of the Agent’s actions: $v = h_1a_1 + h_2a_2 + \xi$ where ξ is a third noise term. The choice variables in the model are therefore the Agent’s actions

$a_i, i = 1, 2$ and b the slope of the optimal contract. As a point of comparison note that the first-best actions of the Agent are those which maximise the expected total surplus, that is, they will maximise the expected value of the sum of the Principal's payoff, $y - \omega$, the Agent's payoff, $\omega - c(a_1, a_2)$ and the value of the physical asset, v .

$$\begin{aligned}
TS^{FB} &= E(y - \omega + \omega - c(a_1, a_2) + v) \\
&= E(y + v) - c(a_1, a_2) \\
&= E(f_1 a_1 + f_2 a_2 + \varepsilon + h_1 a_1 + h_2 a_2 + \xi) - c(a_1, a_2) \\
&= f_1 a_1 + f_2 a_2 + h_1 a_1 + h_2 a_2 - c(a_1, a_2) \text{ assuming } E(\varepsilon) = E(\xi) = 0 \\
&= f_1 a_1 + f_2 a_2 + h_1 a_1 + h_2 a_2 - \frac{1}{2} a_1^2 + \frac{1}{2} a_2^2
\end{aligned}$$

and therefore $a_1^{FB} = f_1 + h_1$ and $a_2^{FB} = f_2 + h_2$.¹² TS^{FB} is independent of the value of b .

If the Principal owns the machine then the Agent is an employee of his firm and the Principal's payoff is $y + v - \omega$, while the Agent's payoff is $\omega - c$. In this case the Agent's optimal actions maximise

$$\begin{aligned}
E(\omega) - c(a_1, a_2) &= E(s + bp) - \frac{1}{2} a_1^2 + \frac{1}{2} a_2^2 \\
&= E(s + b(g_1 a_1 + g_2 a_2 + \phi)) - \frac{1}{2} a_1^2 + \frac{1}{2} a_2^2 \\
&= s + b g_1 a_1 + b g_2 a_2 - \frac{1}{2} a_1^2 + \frac{1}{2} a_2^2 \text{ assuming } E(\phi) = 0.
\end{aligned}$$

The optimal actions are therefore, $a_{1E}^*(b) = b g_1$ and $a_{2E}^*(b) = b g_2$.¹³ The efficient contract slope,

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$$\begin{aligned}
\frac{\partial TS^{FB}}{\partial a_i} &= 0 \\
\Rightarrow f_i + h_i - a_i &= 0 \\
\Rightarrow a_i^{FB} &= f_i + h_i
\end{aligned}$$

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$$\begin{aligned}
\frac{\partial E(\omega) - c(a_1, a_2)}{\partial a_i} &= 0 \\
\Rightarrow b g_i - a_i &= 0 \\
\Rightarrow a_i^*(b) &= b g_i
\end{aligned}$$

b_E^* , maximises the expected total surplus, $E(y + v) - C(a_1, a_2)$ or

$$TS_E(b) = (f_1 + h_1)a_{1E}^*(b) + (f_2 + h_2)a_{2E}^*(b) - \frac{1}{2}a_{1E}^*(b)^2 + \frac{1}{2}a_{2E}^*(b)^2.$$

Alternatively the machine can be owned by the Agent. Gibbons interprets this case as the Agent being an independent contractor. In this situation the payoffs for the Principal will be $y - w$ and for the Agent they are $w + v - c$. The optimal actions for the Agent will therefore be, $a_{1C}^*(b) = g_1b + h_1$ and $a_{2C}^*(b) = g_2b + h_2$.¹⁴ For this case the efficient slope, b_C^* , will maximise the expected total surplus of

$$TS_C(b) = (f_1 + h_1)a_{1C}^*(b) + (f_2 + h_2)a_{2C}^*(b) - \frac{1}{2}a_{1C}^*(b)^2 + \frac{1}{2}a_{2C}^*(b)^2.$$

Gibbons (2005: 211) summaries the analysis so far as

“[...] having the Agent own the asset causes the Agent to respond to a given contract slope (b) differently than when the Agent does not own the asset [i.e. $a_{iE}^*(b) \neq a_{iC}^*(b)$], so the make-or-buy problem amounts to determining which of the Agent's best-response functions – that of the employee, $(a_{1E}^*(b), a_{2E}^*(b))$, or that of the independent contractor, $(a_{1C}^*(b), a_{2C}^*(b))$ – allows the parties to achieve greater total surplus.”

The discussion so far has relied on an unspecified assumption; that the value of the asset is not contractible and therefore the owner of the asset receives its value. Since the asset's value is not contractible, putting ownership in the hands of the Agent provides him with incentives that cannot be replicated via a contract. But providing the Agent with the incentive to increase the value of the asset may or may not help the Principal control the Agent's incentives via contract. That is, if the Agent owns the asset he has two sources of incentives, the asset's post-production value and contracted for performance. Without ownership he concentrates solely on the contracted for performance. Integration would be efficient, that is, having the Principal own the asset is efficient, when having the Agent do so hurts the Principal's efforts to create incentives

¹⁴ $E(\omega + v) - c(a_1, a_2) = E(s + b(g_1a_1 + g_2a_2 + \phi) + h_1a_1 + h_2a_2 + \xi) - \frac{1}{2}a_1^2 + \frac{1}{2}a_2^2$
 $= s + bg_1a_1 + bg_2a_2 + h_1a_1 + h_2a_2 - \frac{1}{2}a_1^2 + \frac{1}{2}a_2^2$ assuming $E(\phi) = E(\xi) = 0$.

The first order conditions are therefore of the form, $bg_i + h_i - a_i = 0$ which gives $a_{iC}^*(b) = g_ib + h_i$, $i = 1, 2$.

via contract.

When we turn to consider the case where the additional capital in the model isn't a machine but is human capital an important difference arises. Critically, ownership can no longer be transferred, as it can in the physical capital case. If the asset is a human capital asset then, without slavery, ownership can not be transferred, it must remain with the person who made the investment in the first place. Also, as above, the non contractible of the asset's value means the Principal and the Agent can not transfer the value of the asset as part of a contract. So in contrast to the physical asset case, with a human asset, neither ownership nor value can be transferred. Thus if the Agent (Principal) makes an investment the value of the investment stays with the Agent (Principal) no matter what the form of the relationship between the Principal and the Agent. Importantly asset ownership can no longer determine whether the Agent is an employee or a contractor. Therefore a human asset can not serve as an instrument in the incentive problem in the same way as a physical asset. This means that the incentive-system theory (in the telling above) can not act as a model of a human capital based firm.

2.5 the Grossman-Hart-Moore approach

A more recent theory of the firm is based on the work of Grossman and Hart, (1986, 1987) and Hart and Moore (1990).¹⁵ Within the GHM approach ownership is defined in terms of residual control over non-human assets, things such as machinery, inventories, buildings, patents, client lists, firm's reputation etc. Owner-managers employ labour that cannot work without the physical capital these firms own. Dismissal/resignation of the labour requires them to find other physical capital owning organisations (firms) to employ them. On liquidation of the firm, physical capital can be sold and the proceeds disbursed to the owners (shareholders). The standard theory of the firm is based on the role of non-human capital in the firm. The definition of a firm, the determinants of the boundaries of a firm – that is, the determinants of vertical integration of firms, the meaning of ownership of the firm, the nature of authority within the firm are all functions of control rights over the firm's non-human assets. Making non-human assets the

¹⁵Introductions to this literature, of varying technical sophistication, can be found in Aghion and Holden (2011), Bolton and Dewatripont (2005: 498-515), Gibbons (2005), Hart (1988, 1989, 1995) and Moore (1992). For empirical evidence see, for example, Acemoglu, Aghion, Griffith and Zilibotti (2010), Baker and Hubbard (2003, 2004), Pérez-González (2005) and Woodruff (2002).

centre of the theory means that questions to do with the ownership and control of the physical information technology can be addressed, but this concentration on non-human assets means that the theory doesn't deal with firms based on human assets. However it had been noted from the beginning that the theory could be extended to include human capital. As Hart (1988: 151) argues:

“[. . .] one difference with previous work is the emphasis on how integration changes control over physical assets. This is in contrast to Coase's 1937 paper which focuses on the way integration changes an ordinary contractual relationship into one where an employee accepts the authority of an employer (within limits). Note that these approaches are not contradictory. Authority and residual rights of control are very close and there is no reason why our analysis of the costs and benefits of allocating residual rights of control could not be extended to cover human, as well as physical, assets.”

But this extension isn't entirely satisfactory.

Once we move to a situation where firms may own\need little physical capital, then the modern theory of the firm loses much of its main reason for being. Once human capital (labour) becomes the most important\sole creator of wealth\value added then modern economic theory is in need of modification. The theory does not, however, lose all relevance. As Hart (1995: 56-7) explains, at least some, nonhuman assets are essential to a theory of the firm. To see why this may be so consider a situation where 'firm' 1 acquires 'firm' 2, which consists entirely of human-capital. The question Hart raises is, What is to stop firm 2's workers from quitting? Without any physical assets—e.g. buildings—firm 2's workers would not even have to relocate themselves physically. If these workers were linked by telephones or computers, which they themselves own, they could simply announce one day that they had decided to become a new firm. For the acquisition of firm 2 by firm 1 to make economic sense there has to be a source of value in firm 2 over and above the human-capital of the workers. It makes little sense to buy a 'firm' if that 'firm' can just get up and walk away. Hart argues there must be some 'glue' holding firm 2's workers in place.

The value which acts as this glue may consist of as little as a place to meet; the firm's name, reputation, or distribution network; the firm's files, containing important information about its

operations or its customers; or even a contract that prohibits firm 2's workers from working for competitors or from taking existing clients with them should they quit. The source of value may even just represent the difficulty firm 2's workers face in co-ordinating a move to another firm. But, Hart points out, without something binding the firm together, the firm becomes a phantom, and as such we should expect that such firms would be flimsy and unstable entities, constantly subject to the possibility of break-up or dissolution.

Thus even a human-capital based firm will involve some nonhuman-capital, but the human-capital will play the dominate role. The important characteristic of human-capital is that it embodies information and knowledge. A theory of the human-capital based firm has to model this co-existence of the human and nonhuman-capital. Brynjolfsson (1994) deals with the issue by extending the property rights approach to the firm to include information whether this information is embodied in humans, in the form of human-capital, or in artifacts. Rabin (1993) also works within the property rights framework but extends it by assuming that an agent has information about how to make production more productive which they are willing to sell. The problem is if the information is not revealed before the agent is paid, a (potential) buyer may have little reason to believe the agent is truly well-informed, but if the agent reveals the information up front, the buyer could simply use the information without payment. Rabin's answer is that the informed agent gains control over productive assets and thus doesn't have to sell the information. We discuss Brynjolfsson (1994) and Rabin (1993) in more detail in Chapter 3.

2.6 knowledge and production location

In his discussion of the neoclassical model Hart (1995: 17) notes that it tells us nothing about where a firm's boundaries will lie or about the size or location of a plant or factory within a given firm. This approach is consistent with every existing firm being a plant or division of one huge firm which produces everything. It is also consistent with every plant or division of each existing firm being a separate and independent firm in their own right. Thus it is not clear in what organisational form production will occur. Will it be organised as a single large factory, several smaller factories or a household? The GHM approach does delineate the boundaries of the firm but still does not tell us anything about the location or size of a plant or factory which is part of

the firm. Again the form of production organisation is indeterminate. What will be argued below is that the division of knowledge is one important influence on the form of organisation in which production takes place. The most obvious issue has to do with the determination of whether or not work occurs in a centralised factory or in separate households or some combination of the two. This has been an issue since at least the industrial revolution.

In his discussion of the development of the factory system during the industrial revolution Mokyr (2001 and 2002: chapter 4) puts forward the argument that the location of production was dependant, in part, on the trade-off between “the relative costs and benefits of moving people as opposed to moving information.” Mokyr (2002: 120). That is, he develops a line of reasoning that suggests that one factor encouraging the organising of workers under a single roof, rather than in separate households, was the division of knowledge.¹⁶ As long as there was little division of knowledge, so that the knowledge needed to carry out production could be summarised in a few basic rules, the household could know all that was needed to act as the “unit of production”. The cost of moving information was low since there was little of it needed and it could be contained within a household. Moving people between households, however, was slow and costly. But as technology developed, the competence required for production moved beyond the capability of a single household. As the knowledge needed to produce things increased, firms faced two related problems. First, a firm needed to be able to incorporate existing knowledge into their production system and second, they had to be able to generate new knowledge to keep or establish a competitive advantage. Inevitably, specialisation and the division of labour become finer. The way to deal with the increased level of knowledge demanded for production was to divide up the production process into smaller manageable tasks. Workers had knowledge about ever smaller pieces of the production puzzle. A result of this more extensive division of labour, which could in some circumstances reinforce the movement towards a single location factory, was noted by Charles Babbage in his book “On the Economy of Machinery and Manufactures”.¹⁷ Babbage

¹⁶Mokyr (2002: 131) outlines the three main explanations for the rise of the factory. “One relies on fixed costs and technical and physical economies of scale and scope, which might have caused the minimum efficient size of plants to become larger than the household. A second explanation is drawn from the modern micro-economics of the firm: because of asymmetric information and the division of labor, costs were higher in decentralized households, and the new technology changed the benefits and costs of monitoring and the incentives to self-monitor. A third argument is that by concentrating all workers under one roof and placing them under supervision, actual labor effort is enhanced.” To these three Mokyr adds a fourth, the division of knowledge, which we discuss here.

¹⁷See Babbage (1835). For more on Babbage and his work relevant to economics see Rosenberg (1994: chapter 2).

observed that the greater the division of labour the less time required for learning any requisite skills. This results in a lessening of the period during which a new entrant to the workforce would be relatively unproductive and unremunerative. Because less knowledge and training was required to learn to undertake a single operation, as opposed to that required to undertake many different operations, a new employee would more quickly reach a situation where he generates a profit for his employer.

Mokyr points out that the importance of the division of knowledge to the firm was first recognised, albeit in a non-historical setting, by Demsetz (1988a) and formalised by Becker and Murphy (1992). What these works suggested was simply a new interpretation of the role of the firm. Given that there are limitations to what a worker can know, the competence that a firm has to possess to produce must be divided into manageable portions and allocated between the workers. The actions of the different groups of workers are then coordinated by the firm's management. Thus workers who produce on the basis of knowledge they themselves do not possess, have their activities directed by someone who does possess (at least more of) the necessary knowledge. This gives a rationale for management. As there are asymmetries in information among workers, management is required to coordinate the activities of the different groups of employees. If the workers knew everything about the production process they could carry out production without coordination. In this way, direction is a substitute for education, that is, a substitute for the transfer of the knowledge itself. Specialisation in knowledge can, therefore, both exacerbate existing information asymmetries and create new ones. Any information asymmetry gives rise to an organisation problem for the firm; How can agents who possess knowledge be encouraged to reveal their knowledge fully and truthfully to other workers or management? Mokyr argues that

“[p]utting all workers under one roof ensured repeated interaction and personal contact provides maximal bandwidth to maximize the chances that the information will be transmitted fully and reliably. Inside a plant agents knew and could trust each other, and this familiarity turned out to be an efficient way of sharing knowledge.”
Mokyr (2002: 141).

From this it can be seen that as long as the minimum competence needed by a firm is

small, the plant size can also be small and can, therefore, coincide with the household. When the competence needed grows, the unit of production has to change or an efficient network for knowledge distribution has to develop. At a time when the main technique for the distribution of knowledge was direct contract, as at the time of the industrial revolution, such networks in the form of professional associations of mechanics, machinists, engineers etc did develop. But the firm was also an answer to the problem of knowledge distribution. Costs of accessing knowledge were minimised in a single plant where workers could communicate face to face. Factories acted as repositories of technical knowledge and allowed workers to access this information at relatively low cost. Thus factories allowed knowledge to pass in two directions: across space so that other workers could carry out a given task and through time so that knowledge passed from one generation of workers to the next.

McDermott (2001: 48) explains that the transition to factory life altered the incentives for both owners and workers with regard to acquiring knowledge and providing training. Workers now had the opportunity to acquire highly specialised knowhow about both their particular firm's production process and about more general, transferable, skills. Owners now had an incentive to educate their workforce since firms, unlike, households can go out of business if they do not keep up. This gave owners the needed impetus to train their employees. Galor and Moav (2006) also argue that support, from capitalists, for the education of workers was due to the increasing importance of human capital in sustaining their profits. Physical capital accumulation in the process of industrialisation gradually intensified the importance of skilled labour in the production process and thereby generated an incentive for investment in human capital. Due to the complementarity between physical and human capital in production, the capitalists were among the prime beneficiaries of the accumulation of human capital by workers. By putting workers under one roof it was easier for owners to compare workers' productivity and select those who were most suitable for greater training and advancement.¹⁸ This process helped differentiate the firm from the household.

Differences in knowledge between 'principals' and 'agents' can affect the desire to move to

¹⁸Lamoreaux, Raff and Temin (2003: 419) illustrate the basic idea with the example of the Ford Motor Company, "[i]n mass-production enterprises where machines controlled the pace of work—the Ford Motor Company's assembly lines, for example—it was much easier to identify workers who were slacking off or unable to keep up. Hence Ford was able to secure a high level of effort from its work force by paying generous wages and dismissing workers who could not make the grade."

a centralised factory for yet more reasons. Lamoreaux, Raff and Temin (2003) note that the putting-out system in U.S. cotton-spinning came under pressure, in part, because of principal-agent problems between the manufacturers and home based weavers. Lamoreaux, Raff and Temin (2003: 412-3) write,

“[h]owever, the enormous coordination problems that this system entailed (for example, unsupervised weavers working in their homes turning out fabrics of vastly varying qualities) spurred manufacturers to reconcentrate production in factories as soon as technological innovation in the form of the power loom enabled them to expand capacity sufficiently.”

Kim (2001) suggests another way in which information can affect firm organisation and business location. Kim makes the point that specialisation adds to transaction costs via a loss in information. With specialisation, firms know their costs but are uncertain as to the demand for their products while consumers know their demands but not the supply conditions of production. Kim notes that before the late nineteenth century most goods were produced using craft technology and were often produced in homes or at best small shops. Such firms tended to operate in a local or regional market, produced a single line of output, and were owned and managed by a single individual or a partnership. Given the relative simplicity of production, consumers could identify the quality level of products either via physical inspection or through the reputation of the producer or seller. As the production process became more sophisticated and production took place away from the consumers' location, information became more and more asymmetric. Producers knew the quality of their goods but consumers were less well informed. This gave rise to a potential adverse selection or “lemons” problem where bad products drive out good.

Kim's argument is that the modern multiunit firm is a solution to the asymmetric information problem.¹⁹ So, production moved away from single-plant, single-region, single-product firms towards multi-plant, multi-region, multi-product enterprises to counter potential lemons problems. The advantage that the multiunit firm had was that as repeat sales were of greater value

¹⁹ “The multiunit firm is defined as a firm that controls and manages from a central administrative organization the production decisions of establishments or plants in at least two different localities. Multiunit firms are usefully categorized into the following three types: horizontal, vertical, and conglomerate or diversified. Horizontal firms produce the same product in different locations, vertical firms use outputs of some of their plants as intermediate inputs to some of their other plants, and conglomerate or diversified firms manage plants in unrelated industries.” (Kim 1999: footnote 1).

to the multiunit firm they were better able to make large firm-specific, sunk cost investments in advertising and branding to credibly signal to buyers that the costs of renegeing on quality were high. Kim (2001: 311) writes,

“[m]ultiunit firms were able to solve the asymmetric information problem through the use of advertising and the development of brand names. In the presence of uncertain quality and the absence of a credible third party enforcer, the main private-contract enforcement mechanism relies on the value of repeat sales to a firm. One solution to signaling a firm’s value of repeated sales is to invest in firm-specific and non-salvageable assets such as advertising and developing brand names. Since the value of repeat sales is limited for most single-unit firms, these firms have little incentive to advertise and develop brand names. On the other hand, for multiunit firms, the value of repeat purchase is potentially much greater. Thus, the economies of marketing for multiunit firms come not only from their ability to spread their costs over many plants or stores, but also from the fact that the cost of renegeing on their product quality is significantly higher.”

Audia, Sorenson and Hage (2001: 79-82) see information affecting the location decision in other ways. For them there is a tradeoff in the organisation of production between geographic dispersion and organisational learning.²⁰ First, a multi-plant firm has advantages in the creation of new knowledge with regard to the optimal method of production. With multiple sites even random variation across those sites can offer the opportunity to gather comparative information on the best production methods. But more strategically, multi-unit firms can undertake parallel experimentation with different plants undertaking different experiments at the same time. This

²⁰Audia, Sorenson and Hage (2001: 77-83) deal with other advantages and disadvantages of multiunit firms. Multiunit firms benefit from product-specific economies.

“Multiunit firms achieve these efficiencies through product specialization. According to S[c]herer et al. (1975: p. 295) “Product specialization exists when plants belonging to the same organization produce for a broad geographic market some narrow segment of the product line normally encompassed within an industry’s definition.” Product specialization allows longer production runs that facilitate worker productivity, increase product quality and simplify production planning.” (Audia, Sorenson and Hage 2001: 77).

When a firm is made up of multiple units, the geographic distribution of its facilities can affect the firm’s performance. Multi-local firms - firms operating in dispersed locations - can gain competitive advantages from several sources: 1) they can minimise transportation costs by producing close to customers. 2) operating at different locations means a firm can weather idiosyncratic risks associated with a given area. 3) operation in multiple markets could allow firms to collude with other multi-market competitors. A disadvantage of multiunit firms is bureaucratisation. Large administrative structures reduce the firms ability to react to environmental changes.

offers at least two advantages: 1) it allows learning to occur at a faster pace. As experimentation takes place in chronological time, being able to undertake multiple-experiments simultaneously reduces the time needed for the firm to investigate the benefits of changes in operating procedures. 2) with the greater number of observations the internal validity of any conclusions is greater. So geographically dispersed firms benefit more from knowledge creation via experimentation than geographically concentrated firms. Second, geographic dispersion of plants will affect the efficiency of knowledge transfer. Here the single-plant firm has an advantage – for reasons similar to those put forward by Mokyr for the development of the factory during the industrial revolution. In particular the transfer of tacit knowledge is difficult even with face-to-face contact but without it such a transfer may be nearly impossible. A second issue with geographic dispersion relates to the usefulness of the knowledge being transferred. As the similarity of the plants declines, the usefulness of information learned at one location to other locations is reduced. In short, geographically dispersed firms benefit less from firm knowledge than geographically concentrated firms.

As pointed out by Mokyr (2002: 141), the Demsetz\Becker-Murphy framework also suggests that when knowledge can be shared and believed among agents without the need for personal contact then firms may survive, but the large plants we know today may become less necessary. This point is becoming more important as the use of ICTs is expanding.

The development of ICTs has meant that the costs of moving people as opposed to moving information have risen sharply. The costs involved in sending and receiving information have fallen thanks to technologies such as email and the Internet along with falls in the costs of long-distance phone calls and the expanding use of cellular networks. The costs of people moving have not fallen however. Commuting to work via congested city and suburban streets, for example, is at least as difficult as it was two decades ago. The increasing interest in congestion pricing in many cities around the world suggests that traffic problems are not lessening. The ever increasing relative cost of moving people would suggest that the size of the “unit of production” should be moving away from the large factory, so dominant for the last two centuries, towards more home based production, as in the period before the industrial revolution. Mokyr (2002: 155) does however add a cautionary note. He argues that the movement away from work in the factory setting will at some point run into diminishing returns and what we will see is the locus of work

remaining a mixture of work at home and work away from home. McDermott (2001: 52-3) reinforces this cautionary note by raising four issues. First McDermott argues that monitoring remotely would be problematic given that to be effective it may well violate norms of privacy. Secondly, joint production in the home of market and household goods could diminish in the future. The increased market provision of “household goods” – day care, mobile dog grooming, internet shopping and home delivery etc – all allow workers to spend an increased amount of time away from home. Thirdly, the growth in personal services means that in the future workers will have to serve people directly in ways that would be difficult to do remotely (personal trainers, customer service representatives, mechanics, craftsmen, for example). Last, to quote McDermott (2001: 53) “[a]s Mokyr notes, citing Gavin Wright, “In the limit we could devise an economy in which technology is designed by geniuses and operated by idiots”. In that case, home production for market may indeed take off. But I am uneasy with that conclusion. It seems to me that a large part of the population may, unfortunately, substitute information and computing power for their own brain development, but these workers will not be the kind that will be left alone to telecommute. These workers will require considerable oversight in something like a factory.”

Brynjolfsson (1994: 1654) also sees advantages in firms being small when information is important in production. In his view smaller firms have an advantage in providing incentives both because it is easier to separate out the contributions made by each individual, and thus to reward each individual accordingly, and also because it is more likely that agents in small firms have a stronger incentive to make uncontractible contributions. Small firms therefore have an advantage over larger ones in situations in which it is important to provide incentives for the application of information in ways that cannot be easily foreseen and incorporated into a contract. Brynjolfsson (1994: footnote 12) goes further by noting that the stronger, output-based incentives for the non-contractible actions in smaller firms will not only induce higher effort overall, but in multidimensional models, will also induce less effort on actions that do not enhance output. As firms sink in size the probability that the unit of production of a firm will coincide with the household increases.

Both the Demsetz\Becker-Murphy and Brynjolfsson models indicate that when knowledge is an important factor of production, small firms have advantages. If Mokyr is right then this downsizing of firms should lead to a movement back towards home production and away from

large factory production. But even if this is so, it is not clear whether these home producers will be single-unit firms or units of a multiunit company.

2.7 the management literature

In the seminal work, Penrose (1959), the firm is thought of as encompassing a broad set of productive resources, more than the standard economic set of inputs – land, labour and capital; but this idea received little formal attention before the 1980s. Wernerfelt (1984) was one of the first papers to formally analyse the firm from the resource side. Wernerfelt (1984: 172) identifies a resource as a tangible or intangible asset which is semipermanently tied to the firm. Such assets could be, for example, brand names, in-house knowledge of technology, skilled employees, efficient procedures etc, and can be either a strength or a weakness of the firm.²¹ Because resources mesh in a team-like way, they are worth more to the firm than they can be sold for on the market. Thus they yield rents to the firm controlling them. Firms can act to develop resource position barriers to help protect them from incumbents in much the same way as an entry barrier protects them from potential entrants. Acquisitions and mergers can be seen, in Wernerfelt's view, as ways of trade otherwise non-tradeable resources. The central issues for Wernerfelt were diversification and growth of the firm.

Barney (1991) extends the strategic management literature on competitive advantage by looking at the case where resources are heterogeneously distributed across firms and these differences are stable over time. He examines the link between firm resources and sustained competitive advantage. The major issue for Barney is how ownership and control of resources can be used to achieve and sustain a competitive advantage. He sees the firm as being concerned with seeking unique, or at least hard to imitate, inputs. Primary attention is focused on how a manager can identify resources that are likely to generate rents and incorporate characteristics that results in these inputs being difficult to copy. Thus the central activity of the firm is seen as the deployment and combination of specific inputs.

While the Barney and Wernerfelt papers greatly expanded our understanding of firm strategy and performance they do not develop the resource-based viewpoint into a theory of the firm per

²¹No longer productive assets may be difficult for firms to rid themselves of.

se.²² But such a development did begin, roughly, contemporaneously with Wenerfelt (1984) and Barney (1991).

Since the early 1990s a knowledge-based (or resource-based) theory of the firm has started to develop in the management literature. The major source of momentum behind this literature was the publication of papers by Conner (1991) and Kogut and Zander (1992). An important point common to all knowledge-based approaches to the theory of the firm is the rejection of the pure contractual interpretation of the nature of the firm that underlies the economic theories of the firm. In the resource-based theory it is argued that the firm is essentially a knowledge-bearing entity and that it is possible to conceive of a theory concerning the existence, boundaries and internal organisation of the firm without reference to property rights, incentives and opportunism.

Early in their article Kogut and Zander state what amounts to their central proposition,

“[o]ur view differs radically from that of the firm as a bundle of contracts that serves to allocate efficiently property rights. In contrast to the contract approach to understanding organizations, the assumption of the selfish motives of individuals resulting in shirking or dishonesty is not a necessary premise in our argument. Rather, we suggest that organizations are social communities in which individual and social expertise is transformed into economically useful products and services by the application of a set of higher-order organizing principles. Firms exist because they provide a social community of voluntaristic action structured by organizing principles that are not reduceable to individuals.” (Kogut and Zander 1992: 384).

What is important for an organisation is that a large part of the stock of knowledge is tacit and social. Knowledge is produced in a social setting and is inseparable from that setting. Knowledge is accumulated through experience and is thus path-dependent. So each organisation is a distinct social and historical entity.

An important implication of this is that when a firm is viewed as a repository of tacit, social and path-dependent organisational knowledge, issues to do with the existence, boundaries and internal organisation of the firm are seen in a different way relative to the view imposed by the contractual approach to the firm. As already noted, the firm is a bearer of specialised and

²²In an article reviewing the origins and impact of Wernerfelt (1984), Lockett, O’Shea and Wright (2008: 1130) write, “Wernerfelt is clear that the RBV is not a theory of the firm, because it does not address issues of firm existence and boundaries.”

tacit knowledge, which can be efficiently employed only when applied within that particular firm. This is because it is difficult, if not impossible, to take just a piece of a given firm's tacit, social and specific knowledge and apply it successfully within some other organisation. Firms exist, therefore, because they provide, in Kogut and Zander's view, a "social community of voluntaristic action" in which this firm-specific knowledge can be produced and applied. The advantage that a firm has over the use of markets is that it can supply the required, if somewhat vaguely defined, "higher order organizing principles".²³ Such principles can not, apparently, be supplied by the market.

Conner (1991) reaches a similar conclusion as Kogut and Zander (1992), in that she also sees that the existence of firms can be explained in a manner conceptually very different from the more standard contractual approach. On the existence issue Conner (1991: 139) argues that,

"[f]or resource-based theory, existence needs to be explained in terms of a firm's superiority to two alternative forms of organization: a collection of market contracts and other firms. By the latter, the intention is to raise the issue of why a particular firm exists, as opposed to its assets being distributed among other firms."

Consideration of transaction costs, opportunism and incentives play no role in Conner's explanation; co-specialisation of assets is the important issue. To deal with the second issue first, Why does a particular firm exist in terms of its relation to other firms? Conner (1991: 139) argues that heterogeneous firms exist because the assets with which they work are themselves heterogeneous, making each asset a "better fit" with some firms than with other firms.²⁴

As to the first existence concern, consider an example from Conner (1991: 141-2). Let there be two related activities, S and T , then the question is, When are S and T best owned in common rather than being owned independently and having a contractual relationship between them? The notation ST will be used to represent the case where S and T are owned together, that is a project involving both activities is undertaken "in house". When the notation $S + T$ is used it refers to the case where the project is undertaken but ownership of S and T is separated and the project involves a contract over the market interface. An important point here is that as separate

²³These principles would seem to include things like, 'shared coding schemes', 'a set of values' which are learned, 'a shared language' and 'a set of higher-order organizing principles [which] act as mechanisms by which to codify technologies into a language accessible to a wider circle of individuals.' (Kogut and Zander 1992: 389).

²⁴Firms are seen as having heterogeneous asset bases in that each has a unique bundle of resources and relationships.

firms each of S and T will have their own CEO and management along with their own set of firm-level routines, cultures etc. What then is the difference between ST and $S+T$? In Conner's view, $S+T$, as compared to ST , should find it more difficult to organise the research in such a way as to make the knowledge and skills accessible to both S and T as separate operations. This is simply because as Conner explains it, "[...] $S+T$ must try to orient in two different directions, one for S and another for T ." Conner (1991: 142). That is, any gains from the relationship, new knowledge, skills and routines etc, need to be integrated into two firm-specific cultures rather than just one. Cooperation in terms of just ST on the other hand is easier because cooperation is needed in only one direction. The implication of this is that these gains from cooperation and coordination associated with ST , relative to $S+T$, are sufficient to explain the existence of ST . The general issue is formulated by Conner as

"[t]o encapsulate the argument to follow, the case made here is that, under certain circumstances, firms have advantage over market relationships in the joint activity of creating and redeploying specific capital. Further, the advantage of firms in the creation-redeployment combination need not stem from an opportunism-control advantage. Instead, it is argued that the firm has advantage over a collection of market transactions in those situations where redeployment inside the firm is more efficient and, perhaps more important, qualitatively more productive because of the opportunity to benefit from asset interdependencies within the firm." (Conner 1991: 142).

Thus the resource-based or knowledge-based theory of the firms claims to be able to explain the existence (and most probably the boundaries of and internal organisation) of the firm without reference to ideas like, property rights, incentives and opportunism, which underlie the orthodox theories of the firm discussed in the previous sections. This claim has not gone unchallenged. Foss (1996a) offers one of the most powerful critiques of this approach.

Foss (1996a: 473) argues that both Conner and Kogut and Zander's approach are versions of "technological determinism".²⁵ That is, the idea that technology directly determines economic organisation. In Foss's view, Conner and Kogut and Zander fall prey to technological determinism when they argue that the need for things like shared codes, languages etc necessitates firm

²⁵See Williamson (1985: 86-90).

organisation in a manner independent of more standard ideas like opportunism and asymmetric information.

Recall that, in the Conner\Kogut and Zander story, to fully utilise assets and resources these assets and resources have to be embedded in higher order organising principles. But such embeddedness does not, in the Foss argument, presuppose common ownership. Separately owned activities could be conceptually more “embedded” in this sense than, as an example, divisions of the same firm. Higher order organising principles are not a distinguishing feature of firms relative to markets. Such principles may be more abundant in firms than markets, but they exist in both. In fact Foss (1996a: 473) goes further and argues that for firms to cultivate better higher order organising principles requires, not moral utopia, but opportunism. Consider a state of moral utopia, characterised by the total absence of opportunism. In such a world any gains from assets being embedded in higher order organising principles can be achieved over the market. Economic agents (human resources) could simply meet at a given location, own their own physical capital (or rent it from each other) and develop, as a team, value-enhancing higher order organising principles among themselves. Given the absence of opportunism, Foss argues, the level of co-specialisation of resources carries no implications for ownership. In terms of the Conner example above, ST and $S + T$ would do just as well as each other.

In a response to Foss (1996a), Conner and Prahalad (1996) argue that an independent-of-opportunism rationale for the organisation of firms can be developed. They argue that, relative to independent contractors, firms can economise on a number of opportunism-independent transaction costs. These costs relate to flexibility, communication, learning, bargaining, and possibly also measurement. Conner and Prahalad see the rationale for the firm in terms of its superior coordinating ability including its capacity to reduce costs associated with information and bargaining. The crucial concepts in Conner and Prahalad’s argument are the “knowledge-substitution effect” and the “flexibility effect”. Put simply, the knowledge-substitution effect means that when an employee takes direction from a manager, the manager’s knowledge is a partial substitute for the employee’s knowledge, while the flexibility effect is due to the fact that an employment contract brings greater flexibility, relative to market contracting, since the employment contract does not require renegotiation. In the Conner and Prahalad view these effects are sensitive to organisational modes. To the degree that firms do better in advancing these two effects, this provides an,

opportunism independent, rationale for the existence of the firm.

Foss (1996b: 520-1) replies that the Conner and Prahalad view that the employment contract is sufficient to characterise the firm is incomplete. He argues that the ownership of physical assets is an indispensable element for any understanding of the firm and that the allocation of control rights to these assets will reflect, in part, the opportunity for opportunism. Foss also argues that both the flexibility and knowledge-substitution effects can be achieved through market contracting.²⁶

Nickerson and Zenger (2004: 617-8) make three additional criticisms of the knowledge-based literature. First, they argue that two common and fundamental arguments within it are contradictory. One group argues that hierarchies exist to avoid knowledge transfer. The emphasis is on the firm's ability to direct, via authority, the activities of others. A second group view hierarchies as enabling knowledge transfer. They emphasise the firm's ability to support the formation of shared identity and language. Secondly, Nickerson and Zenger claim that the literature has yet to provide a theory that predicts when hierarchies are preferred to markets or vice versa. Third, they argue that the literature focuses on knowledge exchange rather than knowledge production.

So, Nickerson and Zenger (2004: 618) conclude, “[i]n summary, we do not yet have a knowledge-based theory of the firm.” While Foss (1996a: 473) says, “[...] co-specialization and the presence of higher order organizing principles are not sufficient to explain the existence of the specific constellation of property rights that characterizes the firm.” Given this, it is not clear how this approach can explain the changes to the firm we see happening as a result of the growth of the knowledge economy.

Nickerson and Zenger (2004) is an attempt to address some of these shortcomings. They set out to develop a theory that explains how the prospective objectives for knowledge generation determine the choice of organisational structure. For Nickerson and Zenger the fundamental question is to do with how a manager should organise individuals in pursuit of the knowledge the firm desires. They wish to explain how different organisational structures influence the efficient production of knowledge valuable to a firm. To this end they start by defining the unit of analysis for knowledge production to be a specific problem. The value of this problem is determined by both the values in the array of possible solutions and the costs of discovering a valuable

²⁶In addition to Conner and Prahalad (1996), Kogut and Zander (1996) also responded to Foss (1996a). Foss (1996b) is a reply to both these papers.

problem. They assume that the solution to complex problems is a unique combination of existing knowledge. An important distinction Nickerson and Zenger make is between decomposable and non-decomposable problems.

Decomposable problems involve limited interaction between agents attempting to solve them, while non-decomposable problems require much greater interaction. This has important implications for the type of searching used to find a solution for a given problem. There are two general methods of searching. First there is directional search, which amounts to trial and error searching. This is effective only for the case of decomposable problems. The second method is heuristic search. This refers to the situation where a team cognitively evaluates a range of probable consequences of design choices. Non-decomposable problems require specialised knowledge to be shared. Such sharing is impeded by two barriers: 1) people are limited in the speed with which they can learn and 2) they are subject to self-interest. The interaction between distributed knowledge and self-interest gives rise to two hazards for the exchanging of knowledge: 1) knowledge appropriation and 2) strategic knowledge accumulation. As a consequence, efficiency considerations require the selection of an optimal governance structure and the provision of incentives.

Nickerson and Zenger examine three distinct governance mechanisms and evaluate their suitability for dealing with problems of different types. The governance mechanisms are 1) markets, 2) authority-based hierarchies and 3) consensus-based hierarchies. They conclude that markets are well suited for situations in which the problem is decomposable and directional search is thought appropriate; that consensus-based hierarchies generate large organisational costs and thus should be used only when the gains from consensus are large, which is the case for problems that are highly complex and non-decomposable; and that an authority-based hierarchy is preferable to the use of markets for cases where heuristic search is applicable and not preferred for those situations where directional search is optimal. The use of authority-based hierarchy is thought best when problems are moderately complex.²⁷

Foss (2004: 44) argues that the use of the problem as the unit of analysis is limited in that it is, in the main, designed to help an understanding of the governance of knowledge creation – that is, problem solving by combining knowledge – not an understanding of knowledge sharing

²⁷Foss (2004) gives an much more expansive discussion of the whole ‘knowledge governance approach’ including the Nickerson and Zenger (2004) contribution.

or integration. An additional point that is not clear from the discussion above, is how “new economy” firms differ from “old economy” firms. Both old and new economy firms have problems to solve and can choose between the alternatives Nickerson and Zenger consider to solve them. Thus it is not clear how this approach can explain the changes to the firm we see happening as a result of the knowledge economy.

2.8 conclusion

Current research offers an increased understanding of how markets operate in the knowledge economy and some understanding of the effect of this on corporate strategy and related management issues.²⁸ This, however, stops short of an actual theory of the knowledge firm. While it is, as Foss (1997a: 309) notes,

“[...] generally recognized that knowledge problems are behind all interesting aspects of economic organization, and that the major function of, for example, firms is to cope with the economic problems introduced by changing, partial, tacit, complex, asymmetrical, etc., knowledge[.]”

it must also be recognised that none of the orthodox theories of the firm capture the full implications of knowledge for economic organisation. The previous sections made this point by briefly outlining the effects of the increasing importance of knowledge for the mainstream theories of the firm. It was argued that the neo-classical production function approach is not a true theory of the firm but rather the firm is portrayed as an uninvestigated perfectly efficient ‘black box’ which simply turns inputs into outputs without organisation structure. Output is produced by the actions of multiple input owners interacting solely via the market. Relationship-specific investment induced hold-up arguments for vertical integration are at their weakest when dealing with human capital. Human capital can not be owned in the same way as physical capital and so the investor in human capital can act opportunistically whether an employee or not. The incentive-system theory assumes the use of a physical asset rather than a human capital asset in the production process. Neither the ownership nor the value of a human asset can be transferred and so

²⁸See, for example, Arora, Fosfuri and Gambardella (2001), Carley (2000), Kling and Lamb (2000), Leibold, Probst and Gibbert (2005), Orlikowski and Iacono (2000), Shapiro and Varian (1999), Smith, Bailey and Brynjolfsson (2000) and Varian, Farrell and Shapiro (2004).

such an asset cannot determine where the boundaries of the firm lie within the model. The extensions of the GHM framework offered by Brynjolfsson (1994) and Rabin (1993) inherit the implicit owner-manager restriction of the original GHM framework and thus are of limited value when modelling the knowledge firm. When we turn to the location of production the models suggest that we should, in general terms, see a movement back towards home production but we are not given a specific relationship between knowledge and plant size or production location.

We are left with an unsatisfactory model of the (knowledge) firm and thus we are unable to give guidance on either empirical or policy questions that flow, via changes to the firm, from the development of the knowledge economy. Firms' organisational structures are changing in response to the increased prominence of information and knowledge in the production process. In the new economy, not only will we see changes in the location of production, but even if production still takes place within a traditional firm, a factory or an office, that firm may have a very different structure and organisation from that which we see today. As was noted in the Introduction Rajan and Zingales (2003: 87) argue that we are in fact seeing a new "kinder, gentler firm". This is in response to the increase in the importance of human capital, along with increased competition and access to finance, all of which have increased the worker's importance and improved the outside options for workers, thereby changing the balance of power within firms. The Introduction also pointed out that in Rajan and Zingales's view, the biggest challenge for management today is to manage in an environment of diminished authority. Authority has to be gained by ensuring that work is enriching, that responsibilities are handed down, and that bonds develop among workers and between workers and the management. (Rajan and Zingales 2003: 87).

Cowen and Parker (1997) make a similar point about changing organisational structures. For them,

"[i]nformation as a factor of production is making old functional structures and methods of organisation and planning redundant in many areas of business. The successful use of knowledge involves not only its generation, but also its mobilisation and integration, requiring a change in the way it is handled and processed." (Cowen and Parker 1997: 12).

Organisational change, as far as Cowen and Parker are concerned, is the consequence of the increasing need to make use of market principles within the firm and the growing importance of human capital. They note that as far as a firm's labour force is concerned,

“[t]he emphasis now is upon encouraging knowledge acquisition, skills and adaptability in the workforce as critical factors in competitive advantage.” (Cowen and Parker 1997: 32).

Firms are obliged to rely more on market based mechanisms as the most efficient way of processing and transmitting information and giving the firm the flexibility and yet also focus it requires. Companies are decentralising their management systems as a way of coping with the uncertainty and pace of change in their markets. The aim is to ensure that those with the required knowledge and right incentives are the ones making the decisions and taking responsibility for the outcomes. Cowen and Parker (1997: 25-8) emphasise how advances in ICTs underlie the ability to be able to combine the advantages of this organisational flexibility with mass production.²⁹

As people become an increasingly important part of the production process two additional issues will become more pressing for the firm. The first is that (tacit) knowledge about how to produce will be more imperfect as it is necessarily distributed among an increasing number of different people. The second problem is that knowledge about how to integrate the know-how of the different workers is also imperfect. As Langlois and Foss (1999: 203) note,

“[t]he first possibility brings us to the issue of *capabilities*; the second to the issue of *qualitative coordination*.”

Capabilities are firm-specific knowledge which is often tacit and distributed among members of the firm.³⁰ Such know-how is only utilised via the implementation of a multi-worker production process where no one worker has complete knowledge of the process. This means that some kind of qualitative coordination is required to utilise efficiently the aggregate knowledge available.

With the growth in the importance of human capital, firms increasingly face the issue of how to align not just the cooperating parties' incentives but also align their knowledge and expectations.

²⁹In addition to Cowen and Parker (1997) see Gable and Ellig (1993) and Koch (2007) for more detail on market-based management.

³⁰For more on capabilities and organisation see, for example, Loasby (1998a, b) and Richardson (1972).

Capabilities and routines have a greater role to play as coordinating devices within the knowledge firm.

Another pressure on the organisation of firms is suggested by Klein (1988). Insofar as he is right that hold-up problems can be based on human capital as much as on physical capital, it is a problem that will, most likely, only get worse as we move towards more human capital based firms. Klein argues that vertical integration can solve potential hold-up problems even if they hinge on human capital. He sees vertical integration as organisational ownership. The major reason human capital based hold-up can not occur after integration is because collusion is difficult with a large number of agents. As Klein (1988: 220) explains in terms of the General Motors Fisher Body example, post integration the Fisher brothers could not hold up General Motors by telling all the employees to leave General Motors and turn up at a new address on Monday morning. This is neither legally possible, since the workers are no longer employees of Fisher Body, or economically feasible. But if integration is, at least partly, an answer to human capital hold-up then it is a reason for firms to become larger rather than smaller as has been argued above.³¹

Another issue with knowledge firms is what would bankruptcy mean for them? If the firm comprises only human capital resources, whose accumulated knowledge is the source of wealth creation, then predictions about what would happen at the dissolution of the firm are unclear. Who has the rights to the sell-off of the assets, when these assets are embodied in human beings? How can these assets be sold-off? How could the “shareholders” or debt holders recover any of their investments?

But little of these types of changes, trade-offs and issues are captured or explained by the mainstream theory of the firm. Expanding the orthodox view of the firm to include the new reality of the knowledge economy should be an urgent issue on the economic research agenda. As was argued in the Introduction, changes to the firm matter simply because so much economic activity takes place within their boundaries. As a consequence, changes to the firm will help

³¹Klein’s argument is somewhat problematic. Freeland (2000) raises one issue in that he sees vertical integration creating, not solving, hold-up problems. Freeland argues that vertical integration can increase vulnerability to hold-up as it did for General Motors. He argues that in the case of the General Motors Fisher Body integration hold-up was not an issue prior to integration, but that the Fisher brothers successfully held up General Motors post integration. Thus far from reducing opportunistic behaviour, vertical integration increased General Motors’s vulnerability to rent-seeking behaviour based in human asset specificity. In addition the Klein argument is a “large numbers argument”. If knowledge-based firms are small for other reasons, the Klein argument loses much of its power. With small numbers collusion is much easier.

determine who are the “winners and losers” from the knowledge economy. As in all previous “economic revolutions”, this is the ultimate issue with the knowledge economy.

Chapter 3

The GHM based approach to the theory of the human-capital based firm

“[...] the boundaries of the firm are likely to be knowledge boundaries. When decisions can be made with relatively few unintended consequences and little need to respond to random events or evolutionary developments, internal management and design are appropriate.”

Kling (2010: 47).

3.1 introduction

Section 2.5 of the previous chapter gave a brief discussion of the GHM approach to modelling the human-capital based firm. The discussion centred on two papers, Brynjolfsson (1994) and Rabin (1993). As these papers are the mainstay of the orthodox approach to this issue we will discuss the theoretical sections of them, and their problems, in greater detail in this chapter as a springboard to developing a more satisfactory model of the human-capital based firm in subsequent chapters.

As pointed out in Section 2.5, in his discussion of the role of nonhuman assets in the property rights approach to the theory of the firm, Hart (1995: 56-9) argues that, at least some, nonhuman assets are essential to a theory of the firm. Hart explains that even a human-capital based firm will involve some nonhuman-capital, but the human-capital will play the dominant role. Management scholar Peter F. Drucker makes a similar point,

“[i]n this society, knowledge is *the* primary resource for individuals and for the economy overall. Land, labor, and capital – the economist’s traditional factors of production – do not disappear, but they become secondary.” (Drucker 1992: 95).

The important characteristic of human-capital is that it embodies information and knowledge. A theory of the human-capital based firm has to model this co-existence of the human and nonhuman-capital. Brynjolfsson (1994) deals with the issue by extending the property rights

approach to the firm to include information whether this information is embodied in humans, in the form of human-capital, or in artifacts. Rabin (1993) extends the property rights framework by assuming that an agent has information about how to make production more productive which they are willing to sell. The problem is if the information is not revealed before the agent is paid, a (potential) buyer may have little reason to believe the agent is truly well-informed, but if the agent reveals the information up front, the buyer could simply use the information without payment. Rabin's answer is that the informed agent gains control over productive assets and thus doesn't have to sell the information. We discuss each paper in turn.

3.2 Brynjolfsson (1994)

The Brynjolfsson approach is to include "information assets" along with physical assets in the property rights theory of the firm. These information assets can take the form of human capital or can embed information in the form of physical equipment. One of the major objectives of the Brynjolfsson paper is to look at the incentive effects of the allocation of both these "information assets" and the firm's physical assets. This approach makes possible a discussion of five basic questions (Brynjolfsson 1994: 1645-6):

1. How does the location of information affect incentives and ownership structure?
2. What is the impact of making information alienable or contractible?
3. Do smaller firms provide better incentives for exploiting information?
4. Are flexible assets more appropriate for informed agents?
5. How does "coordination information" affect the optimal distribution and ownership of production assets?

Section 2 of the paper covers "information and asset ownership". It opens with a discussion, in Section 2.1, of 'asset ownership and incentives'. Brynjolfsson begins by considering the simplest of organisational forms, a relationship between a principal and an agent. As is commonly argued appropriate incentives must be provided for the agent by the principal. This is the basis of the

famous principal-agent framework. Incentives are achieved, in simple models, by making the agent's pay depend, at least partly, on performance.

Problems can arise if it is difficult to specify performance measures in advance. For example, the owner of a firm may have insufficient information to pre-specify the decision-making activities of the firm's managers. If this is so then simply linking the pay of the management to sales or profits could result in resources being shifted, inappropriately, away from R&D and maintenance, for example. Agency theory's solution to this is to write a comprehensive contract that takes into account not only the marginal value to all the agent's activities but also the marginal cost to the agent in all possible worlds along with the ability of the principal to commit to pay the appropriate wage for each outcome. Without such a contract, incentives will be suboptimal and thus production will be at suboptimal levels.

Brynjolfsson now makes the point that a key difference between the property rights approach and agency theory is that under the property rights theory it is assumed that contracts are not comprehensive, but are incomplete, that is, they inevitably leave out some relevant circumstances or contingencies. Such gaps occur since some contingencies are not able to be foreseen or are too expensive to enumerate. This is a natural consequence of the bounded rationality of the contracting parties. Under the contract each party will have certain rights specified, but given incompleteness there will remain at least some "residual rights", which are those rights not specified in the contract. If these residual rights pertain to the use of any asset, then the institution which allocates said rights is property ownership. That is, the owner of an asset is whoever has the residual control rights over that asset.

The allocation of residual control rights will have an impact on the relative bargaining strengths of the parties to a contract after they have made investments in their relationship. Ex post bargaining positions are determined largely by property rights given the absence of comprehensive contracts. At least some of the benefits of the relationship not explicitly allocated in the contract will be earned by each party who owns at least some of the assets essential to the relationship since they can threaten to withhold those assets otherwise. If however a party owns no essential assets, and is therefore unnecessary to the creation of value, then they must rely on the letter of the contract to receive any portion of the output. As a result, such an agent risks going unpaid for any work not specifically contracted for. On the other hand an agent who

does control an essential input can “veto” any allocation of residual rewards which they think insufficiently advantageous to them. Therefore, essential input ownership and receipt of residual income go hand in hand.

In summary, Brynjolfsson makes the point that the problem of providing incentives to agents when comprehensive contracts can not be written can be mitigated if agents are assured a large enough share of the output they produce by providing them with ex post bargaining power inherent in asset ownership. Based on this idea, Grossman, Hart and Moore have derived a theory of vertical and lateral integration. In Section 2.2 of his paper Brynjolfsson takes a closer look at the Hart and Moore (1990) framework.

Brynjolfsson begins by noting that Hart and Moore (1990) develop a framework, and notation, that examines how changes in the distribution of asset ownership affects the incentives of the individuals who work with those assets. Within this framework Hart and Moore establish a number of results regarding the optimality of differing ownership arrangements.

For his application of the Hart and Moore (1990) framework Brynjolfsson makes a number of assumptions which are detailed in an Appendix to his paper (Brynjolfsson 1994: 1661); see below for more details. Of the assumptions made by Brynjolfsson it is worth noting that assumption A4 says that the actions of the agents are complementary at the margin and assumption A6 implies that marginal return on investment is not decreasing with the number of other agents and actions in the coalition.

Because ownership only makes sense when actions are uncontractible, Brynjolfsson assumes that all actions by the model’s agents can not be contracted upon. This means that within the model incentives are only provided by the ownership of non-human assets. To begin, assume there is a grand-coalition S^I made up of I different agents. The cost to agent i of a (one dimensional) action, x_i , is given by $c_i(x_i)$. The **marginal value** created by i ’s action when he is involved in a coalition $S \subset S^I$, of size s , formed by i plus a subset $S \setminus \{i\}$ of $(s - 1)$ other agents, is denoted $v^i(S, A(S)|x)$, where $A(S)$ is the set of all assets owned by the coalition’s s members and x is the vector of actions taken by the members of the coalition. To apportion the **total value**, $V(x) = v(S^I, A(S^I)|x)$, generated by the members of the grand-coalition of all I agents working together, Brynjolfsson follows Hart and Moore by suggesting the use of the Shapley value.¹ It

¹The Shapley value can be written $\sum_{S|i \in S} \frac{(s-1)!(I-s)!}{I!} [v(S, A|x) - v(S \setminus \{i\}, A(S \setminus \{i\})|x)]$ where s is the number of agents in a given subset S and I is the total number of agents. This formula expresses the Shapley value

should be noted that the exact rule for determining the division of surplus will generally have no qualitative effect on the results just so long as each agent's share of output is increasing in his access to essential assets.

More formally, this can be written: assume that there is a set S^I of I risk neutral agents, $S^I = \{1, \dots, i, \dots, I\}$, each of whom takes a scalar action x_i . This action affects agent i 's value in some (uncontractible) way and it costs i $c_i(x_i)$. Each of the I agents chooses his action in a non-cooperative manner thereby generating a total value of $V(x) = v(S^I, A(S^I)|x)$ which the I agents will divide between them. The subset of assets $A \subset A(S^I)$ is controlled by the subset $S \subset S^I$ of the agents according to the mapping $\alpha(S)$ satisfying $B1 - B3$:

$B1 : \alpha(S) \cap \alpha(S^I \setminus S) = \emptyset$, where \emptyset is the empty set²

$B2 : \text{For all subsets } S' \subseteq S, \alpha(S') \subseteq \alpha(S)$

$B3 : \alpha(\emptyset) = \emptyset$

In addition Brynjolfsson (1994: 1661) assumes that:

“Assumption A1. $c_i(x_i) \geq 0$ and $c_i(0) = 0$, c_i is twice differentiable, $x_i \in [0, X_i]$, if $X_i > 0$, then $c'_i(x_i) > 0$ and $c''_i(x_i) > 0$ for $x_i \in (0, X_i)$ with $\lim_{x_i \rightarrow 0} c'_i(x_i) = 0$ and $\lim_{x_i \rightarrow X_i} c'_i(x_i) = \infty$.

Assumption A2. $v(S, A|x) \geq 0$ and $v(\emptyset, A|x) = 0$, $v(S, A|x)$ is twice differentiable in x , if $X_i > 0$, then $v^i(S, A|x) \geq 0$ for $x_i \in (0, X_i)$, $v(s, A|x)$ is concave in x .

Assumption A3. $v^i(S, A|x) = 0$, if $i \notin S$.

Assumption A4. $\frac{\partial v^i(S, A|x)}{\partial x_j} \geq 0$, for all $j \neq i$.

Assumption A5. For all subsets $S' \subseteq S$, $A' \subseteq A$,

$$v(S, A|x) \geq v(S', A'|x) + v(S \setminus S', A \setminus A'|x).$$

Assumption A6. For all subsets $S' \subseteq S$, $A' \subseteq A$,

$$v^i(S, A|x) \geq v^i(S', A'|x).”$$

In Section 2.3 (Information as an “Asset”) Brynjolfsson asks what are the “assets” in the model. For Hart and Moore assets are relevant insofar as they have an effect on the marginal

for an agent i as a weighted sum of his marginal contributions to all coalitions he can join. It can be interpreted as the expected marginal contribution of each agent when he enters a coalition.

² $S^I \setminus S = \{i : i \in S^I \text{ and } i \notin S\}$

product of an agent. The marginal value of an agent's actions are higher when the amount of assets available to him is greater:

$$v^i(S, A|x) \geq v^i(S, A'|x) \text{ for all subsets } A' \text{ of } A \quad (3.1)$$

In the Hart and Moore model "assets" are given the interpretation of being nonhuman assets such as machines, factories or customer lists because these are alienable and thus can change "ownership". This focus on physical assets has been to the detriment of human capital and intangibles such as information, knowledge and skills. Brynjolfsson adapts the Hart and Moore model to include human capital as an asset which will affect an agent's marginal product when they have access to it. This results in a movement away from the idea that only tradeable commodities can be "assets".

The argument that Brynjolfsson makes is that information that an agent knows can be critical to his productivity and incentives, thereby making human capital an asset which needs to be treated on par with physical capital, a frequently made argument in much of the knowledge economy literature. He therefore considers the information known to a particular agent an "asset" that the agent "owns". Such an approach enables Brynjolfsson to study how the inalienability of an asset like knowledge affects the allocation of other assets in the firm. This allocation will in turn determine the organisational structure and boundaries of a firm.

Considering information as an asset also allows Brynjolfsson to treat endogenously the question of whether information should be created in an alienable or inalienable form. In a large number of cases information, knowledge and skills can be embodied in either humans or in tradeable physical forms such as software or databases. What are the advantages, disadvantages of each and what are the implications for the structure of the organisation?

Last Brynjolfsson assumes that the synergies between agents occur only through the assets – which now includes information – that they have access to and thus he simplifies the notation by the suppression of the explicit reference to the coalition of other agents. In addition he suppresses the vector of the agents' actions, x and thus the marginal value of agents i 's action can now be represented as:

$$v^i(A) \equiv v^i(S, A(S)|x) \quad (3.2)$$

Something to keep in mind that within this framework, actions x do not directly create or change the value of assets, but access to assets can affect the value of actions.

In Section 3 (Information and Organizational Structure) Brynjolfsson looks at a number of questions with regard to the relationship between information, technology and organisations. This section opens with a subsection, 3.1, on “How Does the Location of Information Affect Incentives and Ownership structure?” The first case looked at considers an entrepreneur who has some expertise necessary to the running of the firm. It is assumed here that the only relevant assets are the information in the entrepreneur’s head, denoted a_I , and the physical assets of the firm, a_F . Further, it is assumed that no value can be created without access to both of these assets. In addition Brynjolfsson assumes a strong form of complementarity in that he assumes that the information is of no value without access to the firm while the firm is of no value without the expertise of the entrepreneur. Assuming no comprehensive contract can be written to cover the disposition of the firm in all possible future states of the world, should the entrepreneur or some other agent own the firm?

Consider, to begin with, the case in which the entrepreneur does not own the firm, i.e. he does not own a_F . In such a situation if the entrepreneur makes an investment of effort and thereby creates additional value he may be subject to hold-up by whomever owns a_F since the entrepreneur requires a_F to realise the additional value. Brynjolfsson assumes that no contract for the use of a_F can be written and thus the parties must bargain over the division of the surplus. Under Nash bargaining both of the parties will receive half of the additional surplus created (this is their Shapley value).³ Similarly, if the other agent was to create value then the entrepreneur could bargain for half of the additional surplus by threatening to withhold his expertise, a_I ,

³The Shapley value for agent i will be:

$$SV_i = \sum_{S|i \in S} \frac{(s-1)!(I-s)!}{I!} [v(S, A|x) - v(S \setminus \{i\}, A(S \setminus \{i\})|x)]$$

which for agent 1 in this case will be

$$\begin{aligned} SV_1 &= \frac{1}{2} [v(a_F, a_I) - v(a_F)] + \frac{1}{2} [v(a_I) - v(\emptyset)] \\ &\text{but } v(a_F) = v(a_I) = v(\emptyset) = 0, \text{ so} \\ SV_1 &= \frac{1}{2} v(a_F, a_I) \end{aligned}$$

which is just half of the additional value created. The Shapley value for agent 2 can be worked out in a similar manner.

The Nash bargaining solution in this case is

$$N = \arg \max (v_1 - d_1) \cdot (v_2 - d_2)$$

otherwise. Each party will continue to exert effort up until the marginal benefit from doing so will just equal the marginal cost of doing so. Since each agent will bear the full cost of their efforts but can only rationally expect to gain half of the incremental value created, both parties will underinvest in this ownership arrangement.

The first order conditions for each agent can be written as:

$$\frac{1}{2}v^1(a_F, a_I) + \frac{1}{2}v^1(a_I) = c'_1(x_1) \quad (3.3)$$

$$\frac{1}{2}v^2(a_F, a_I) + \frac{1}{2}v^2(a_F) = c'_2(x_2) \quad (3.4)$$

where the entrepreneur and the other party are denoted by 1,2 respectively.⁴

Due to the assumption that information and physical assets are only productive when used together, the second terms in both equation (3.3) and (3.4) are equal to zero. Thus we get the result that each agent will invest in effort only up to the point where marginal costs are equal to

where v_i is the pay off to agent i under Nash bargaining and d_i is the disagreement point for agent i . Given that the surplus to be bargained over is the additional surplus created by an action on the part of agent 1, $v(a_F, a_I)$ and $v(a_F) = d_2 = v(a_I) = d_2 = 0$ we get that

$$\begin{aligned} \aleph &= \arg \max (v_1) \cdot (v_2) \\ \text{s.t. } &v_1 + v_2 = v(a_F, a_I) \end{aligned}$$

which can be rewritten as

$$\begin{aligned} \aleph &= \arg \max (v_1) \cdot (v(a_F, a_I) - v_1) \\ &\Rightarrow \arg \max (v_1 v(a_F, a_I) - v_1^2) \end{aligned}$$

which results in a FOC of

$$\begin{aligned} \frac{\partial \aleph}{\partial v_1} &= v(a_F, a_I) - 2v_1 = 0 \\ \Rightarrow v_1 &= \frac{1}{2}v(a_F, a_I) \end{aligned}$$

and thus $v_2 = \frac{1}{2}v(a_F, a_I)$.

⁴These FOCs can be derived from an objective function of the form: agent's payoff equals their Shapley value minus their costs. For agent 1 there are two coalitions he can be a member of, $\{1, 2\}$ and $\{1\}$. Each of these coalitions occurs with probability a half, i.e.

$$\frac{(s-1)!(I-s)!}{I!} = \frac{(2-1)!(2-2)!}{2!} = \frac{1}{2} = \frac{(1-1)!(2-1)!}{2!}$$

Formally, the payoff function for the case of the entrepreneur, agent 1, is given by

$$B_1(A|x) = \frac{1}{2}[v(a_F, a_I) - v(a_F)] + \frac{1}{2}[v(a_I) - v(\emptyset)] - c_1(x_1)$$

where $v(\emptyset)$ means the coalition controls no assets.

The FOC is

$$\frac{\partial B_1(A|x)}{\partial x_1} = \frac{1}{2}v^1(a_F, a_I) + \frac{1}{2}v^1(a_I) - c'_1(x_1) = 0$$

The FOC for agent 2 can be found in a analogous manner.

half of marginal value.

As an alternative ownership structure, consider giving ownership of both the firm, a_F , and the expertise, a_I , to the entrepreneur. Here we see that the other agent can not hold up the entrepreneur, since the entrepreneur controls both essential assets. This clearly improves the incentives for the entrepreneur while, surprisingly, the other party's incentives are unaffected, since, as above, the entrepreneur can bargain for half of the increase in surplus created by the other party's investment.⁵

Next Brynjolfsson points out that net benefits will be maximised by providing each agent with the strongest feasible incentives to exercise effort. The problem to which this gives rise is, in terms of organisation design, one of choosing between the feasible allocations of asset ownership for the one that maximises the share of value that each party expects to receive. From the above it is clear that it is optimal to give ownership of the physical assets to the entrepreneur since this would improve his incentives for effort while leaving the other agent's incentives unaffected. Thus, from an incentives standpoint, the agent with the essential information should be given ownership of the assets necessary to his work.

Brynjolfsson offers an interpretation of his result in terms of two propositions from Hart and Moore (1990). Proposition 6 states that an agent who is "indispensable" to an asset should own

⁵In this case the objective function for agent 1 is given by:

$$B_1(A|x) = \frac{1}{2}[v(a_F, a_I) - v(\emptyset)] + \frac{1}{2}[v(a_F, a_I) - v(\emptyset)] - c_1(x_1).$$

Again there are two coalitions that agent 1 can be a member of, $\{1, 2\}$ and $\{1\}$, each with probability of a half. The FOC is

$$\begin{aligned} \frac{\partial B_1(A|x)}{\partial x_1} &= \frac{1}{2}v^1(a_F, a_I) + \frac{1}{2}v^1(a_F, a_I) = c'_1(x_1) \\ &\Rightarrow v^1(a_F, a_I) = c'_1(x_1). \end{aligned} \quad (3.5)$$

The objective function for agent 2 is given by:

$$B_2(A|x) = \frac{1}{2}[v(\{1, 2\}, \{a_F, a_I\}|\{x_1, x_2\}) - v(\{1\}, \{a_F, a_I\}|\{x_1\})] + \frac{1}{2}[v(\emptyset) - v(\emptyset)] - c_2(x_2).$$

Again there are two coalitions that agent 2 can be a member of, $\{1, 2\}$ and $\{2\}$, each with probability of a half. The FOC is

$$\frac{\partial B_2(A|x)}{\partial x_2} = \frac{1}{2}v^2(\{1, 2\}, \{a_F, a_I\}|\{x_1, x_2\}) = c'_2(x_2) \quad (3.6)$$

Note that as $v^2(a_F) = 0$, the left-hand side of equation (3.6) is equal to the left-hand side of equation (3.4). This shows that the other party's incentives are not affected by the change in asset ownership. A comparison of equations (3.3) and (3.5) shows that the incentives for the entrepreneur are strictly greater when he owns the physical as well as the expertise assets.

that asset. Given that the entrepreneur has information essential to the productivity of the physical asset then he is effectively “indispensable” by the Hart and Moore definition.⁶ Another view of the result above is offered in terms of Proposition 8 from Hart and Moore. Given that in the model used here the information asset is necessary to the productivity of the physical assets, they can be seen as complementary assets. Proposition 8 states that complementary assets should be owned together when complete contracts can not be written.

Up to this point Brynjolfsson has assumed that the expertise of the entrepreneur is essential to the productivity of the physical assets, and hence $v^2(a_F) = 0$. What happens if this expertise is not completely essential to the productivity of the other assets. Here giving ownership of the physical assets to the entrepreneur would reduce the incentives of the other agent.

To see this compare equation (3.6) with equation (3.4). Under equation (3.6) we get a lower equilibrium level of investment since the second term in (3.4) is no longer zero. As to whether or not the loss in effort from the other agent is fully compensated by the improved incentives of the informed agent is a function of how necessary that agent’s information is to the productivity of the firm and how necessary it is to maximise the entrepreneur’s incentives relative to those of the other agent. The first order conditions of the alternative ownership structures shows that the more important it is to provide incentives to the entrepreneur, the more important it is to give him ownership over the physical assets: equation (3.4) gives a higher level of investment by the entrepreneur than equation (3.6). In addition Brynjolfsson notes that to the extent that it is difficult to ex ante describe outputs for “information work”, the more likely it is that the informed agent will have significant uncontractible actions.

Brynjolfsson then suggests a corollary to a result that appears in Hart and Moore (1990). Hart and Moore show that ownership of physical assets is likely to lead to “authority” over any agents that need access to those assets to be productive. The corollary Brynjolfsson offers is that as informed agents should own the essential assets, they are also likely to gain authority over uninformed agents.

⁶For Hart and Moore an agent i is indispensable to an asset a_n if, without agent i in a coalition, asset a_n has no effect on the marginal product of investment for the members of that coalition. That is, for all agents j in any coalition S and for all sets A of assets containing a_n ,

$$v^j(S, A) \equiv v^j(S, A \setminus \{a_n\}) \quad \text{if } i \notin S.$$

From the above we can see why an entrepreneur who has information essential to the success of a firm is more likely to own the firm rather than have ownership in the hands of other people from within or outside the firm. In the case of a new venture if there is a key individual with knowledge essential to the success of the firm the venture capitalist is likely to insist that that individual take an ownership stake in the firm. This will help improve the key person's incentive without reducing those of the other parties proportionately.

An exception to the analysis presented above is suggested by Brynjolfsson: when a key individual's actions are entirely contractible, incentives can be provided via the contract and thus this individual need not have any ownership rights to the firm. A second implication of the analysis is that ownership of the physical assets of the firm, a_F , are of little value if any complementary information assets, a_I , are not also controlled. A purchaser of a firm buys, by definition, only the (alienable) physical assets of the firm, that is a_F . Thus for a "knowledge based" firm, for which the human assets are importance, ownership of the nonhuman assets may be of little value. The purchaser may have to share profits with the key owners of the human assets to provide the necessary incentives. Brynjolfsson therefore puts forward a empirically testable prediction: "[...] that a potential purchaser will pay much less for a knowledge-based firm than a traditional firm with a comparable earnings record." (Brynjolfsson 1994: 1651). Another implication of the analysis is that a knowledgeable entrepreneur may only be able to "cash out" if he can find a way of making the firm independent of the inalienable human-capital.

In his next section, 3.2, Brynjolfsson asks "What is the impact of making information alienable or contractible?" A outcome not considered thus far is to give the uninformed party "ownership" of both the physical and information assets. An obvious requirement for this to happen is that the information must be alienable. That is, the information must be in the form of, say, an expert system, a procedures manual or some other artifact. It may be in some circumstances more efficient to move the information than to shift ownership of all the physical assets to the informed party.

Giving agent 2 ownership over both the information asset, a_I , and the other assets, a_F , results in the first-order conditions:⁷

⁷In this case the objective function for agent 1 is given by:

$$B_1(A|x) = \frac{1}{2}[v(\{1, 2\}, \{a_F, a_I\}|\{x_1, x_2\}) - v(\{2\}, \{a_F, a_I\}|\{x_2\})] + \frac{1}{2}[v(\emptyset) - v(\emptyset)] - c_1(x_1).$$

$$\frac{1}{2}v^1(a_F, a_I) = c'_1(x_1) \quad (3.9)$$

$$\frac{1}{2}v^2(a_F, a_I) + \frac{1}{2}v^2(a_F, a_I) = c'_2(x_2) \quad (3.10)$$

Under this distribution of ownership rights, the incentives of agent 2 have been maximised but those of agent 1 have been weakened. If the actions of agent 2 are relatively important then this pattern of rights will be superior to the case where agent 1 has ownership of both assets.

There are a number of reasons, however, why it will be difficult, if not impossible, to sell the information “asset”. First, the reason that an agent is hired in the first place is often to reduce the information processing tasks of the principal. Also the relevant information may be generated by the hired agent in the normal course of his duties and information may be costly to communicate to agent 2 due to problems like the difficulties of codifying and transmitting it along with adverse selection issues. It is difficult to transmit information since the purchaser does not know the value of the information until he has access to it but then he has in effect acquired the information at zero cost.

A quick summary of this section so far would be that if the information asset cannot be owned by agent 2, yet this asset is needed for the productive use of the physical asset, the incentive considerations discussed above suggest that the best implementable solution is to assign ownership of the physical assets to the informed party. When contracts are incomplete, complementary assets should be owned by the same agent and given the inalienability of the information asset ownership of the alienable physical assets must be passed to the informed party. Here we see that control of information can determine the organisational structure of a firm and thus authority within the firm.

Again there are two coalitions that agent 1 can be a member of, $\{1, 2\}$ and $\{1\}$, each with probability of a half. The FOC is

$$\frac{\partial B_1(A|x)}{\partial x_1} = \frac{1}{2}v^1(\{1, 2\}, \{a_F, a_I\}|x_1, x_2) = c'_1(x_1). \quad (3.7)$$

The objective function for agent 2 is given by:

$$B_2(A|x) = \frac{1}{2}[v(a_F, a_I) - v(\emptyset)] + \frac{1}{2}[v(a_F, a_I) - v(\emptyset)] - c_2(x_2).$$

Again there are two coalitions that agent 2 can be a member of, $\{1, 2\}$ and $\{2\}$, each with probability of a half. The FOC is

$$\frac{\partial B_2(A|x)}{\partial x_2} = \frac{1}{2}v^2(a_F, a_I) + \frac{1}{2}v^2(a_F, a_I) = c'_2(x_2) \quad (3.8)$$

Next Brynjolfsson points out that the framework he has developed allows him to quantify the potential improvement in incentives and therefore increase in value induced by making information transferable. He suggests a comparison of the output created under the best possible ownership structure when information is alienable (the unconstrained allocation) to the output created under the best possible ownership structure when information is “owned” by a particular agent (the constrained allocation). Given the situation discussed above this procedure would amount to making a comparison of the maximum of value created when choosing an ownership structure described by equations (3.3)\(3.4), (3.5)\(3.6) or (3.9)\(3.10) with the maximum value created by limiting the choice to ownership structures given by equations (3.3)\(3.4) or (3.5)\(3.6). Clearly if we add in an inalienability constraint to any asset then the ownership of alienable assets can be affected. The difference in values of the two alternatives is termed the “value of alienability” by Brynjolfsson. If this difference is large then it suggests that merely transforming information from an inalienable form into a tradeable form can create value without increasing the stock of knowledge.

From this we can see that the decision as to which assets are alienable and which are not can be, at least to a degree, made endogenous. There will be strong incentives to develop technology in the form of alienable assets when the “value of alienability” is high.

While knowledge that can be articulated can be, in many cases, embodied in an alienable asset, for tacit knowledge this may not be possible. Some tacit knowledge may be transferred through shared understandings of collectives. Corporate cultures can be seen as a “technology” which allows information to be transferred at relatively low cost but only between those people who share the culture. Brynjolfsson argues that languages and education can be seen in a similar light.

With the digital revolution numerous new alienable information assets have been created. The model above tells us that the main financial winners from this will be those who own the information assets but who in the past could only benefit by being personally involved. Consider the incomes of popular musicians who now have an expanded range of recording media with which to trade their music.

The arguments of Sections 3.1 and 3.2 suggest that incentives are increased by having control of both the information and complementary physical assets in the hands of the same person.

Separating controls leads to potential holdup problems. This conclusion can be altered if we relax the assumption that no comprehensive contracts can be written. Note that if information is fully contractible then there are no “residual rights” and therefore ownership is irrelevant (not even really defined). The party who owns the physical assets need not also own the information assets since holdup is not possible.

Making information alienable improved incentives since it increased the number of ownership arrangements that are possible but it still fell short of first best. This is because the agent who does not have control of the information asset risks being held up. If however we allow information to be contracted upon fully then we could potentially give each party optimal incentives. In principle we give access to the information asset in such a way that, dependent on circumstances, each individual will be given maximum incentives. As with the case of alienation we could compare the value created when information is contractible with the value obtained when information can not be contracted upon. It seems likely that in many situations the “value of alienability” will be high.

In Section 3.3 the question is asked, Do smaller firms provide better incentives for exploiting information? In this section Brynjolfsson extends the model to have multiple informed agents each of whom requires access to the firm’s physical assets to be productive.

There are now n informed agents ($i = 1, \dots, n$), each of whom has some information ($a_i = 1, \dots, n$) which requires access to a physical asset (the firm : a_F) to be productive. Assume that the information of one agent does not affect the information of other agents.

Assume that agent j is given ownership of the firm, that is, ownership of a_F . Given this j ’s first-order condition will be

$$v^j(a_F, a_j) = c'_j(x_j). \quad (3.11)$$

For any other agent $i \neq j$ their first-order condition will be

$$\frac{1}{2}v^i(a_F, a_i) = c'_i(x_i).^8 \quad (3.12)$$

⁸For an example see footnote 9, page 115.

It does not matter which agent owns the physical asset, all the other agents in the firm will have insufficient incentives with regard to exerting effort.⁹ Should these underpowered incentive lead to these agents under-utilising their information then the firm's overall productivity could be improved if a single agent could own all the information assets in addition to the physical assets. This is consistent with the idea of an owner/manager being supplied with all necessary

⁹Consider, as an example, the case where there are three agents, ($i = 1, 2, 3$). Let agent 1 own the physical asset. Thus any coalition without agent 1 will be unproductive. Given that there are four coalitions that agent 1 can be a member of, $\{(1,2,3), (1,2), (1,3), (1)\}$, the Shapley value for agent 1 would be

$$\begin{aligned}
SV_1 &= \frac{(3-1)!(3-3)!}{3!} (v(\{1, 2, 3\}\{a_F, a_1, a_2, a_3\}|\{x_1, x_2, x_3\}) - v(\{2, 3\}\{a_2, a_3\}|\{x_2, x_3\})) \\
&+ \frac{(2-1)!(3-2)!}{3!} (v(\{1, 2\}\{a_F, a_1, a_2\}|\{x_1, x_2\}) - v(\{2\}\{a_2\}|\{x_2\})) \\
&+ \frac{(2-1)!(3-2)!}{3!} (v(\{1, 3\}\{a_F, a_1, a_3\}|\{x_1, x_3\}) - v(\{3\}\{a_3\}|\{x_3\})) \\
&+ \frac{(1-1)!(3-1)!}{3!} (v(\{1\}\{a_F, a_1\}|\{x_1\}) - v(\emptyset)) \\
&= \frac{2}{6} (v(\{1, 2, 3\}\{a_F, a_1, a_2, a_3\}|\{x_1, x_2, x_3\}) - v(\{2, 3\}\{a_1, a_2, a_3\}|\{x_2, x_3\})) \\
&+ \frac{1}{6} (v(\{1, 2\}\{a_F, a_1, a_2\}|\{x_1, x_2\}) - v(\{2\}\{a_2\}|\{x_2\})) \\
&+ \frac{1}{6} (v(\{1, 3\}\{a_F, a_1, a_3\}|\{x_1, x_3\}) - v(\{3\}\{a_3\}|\{x_3\})) \\
&+ \frac{2}{6} (v(\{1\}\{a_F, a_1\}|\{x_1\}) - v(\emptyset))
\end{aligned}$$

This gives an objective function of

$$\begin{aligned}
B_1(A|x) &= SV_1 - c_1(x_1) \\
&= \frac{2}{6} (v(\{1, 2, 3\}\{a_F, a_1, a_2, a_3\}|\{x_1, x_2, x_3\}) - v(\{2, 3\}\{a_2, a_3\}|\{x_2, x_3\})) \\
&+ \frac{1}{6} (v(\{1, 2\}\{a_F, a_1, a_2\}|\{x_1, x_2\}) - v(\{2\}\{a_2\}|\{x_2\})) \\
&+ \frac{1}{6} (v(\{1, 3\}\{a_F, a_1, a_3\}|\{x_1, x_3\}) - v(\{3\}\{a_3\}|\{x_3\})) \\
&+ \frac{2}{6} (v(\{1\}\{a_F, a_1\}|\{x_1\}) - v(\emptyset)) \\
&- c_1(x_1)
\end{aligned}$$

Thus the FOC is

$$\begin{aligned}
\frac{\partial B_1(A|x)}{\partial x_1} &= \frac{2}{6} v^1(\{1, 2, 3\}\{a_F, a_1, a_2, a_3\}|\{x_1, x_2, x_3\}) \\
&+ \frac{1}{6} v^1(\{1, 2\}\{a_F, a_1, a_2\}|\{x_1, x_2\}) \\
&+ \frac{1}{6} v^1(\{1, 3\}\{a_F, a_1, a_3\}|\{x_1, x_3\}) \\
&+ \frac{2}{6} v^1(\{1\}\{a_F, a_1\}|\{x_1\}) \\
&= c'_1(x_1) \\
&\Rightarrow v^1(a_F, a_1) = c'_1(x_1)
\end{aligned}$$

This is because given that the information of one agent doesn't affect the information of the other agents $v^1(\{1, 2, 3\}\{a_F, a_1, a_2, a_3\}|\{x_1, x_2, x_3\}) = v^1(\{1, 2\}\{a_F, a_1, a_2\}|\{x_1, x_2\}) = v^1(\{1, 3\}\{a_F, a_1, a_3\}|\{x_1, x_3\}) = v^1(\{1\}\{a_F, a_1\}|\{x_1\})$.

information for the efficient running of the firm. The owner/manager would then have all the information and first-best incentives for maximising the firm's returns, while all other agents would simply carry out the owner's instructions, with little in the way of information and/or physical asset ownership of their own. Due to their uncontractible actions being kept to a minimum, supplying incentives via ownership is unnecessary for these agents.

An alternative to single ownership is a partnership, a topic to which Brynjolfsson now turns. In this case control is allocated on the basis of majority rule and thus an agent will control the firm as long as he is a member of a majority coalition. If we assume random coalitions on any

For agent 2 we get an objective function of the form:

$$\begin{aligned}
B_2(A|x) &= SV_2 - c_2(x_2) \\
&= \frac{2}{6} (v(\{1, 2, 3\}\{a_F, a_1, a_2, a_3\}|\{x_1, x_2, x_3\}) - v(\{1, 3\}\{a_F, a_1, a_3\}|\{x_1, x_3\})) \\
&+ \frac{1}{6} (v(\{1, 2\}\{a_F, a_1, a_2\}|\{x_1, x_2\}) - v(\{1\}\{a_F, a_1\}|\{x_1\})) \\
&+ \frac{1}{6} (v(\{2, 3\}\{a_2, a_3\}|\{x_2, x_3\}) - v(\{3\}\{a_3\}|\{x_3\})) \\
&+ \frac{2}{6} (v(\{2\}\{a_2\}|\{x_2\}) - v(\emptyset)) \\
&- c_2(x_2)
\end{aligned}$$

Remember there are four coalitions that agent 2 can be a member of, $\{(1,2,3),(1,2),(2,3),(2)\}$. Note that without a_F , that is, without agent 1, a coalition is unproductive. Thus the FOC is

$$\begin{aligned}
\frac{\partial B_2(A|x)}{\partial x_2} &= \frac{2}{6} v^2(\{1, 2, 3\}\{a_F, a_1, a_2, a_3\}|\{x_1, x_2, x_3\}) \\
&+ \frac{1}{6} v^2(\{1, 2\}\{a_F, a_1, a_2\}|\{x_1, x_2\}) \\
&= c'_2(x_2) \\
\Rightarrow \frac{1}{2} v^2(a_F, a_1, a_2) &= c'_2(x_2)
\end{aligned}$$

Both the $v^2(\cdot)$ terms are the same since the information of one agent doesn't affect the information of the other agents. The FOC for agent 3 can be calculated in a similar manner to that of agent 2.

given issue his first order-condition (for n odd) is:

$$\left(\frac{1}{2} \cdot \frac{n+1}{n}\right) v^i(a_F, a_i) = c'_i(x_i)^{10} \quad (3.13)$$

From this it is clear that agents still have insufficient incentives to invest compared to the first best situation. This is especially true as n becomes large.

The fundamental problem here is that no combination of voting patterns can overcome the disincentive to invest since there not enough residual income to go around. To achieve the first best it is necessary for each agent to receive, at the margin, 100 percent of his contribution, which is not possible. This impossibility stems from the fact only total output is observable, marginal contributions are not, and a balanced budget is to be achieved.¹¹

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$$\begin{aligned} \frac{C_s^n - C_s^{n-1}}{C_s^n} &= 1 - \frac{C_s^{n-1}}{C_s^n} \\ &= 1 - \frac{\frac{(n-1)!}{s!(n-1-s)!}}{\frac{n!}{s!(n-s)!}} \\ &= 1 - \frac{(n-1)!}{s!(n-1-s)!} \cdot \frac{s!(n-s)!}{n!} \\ &= 1 - \frac{(n-1)!}{s!(n-1-s)!} \cdot \frac{s!(n-s)(n-s-1)!}{n(n-1)!} \\ &= 1 - \frac{n-s}{n} \\ &= \frac{n}{n} - \frac{n-s}{n} \\ &= \frac{n - (n-s)}{n} \\ &= \frac{s}{n} \end{aligned}$$

In this case $s = \frac{n+1}{2}$ so $\frac{s}{n} = \frac{\frac{n+1}{2}}{n} = \frac{1}{2} \cdot \frac{n+1}{n}$ as required. Note that the term $C_s^n - C_s^{n-1}$ is the number of winning coalitions that the n^{th} , i.e. marginal, agent is a member of. Thus the term $\frac{C_s^n - C_s^{n-1}}{C_s^n}$ is the ratio of the winning coalitions the marginal agent is a member of, to the total number of winning coalitions, and thus is the probability of the marginal agent being in a winning coalition.

¹¹McAfee and McMillan (1991: 562) describe the problem and one solution mechanism as,

“[t]he principal offers to pay each of the n agents 100 percent of any marginal increase in team output. Clearly this gives each agent the appropriate incentive to exert effort. It does, however, result in the principal’s total variable payment being n times the value of output. To balance this, the fixed part of the payment function must be negative: in fact, in this case each agent’s fixed payment is set equal to the expected value of output minus the agent’s production cost, so that the agents earn zero rents on average. Thus the optimal contract has the principal initially (before production takes place) collecting money from the agents, and then (after the production process) paying each agent the full value of the team’s output. In other words, in the presence of moral hazard, the principal achieves his ideal outcome by, at the margin, breaking the budget: by eliminating the requirement that the marginal payments sum to one, and by manipulating the lump-sum payments instead of the marginal payments (as Groves 1973 first noted).”

A formal discussion can be found in Holmström (1982: 326-9).

Given these problems, Brynjolfsson returns again to the basic assumption being made that all actions are uncontractible. Clearly there are benefits from designing the production system in such a way as to ensure that actions are contractible. With contractible actions, ownership does not have to bear the (impossible) burden of providing incentives to all agents within the firm.

Brynjolfsson makes the argument that small firms have an advantage in providing incentives in these situations. This is not only because they can more easily separate out and contractually reward individual contributions but also because agents in these smaller firms will, in addition, have a stronger incentive to take uncontractible actions. From equation (3.13) it is clear that small partnerships will provide stronger incentives than large partnerships, with the case of one owner maximising incentives. For situations where it is important to provide incentives for the use of knowledge in ways that can not be easily foreseen and contracted upon, ownership in the hands of the few has a relative advantage over a large firm.

Section 3.4 of the paper deals with the question “Are flexible assets more appropriate for informed agents?” It is possible to alleviate the problems inherent in there being a number of informed agents working in the same firm if each of the agents is given uncontested ownership, and thus access to, the non-human assets of the firm.

If the physical assets of the firm are not unique and if economies scale in the use of these assets do not exist then it is possible to costlessly achieve the first best outcome if all of the informed parties are given their own firm, that is, an a_F asset is associated with each a_i asset for all i (as in equation 3.11).

An alternative possibility is that the assets of the firm are, at least to a degree, divisible. In this case, a given agent i may not need to access all the physical assets of the firm but only a subset of them, a_{Fi} . If this is so then there is a trade-off between keeping the assets together and distributing them among the firm’s agents. Insofar as the assets are complementary, divided ownership would reduce their productivity in those coalitions into which they were separated. On the other hand, if there are synergies between a particular subset of the physical assets, a_{Fi} , and agent i ’s information assets, then there are advantages to giving i ownership of a_{Fi} .

Consider, as an example, the situation where there are three agents and three physical assets of the firm. It is assumed that there are synergies between each agent’s information assets and the firm’s physical assets along with synergies among the firm’s assets. When agent i owns the

subset a_{F_i} of the firm's physical assets along with his private information, a_i , the FOC for agent 1 is¹²

$$\begin{aligned} \frac{1}{3}v^1(a_1, a_{F1}, a_{F2}, a_{F3}) + \frac{1}{6}v^1(a_1, a_{F1}, a_{F2}) + \frac{1}{6}v^1(a_1, a_{F1}, a_{F3}) \\ + \frac{1}{3}v^1(a_1, a_{F1}) = c'_1(x_1) \end{aligned} \quad (3.14)$$

The alternative is that all the assets of the firm are owned by one agent, not agent 1, which gives agent 1's FOC as¹³

$$\frac{1}{2}v^1(a_1, a_{F1}, a_{F2}, a_{F3}) = c'_1(x_1) \quad (3.15)$$

¹²Given that there are four coalitions that agent 1 can be a member of, $\{(1,2,3), (1,2), (1,3), (1)\}$, his objective function is

$$\begin{aligned} B_1(A|x) &= SV_1 - c_1(x_1) \\ &= \frac{2}{6}(v(\{1, 2, 3\}\{a_1, a_{F1}, a_2, a_{F2}, a_3, a_{F3}\}\{x_1, x_2, x_3\}) - v(\{2, 3\}\{a_2, a_{F2}, a_3, a_{F3}\}\{x_2, x_3\})) \\ &+ \frac{1}{6}(v(\{1, 2\}\{a_1, a_{F1}, a_2, a_{F2}\}\{x_1, x_2\}) - v(\{2\}\{a_2, a_{F2}\}\{x_2\})) \\ &+ \frac{1}{6}(v(\{1, 3\}\{a_1, a_{F1}, a_3, a_{F3}\}\{x_1, x_3\}) - v(\{3\}\{a_3, a_{F3}\}\{x_3\})) \\ &+ \frac{2}{6}(v(\{1\}\{a_{F1}, a_1\}\{x_1\}) - v(\emptyset)) \\ &- c_1(x_1) \end{aligned}$$

This gives the FOC of

$$\begin{aligned} \frac{\partial B_1(A|x)}{\partial x_1} &= \frac{2}{6}v^1(\{1, 2, 3\}\{a_1, a_{F1}, a_2, a_{F2}, a_3, a_{F3}\}\{x_1, x_2, x_3\}) \\ &+ \frac{1}{6}v^1(\{1, 2\}\{a_1, a_{F1}, a_2, a_{F2}\}\{x_1, x_2\}) \\ &+ \frac{1}{6}v^1(\{1, 3\}\{a_1, a_{F1}, a_3, a_{F3}\}\{x_1, x_3\}) \\ &+ \frac{2}{6}v^1(\{1\}\{a_{F1}, a_1\}\{x_1\}) \\ &= c'_1(x_1) \end{aligned}$$

¹³Assume agent 2 owns all of (a_{F1}, a_{F2}, a_{F3}) , then the objective function for agent 1 is

$$\begin{aligned} B_1(A|x) &= SV_1 - c_1(x_1) \\ &= \frac{2}{6}(v(\{1, 2, 3\}\{a_1, a_{F1}, a_2, a_{F2}, a_3, a_{F3}\}\{x_1, x_2, x_3\}) - v(\{2, 3\}\{a_2, a_{F2}, a_3, a_{F3}\}\{x_2, x_3\})) \\ &+ \frac{1}{6}(v(\{1, 2\}\{a_1, a_{F1}, a_2, a_{F2}\}\{x_1, x_2\}) - v(\{2\}\{a_2, a_{F2}\}\{x_2\})) \\ &+ \frac{1}{6}(v(\{1, 3\}\{a_1, a_{F1}, a_3, a_{F3}\}\{x_1, x_3\}) - v(\{3\}\{a_3, a_{F3}\}\{x_3\})) \\ &+ \frac{2}{6}(v(\{1\}\{a_{F1}, a_1\}\{x_1\}) - v(\emptyset)) \\ &- c_1(x_1) \end{aligned}$$

The FOCs for the other agents can be found in a similar manner. What is needed now is to determine which ownership structure provides the most powerful incentives for an agent. Brynjolfsson does this by comparing the left hand sides of equations (3.14) and (3.15). He notes that if the assets are highly complementary, that is, a_1 needs access to all of a_{F1}, a_{F2} and a_{F3} to be productive, then the second, third and fourth terms in equation (3.14) will be small or near zero. This means that the equation will be approximately equal to $\frac{1}{3}v^1(a_1, a_{F1}, a_{F2}, a_{F3})$ compared to $\frac{1}{2}v^1(a_1, a_{F1}, a_{F2}, a_{F3})$ for equation (3.15). Thus there are better incentives when the assets are combined than when they are separated. On the other hand, if the information asset, a_1 , is for the most part productive when applied to a_{F1} only, and thus does not need access to a_{F2} and/or a_{F3} to be productive, then the second, third and fourth terms in equation (3.14) may be large and thus comparing equations (3.14) and (3.15) tells us that separate ownership is optimal.

An upshot of this is that when there are a number of agents all of whom have an information asset, a_i , important to the production process, which requires access to physical assets to be fully productive means that the first-best outcome cannot be achieved by organising those agent into a single firm, as denoted by equation (3.15). Thus when information is decentralised this opens up the possibility that physical asset ownership will also be decentralised and therefore we should see an increased use of markets to coordinate economic activity.

which equals

$$\begin{aligned}
B_1(A|x) &= SV_1 - c_1(x_1) \\
&= \frac{2}{6}(v(\{1, 2, 3\}\{a_1, a_{F1}, a_2, a_{F2}, a_3, a_{F3}\}|\{x_1, x_2, x_3\}) - v(\{2, 3\}\{a_2, a_{F2}, a_3, a_{F3}\}|\{x_2, x_3\})) \\
&+ \frac{1}{6}(v(\{1, 2\}\{a_1, a_{F1}, a_2, a_{F2}\}|\{x_1, x_2\}) - v(\{2\}\{a_2, a_{F2}\}|\{x_2\})) \\
&- c_1(x_1)
\end{aligned}$$

since agent 1 needs agent 2 to being productive. The FOC is given by

$$\begin{aligned}
\frac{\partial B_1(A|x)}{\partial x_1} &= \frac{2}{6}v^1(\{1, 2, 3\}\{a_1, a_{F1}, a_2, a_{F2}, a_3, a_{F3}\}|\{x_1, x_2, x_3\}) \\
&+ \frac{1}{6}v^1(\{1, 2\}\{a_1, a_{F1}, a_2, a_{F2}\}|\{x_1, x_2\}) \\
&= c'_1(x_1) \\
&\Rightarrow \frac{1}{2}v^1(\{1, 2, 3\}\{a_1, a_{F1}, a_2, a_{F2}, a_3, a_{F3}\}|\{x_1, x_2, x_3\}) \\
&= c'_1(x_1)
\end{aligned}$$

given the assumption that

$$v^1(\{1, 2, 3\}\{a_1, a_{F1}, a_2, a_{F2}, a_3, a_{F3}\}|\{x_1, x_2, x_3\}) = v^1(\{1, 2\}\{a_1, a_{F1}, a_2, a_{F2}\}|\{x_1, x_2\}).$$

Another issue Brynjolfsson highlights is the importance of asset specificity of the physical assets in regard to the integration/non-integration trade-off. If information technologies mean that assets are more flexible, so that they are not locked-in to other particular assets, then this will motivate the decentralisation of asset ownership. Alternatively, if the information technologies increase lock-in, via things like network externalities, proprietary standards or idiosyncratic hardware and software protocols, it will make centralised ownership less costly and thus more likely.

What we see is that technology will affect the choice of the organisational form of the firm both via its effect on the distribution of information and by changing the nature of the non-human assets. There are interactions between these two effects and they feedback upon each other. At this stage Brynjolfsson makes the point that the best incentives can be achieved in one of two ways depending on the situation. First, via the centralisation of information and asset ownership under a single party, which eliminates any costs of high asset specificity; or second, via the decentralisation of information and assets which requires that there be little in the way of asset specificity. Thus it seems likely that the distribution of information will affect the types of assets utilised in the productions of goods and services, and vice versa.

Section 3.5 looks at the question “How does “coordination information” affect the distribution and ownership of production assets?” Up until this point Brynjolfsson has considered only complementarities between the physical assets or the physical and information assets. Now he turns to complementarities among the information assets. Clearly when there are a number of informed agents it is quite possible that at sometime any given agent will need access to the information of some other agent. One major issue that can arise here is that if an agent’s output does depend on information known only to another agent, then no rearrangement of the non-human assets of the firm can eliminate the interdependency. One way to limit the number of necessary links between agents is to channel all interactions through a central coordinator. This reduces the number of links needed between agents. Instead of having each of the n agents interacting with each of the other $(n - 1)$ agents, for a total of $n \cdot (n - 1)$ links, you get each agent only having to deal with the central coordinator, resulting in a total of n links. In most cases when centralised control is required it is achieved via a firm rather than between firms. Brynjolfsson shows that the existence of one agent with essential coordination information can make centralised ownership

of all physical optimal in two cases: 1) it is important to provide incentives to the “coordinator” or 2) the physical assets are even weakly complementary.

For case 1) consider a situation where instead of each agent being able to contact the other agent directly they can only communicate with the “coordinator”. Because he is the central coordinator he obtains information which is essential to the productivity of the agents. This situation reduces the total number of links that need to be maintained, as noted above, but, as a downside, makes the agents very dependent upon the coordinator. Assume that to be productive the typical agent requires access to the coordination information, denoted a_c , but the information of this agent is irrelevant to the coordinator or the other agents directly. In addition Brynjolfsson assumes that access to certain physical assets, a_{F_i} enhances the productivity of the agent but his productivity is independent of the other assets, $a_{F_j}, j \neq i$.

When each of the agents owns some physical assets, a_{F_i} , in addition to their information, a_i , the first-order condition for the typical agent is:¹⁴

¹⁴There are four coalitions that agent 1 can be a member of, $\{(1, 2, c), (1, 2), (1, c), (1)\}$. This gives an objective function of

$$\begin{aligned}
 B_1(A|x) &= SV_1 - c_1(x_1) \\
 &= \frac{2}{6} (v(\{1, 2, c\}\{a_1, a_{F1}, a_2, a_{F2}, a_c\}|\{x_1, x_2, x_c\}) - v(\{2, c\}\{a_2, a_{F2}, a_c\}|\{x_2, x_c\})) \\
 &+ \frac{1}{6} (v(\{1, 2\}\{a_1, a_{F1}, a_2, a_{F2}\}|\{x_1, x_2\}) - v(\{2\}\{a_2, a_{F2}\}|\{x_2\})) \\
 &+ \frac{1}{6} (v(\{1, c\}\{a_1, a_{F1}, a_c\}|\{x_1, x_c\}) - v(\{c\}\{a_c\}|\{x_c\})) \\
 &+ \frac{2}{6} (v(\{1\}\{a_1, a_{F1}\}|\{x_1\}) - v(\emptyset)) \\
 &- c_1(x_1)
 \end{aligned}$$

Differentiating with respect to x_1 gives the FOC:

$$\begin{aligned}
 \frac{\partial B_1(A|x)}{\partial x_1} &= \frac{2}{6} v^1(\{1, 2, c\}\{a_1, a_{F1}, a_2, a_{F2}, a_c\}|\{x_1, x_2, x_c\}) \\
 &+ \frac{1}{6} v^1(\{1, 2\}\{a_1, a_{F1}, a_2, a_{F2}\}|\{x_1, x_2\}) \\
 &+ \frac{1}{6} v^1(\{1, c\}\{a_1, a_{F1}, a_c\}|\{x_1, x_c\}) \\
 &+ \frac{2}{6} v^1(\{1\}\{a_1, a_{F1}\}|\{x_1\}) \\
 &= c_1(x_1)
 \end{aligned}$$

It is assumed that the marginal productivity of agent i is unaffected by the physical or information assets specific to other agents and thus

$$\begin{aligned}
 v^1(\{1, 2, c\}\{a_1, a_{F1}, a_2, a_{F2}, a_c\}|\{x_1, x_2, x_c\}) &= v^1(\{1, c\}\{a_1, a_{F1}, a_c\}|\{x_1, x_c\}) \\
 \text{and } v^1(\{1, 2\}\{a_1, a_{F1}, a_2, a_{F2}\}|\{x_1, x_2\}) &= v^1(\{1\}\{a_1, a_{F1}\}|\{x_1\}).
 \end{aligned}$$

$$\frac{1}{2}v^i(a_i, a_{Fi}, a_c) + \frac{1}{2}v^i(a_i, a_{Fi}) = c'_i(x_i) \quad (3.16)$$

When all physical assets are owned by the coordinator, the first-order condition for agent 1 is:¹⁵

$$\frac{1}{2}v^i(a_i, a_{Fi}, a_c) + \frac{1}{2}v^i(a_i) = c'_i(x_i) \quad (3.17)$$

Because agent i needs access to the information of the coordinator, the second term in each of equations (3.16) and (3.17) is zero. This means that the incentives of agent i are unchanged

This allows us to rewrite the FOC as

$$\begin{aligned} \frac{\partial B_1(A|x)}{\partial x_1} &= \frac{1}{2}v^1(\{1, 2, c\}\{a_1, a_{F1}, a_2, a_{F2}, a_c\}|\{x_1, x_2, x_c\}) \\ &+ \frac{1}{2}v^1(\{1\}\{a_1, a_{F1}\}|\{x_1\}) \\ &= c_1(x_1) \end{aligned}$$

¹⁵There are four coalitions that agent 1 can be a member of, $\{(1, 2, c), (1, 2), (1, c), (1)\}$. This gives an objective function of

$$\begin{aligned} B_1(A|x) &= SV_1 - c_1(x_1) \\ &= \frac{2}{6}(v(\{1, 2, c\}\{a_1, a_{F1}, a_2, a_{F2}, a_c\}|\{x_1, x_2, x_c\}) - v(\{2, c\}\{a_2, a_{F1}, a_{F2}, a_c\}|\{x_2, x_c\})) \\ &+ \frac{1}{6}(v(\{1, 2\}\{a_1, a_2\}|\{x_1, x_2\}) - v(\{2\}\{a_2\}|\{x_2\})) \\ &+ \frac{1}{6}(v(\{1, c\}\{a_1, a_{F1}, a_{F2}, a_c\}|\{x_1, x_c\}) - v(\{c\}\{a_{F1}, a_{F2}, a_c\}|\{x_c\})) \\ &+ \frac{2}{6}(v(\{1\}\{a_1\}|\{x_1\}) - v(\emptyset)) \\ &- c_1(x_1) \end{aligned}$$

Differentiating with respect to x_1 gives the FOC:

$$\begin{aligned} \frac{\partial B_1(A|x)}{\partial x_1} &= \frac{2}{6}v^1(\{1, 2, c\}\{a_1, a_{F1}, a_2, a_{F2}, a_c\}|\{x_1, x_2, x_c\}) \\ &+ \frac{1}{6}v^1(\{1, 2\}\{a_1, a_2\}|\{x_1, x_2\}) \\ &+ \frac{1}{6}v^1(\{1, c\}\{a_1, a_{F1}, a_{F2}, a_c\}|\{x_1, x_c\}) \\ &+ \frac{2}{6}v^1(\{1\}\{a_1\}|\{x_1\}) \\ &= c'_1(x_1) \end{aligned}$$

It is assumed that the marginal productivity of agent i is unaffected by the physical or information assets specific to other agents and thus

$$v^1(\{1, 2, c\}\{a_1, a_{F1}, a_2, a_{F2}, a_c\}|\{x_1, x_2, x_c\}) = v^1(\{1, c\}\{a_1, a_{F1}, a_{F2}, a_c\}|\{x_1, x_c\})$$

$$\text{and } v^1(\{1, 2\}\{a_1, a_2, \}\{x_1, x_2\}) = v^1(\{1\}\{a_1\}|\{x_1\}).$$

This allows us to rewrite the FOC as

$$\begin{aligned} \frac{\partial B_1(A|x)}{\partial x_1} &= \frac{1}{2}v^1(\{1, 2, c\}\{a_1, a_{F1}, a_2, a_{F2}, a_c\}|\{x_1, x_2, x_c\}) \\ &+ \frac{1}{2}v^1(\{1\}\{a_1\}|\{x_1\}) \\ &= c'_1(x_1) \end{aligned}$$

between the two ownership structures but the incentives for the coordinator are unambiguously increased, even if they only increase his productivity marginally, by transferring ownership of all physical assets to him. Therefore we find that if it is important to provide incentives to the central coordinator then centralised ownership, in the hands of the coordinator, is optimal.

For case 2), noted above, we have a situation where the physical assets are at least weakly complementary. The interesting outcome here is that it is optimal to give the coordinator all physical assets even when the effect on the incentives of the coordinator is unimportant. The reasoning here is that shifting assets from agent i to the coordinator will improve the incentives of the other agents $j \neq i$.

Brynjolfsson considers the case where there are only two agents ($i = 1, 2$) and a coordinator (c), for reasons of tractability. It is assumed that the two agents each own valuable information, a_i , in addition to a physical asset a_{Fi} . In contrast to case 1), considered previously, it is now assumed that the physical assets a_{F1} and a_{F2} are at least weakly complementary with each other. For each agent the first-order condition will be:¹⁶

$$\begin{aligned}
\frac{\partial B_i(A|x)}{\partial x_i} &= \frac{1}{3}v^i(\{i, j, c\}\{a_i, a_{Fi}, a_{Fj}, a_j, a_c\}|\{x_i, x_j, x_c\}) \\
&+ \frac{1}{6}v^i(\{i, c\}\{a_i, a_{Fi}, a_c\}|\{x_i, x_c\}) \\
&+ \frac{1}{6}v^i(\{i, j\}\{a_i, a_{Fi}, a_{Fj}, a_j\}|\{x_i, x_j\}) \\
&+ \frac{1}{3}v^i(\{i\}\{a_i, a_{Fi}\}|\{x_i\}) \\
&= c'_i(x_i) \quad \text{for } i, j = 1, 2 \text{ and } j \neq i.
\end{aligned} \tag{3.18}$$

¹⁶For agent 1 the coalitions to which he can belong will be $(\{1,2,c\}, \{1,2\}, \{1,c\}, \{1\})$. This give rise to the objective function

$$\begin{aligned}
B_1(A|x) &= SV_1 - c_1(x_1) \\
&= \frac{1}{3}(v(\{1, 2, c\}\{a_1, a_{F1}, a_{F2}, a_2, a_c\}|\{x_1, x_2, x_c\}) - v(\{2, c\}\{a_2, a_{F2}, a_c\}|\{x_2, x_c\})) \\
&+ \frac{1}{6}(v(\{1, c\}\{a_1, a_{F1}, a_c\}|\{x_1, x_c\}) - v(v(\{c\}\{a_c\}|\{x_c\}))) \\
&+ \frac{1}{6}(v(\{1, 2\}\{a_1, a_{F1}, a_{F2}, a_2\}|\{x_1, x_2\}) - v(v(\{2\}\{a_{F2}, a_2\}|\{x_2\}))) \\
&+ \frac{1}{3}(v(\{1\}\{a_1, a_{F1}\}|\{x_1\}) - v(v(\emptyset))) \\
&- c_1(x_1)
\end{aligned}$$

Differentiating this with respect to x_1 gives equation (3.18). The FOC for agent 2 can be found in a similar manner.

The other possibility is for both the physical assets of the firm, (a_{F1}, a_{F2}) , to be owned by the central coordinator. In this case each agent's first-order condition is:

$$\begin{aligned} \frac{\partial B_i(A|x)}{\partial x_i} &= \frac{1}{2}v^i(\{i, j, c\}\{a_i, a_{Fi}, a_{Fj}, a_j, a_c\}|\{x_i, x_j, x_c\}) \\ &+ \frac{1}{2}v^i(\{i\}\{a_i\}|\{x_i\}) \\ &= c'_i(x_i)^{17} \end{aligned} \quad (3.19)$$

As it has been assumed that each agent needs access to the central coordinator's information in order for them to be productive, the third and fourth terms in equation (3.18) and the second term in (3.19) must all be zero. If there are even weak complementarities between a_{Fi} and a_{Fj} then the first two terms in (3.18) will sum to less than the first term of (3.19).¹⁸ But we can see from equation (3.19) that $\frac{1}{2}v^i(\{i, j, c\}\{a_i, a_{Fi}, a_{Fj}, a_j, a_c\}|\{x_i, x_j, x_c\})$ is the incentive that the agent would get under centralised asset ownership.

These results can be summarised by saying that when there is a need for centralised coordination, the incentives of all agents can be improved by centralising the ownership of assets as well. This means that firms have an advantage over markets when it comes to centralised coordination. On the other hand, when direct coordination between agents is possible, the need for centralised coordination and asset ownership is reduced.

Section 4 of the Brynjolfsson paper is the conclusion. Section 4.1 is a summary. Section 4.2 is a "comparison with the empirical evidence" while 4.3 is "comparison with related literature".

¹⁷For agent 1 the coalitions to which he can belong will be $(\{1,2,c\},\{1,2\},\{1,c\},\{1\})$. This give rise to the objective function

$$\begin{aligned} B_1(A|x) &= SV_1 - c_1(x_1) \\ &= \frac{1}{3}(v(\{1, 2, c\}\{a_1, a_{F1}, a_{F2}, a_2, a_c\}|\{x_1, x_2, x_c\}) - v(\{2, c\}\{a_{F1}, a_2, a_{F2}, a_c\}|\{x_2, x_c\})) \\ &+ \frac{1}{6}(v(\{1, c\}\{a_1, a_{F1}, a_{F2}, a_c\}|\{x_1, x_c\}) - v(v(\{c\}\{a_{F1}, a_{F2}a_c\}|\{x_c\}))) \\ &+ \frac{1}{6}(v(\{1, 2\}\{a_1, a_2\}|\{x_1, x_2\}) - v(v(\{2\}\{a_2\}|\{x_2\}))) \\ &+ \frac{1}{3}(v(\{1\}\{a_1\}|\{x_1\}) - v(v(\emptyset))) \\ &- c_1(x_1) \end{aligned}$$

Differentiating this with respect to x_1 and taking into account that the marginal productivity of agent i is unaffected by the information assets specific to other agents gives equation (3.19). The FOC for agent 2 can be found in a similar manner.

¹⁸This means that $\frac{1}{2}v^i(\{i, j, c\}\{a_i, a_{Fi}, a_{Fj}, a_j, a_c\}|\{x_i, x_j, x_c\}) > \frac{1}{3}v^i(\{i, j, c\}\{a_i, a_{Fi}, a_{Fj}, a_j, a_c\}|\{x_i, x_j, x_c\}) + \frac{1}{6}v^i(\{i, c\}\{a_i, a_{Fi}, a_c\}|\{x_i, x_c\})$ given that $v^i(\{i, c\}\{a_i, a_{Fi}, a_c\}|\{x_i, x_c\})$ will be small since it lacks a_{Fj} .

3.3 Rabin (1993)

Rabin introduces his paper in Section 1. He starts by pointing out that it has been long realised that there are problems for an agent who has useful information, to sell this information to others. The basic problem is that if the information is not revealed before the agent is paid, a (potential) buyer may have little reason to believe the agent is truly well-informed, but if the agent reveals the information up front, the buyer could simply use the information without payment. Rabin's response is to develop a series of formal models in which the informed agent may gain control over productive assets to mitigate such problems. These models work within the framework of research on the incomplete contracts approach to the theory of the firm. Rabin states that he wishes to consider the differing organisational implications of assumptions about the feasibility of revealing information and writing contracts. Emphasis is also placed on how the bargaining process may determine organisational design. Three main models are presented and these demonstrate the effects of the different informational, contracting and bargaining assumptions on whether two parties will integrate and assuming they do, who will have control over the (nonhuman) productive assets.

In Section 2 (Asset Ownership, Moral Hazard, and Adverse Selection) Rabin starts by showing that efficient production depends on asset ownership in the presence of moral hazard (a basic result in the property rights literature) and then shows that if the constraint that an informed outside party earns more than an uninformed outside party is added, efficient production will also depend on ownership in the face of adverse selection.

The section opens with Rabin introducing a reduced-form version of the property rights framework.¹⁹ This framework outlines the main informational assumptions important to the three models presented in Rabin's paper. Consider a factory where the manager can expend costly effort, and let e be the cost of this effort. It is assumed that there are two levels of effort that the manager can exert; $e = 0$, which means he does not work hard and $e = e^* > 0$, which means he does work hard. The revenue generated, $B(e)$, by the manager's effort is greater when he works hard than when he doesn't, i.e. $B(e^*) = 1$ and $B(0) = 0$. Rabin's interest is in the case where the net benefits are greater from working harder, that is, when $e^* < 1$ so that $B(e^*) - e^* > B(0) - 0 = 0$.

¹⁹Rabin's model is based on that developed in Hart (1988) and discussed in Holmström and Tirole (1989).

In a world of complete contracts nothing of importance depends on the ownership of the factory. Full productive efficiency would occur regardless of who owns the firm. If someone other than the manager owns the factory, an incentive contract contingent on e could be written which would result in the efficient outcome.

There are however at least two problems in writing such incentive contracts. In may be that the level of effort expended by the manager is not verifiable to an outside court. Also the court may be unable to tell if the owner of the factory has been “skimming off” profits. The courts may only be able observe profits after any skimming has taken place.

These issues are formalised by Rabin in the following way. The manager moves first, he chooses an unverifiable level of effort, e , which results in profits $B(e)$. Next, the owner gets to choose to skim off an amount x from these profits. The court can not observe either the amount skimmed or the original level of profits. What it can observe is post skimming profits: $\pi = B(e) - x$. Skimming the amount x from profits gives the owner an unobservable profit of $g \cdot x$, where $g \leq 1$.

If $g < 1$ then skimming profits means that profits are lowered, that is, skimming is costly. If the owner diverts profits, they lose some in the process. $B(e) - x + g \cdot x < B(e)$. On the other hand, if $g = 1$ then the owner can perfectly extract all the profits of the firm which will render any incentive contract ineffective. For the main models in his paper Rabin’s focus, for reasons of simplicity, is on the $g = 1$ case but he makes subsidiary assumptions such that this simpler case mimics the $g < 1$ case. For the rest of this section he outlines the features of the $g < 1$ case.

First note that only observable, to the court, profits can be the basis of an incentive contract. Thus any such contract between the owner and manager will be of the form $w(\pi)$. For a given contract and a given π , the owner will choose the optimal level of skimming. Taking the incentive contract and the behaviour of owner into account, the manager will choose the optimal level of effort he wishes to exert. Rabin assumes that both the manager and owner are risk neutral.

Can an incentive contract be written such that the manager will exert the optimal level of effort? Consider a given contract $w(\pi)$, which means that the manager will receive the amount $w(\pi)$ if observable profits are π . The question Rabin asks is, will the manager set $e = e^*$. Assume the owner does not skim profits (he sets $x = 0$). If this is so then the manager will set $e = e^*$ only if $w(1) - w(0) > e^*$. That is, the additional payment to the manager for exerting high effort

rather than low effort must be greater than the extra cost to the manager from exerting high rather than low effort. If this inequality holds, that is the manager sets $e = e^*$, then the owner's payoff will be $1 - w(1)$ if he does not skim any profits.²⁰ If he does skim all profits by setting $x = 1$ then profits for him are $g - w(0)$.²¹ So the owner will skim if the payoff to skimming is greater than that to not skimming, i.e. if

$$\begin{aligned} g - w(0) &> 1 - w(1) \\ \Rightarrow w(1) - w(0) &> 1 - g \end{aligned}$$

Also if it is known that the owner will skim then the manager will put in no effort since he knows he will receive a payment of $w(0)$. In combination we get the result that if $1 - g < e^*$ then an incentive contract inducing $e = e^*$ is impossible.²² Thus for either high values of g or e^* , the owner and the manager must be the same person to ensure that efficient production occurs. An incentive contract based on observable profits can not achieve the efficient outcome. This is the basic insight from the property rights approach to the firm: in a world of incomplete contracts the efficiency of production depends on asset ownership.

Rabin next deals with the problem of adverse selection. Again he shows that asset ownership matters. In this case it is assumed that there is one agent, R, who currently owns and runs a factory and that he can be productive at no effort, that is $e^* = 0$. There is also an outside agent, Q, who if informed can improve the productivity of the factory. The problem for R is that only a proportion, p , of outsiders are truly informed, and he can not tell the difference between the informed and uninformed. It is further assumed that a truly informed outsider can add a value of 1 to the production of the factory while uninformed outsiders add no value.

For this case of adverse selection there is an efficient incentive contract under which R owns the factory and Q is simply hired as an employee. R just hires Q and pays her a very small but positive percentage, ϵ , of the increase in profits she brings about. Q will reveal her knowledge

²⁰No skimming means $x = 0$ and along with $e = e^*$ we get that the owner's payoff is revenue, $B(e^*) = 1 = \pi$, minus costs, $w(\pi) = w(1)$, which gives $1 - w(1)$.

²¹ $B(e^*) = 1$, $x = 1$ so owner's private profit is $g \cdot 1$, and $\pi = 0$, the manager gets $w(0)$, giving the net profit for the owner of $g - w(0)$.

²²This is because if $w(1) - w(0) > e^* > 1 - g$ then $w(1) - w(0) > 1 - g$ and so the owner will skim and the manager puts in no effort, i.e. $e < e^*$. If $e^* > w(1) - w(0) > 1 - g$ then $w(1) - w(0) > 1 - g$ and so the owner will skim and the manager puts in no effort, i.e. $e < e^*$, and if $e^* > 1 - g > w(1) - w(0)$ then the manager will not put in any effort, i.e. $e < e^*$.

since this will costlessly increase profits and if $g < 0$ then R will not skim since this would reduce his profits.²³

Now assume that informed outsiders can earn more than zero as their outside option. Let the outside option of the informed agent be at least c in wages, where $c > 0$. Also assume that uninformed outsiders will accept any contract giving them a payoff greater than zero. Intuitively this just means that an informed type of Q will try to tract some rent from their information.

Consider a “separating” contract which is such that R offers to employ Q but only informed Qs will accept the contract. To make sure that the uninformed types do not accept the contract, $w(0) \leq 0$. Here $w(\cdot)$ is a function of observable profits. These can be zero for three reasons: either R is skimming all profits or there is no skimming but there is either an uninformed Q or an informed Q who does not reveal their information. $w(0) \leq 0$ would deter both informed and uninformed types of Q. To ensure the informed type Qs do take the contract it must be that doing the best they can, that is, revealing their information, results in a payoff of greater than c , i.e. $w(1) \geq c$. Only the informed types can generate profits of 1; with observable profits being 1 only if there is no skimming by R. If there is skimming, observable profits would be 0 and an informed Q would not take the contract as $c > 0$. Thus it must also be true that R, assuming they are the owner, does not skim, that is, the contract must be incentive compatible for R to ensure they have no incentive to skim the profits. This means the payoff from not skimming, $1 - w(1)$, is greater than the payoff from skimming, $g \cdot 1 - w(0)$. Rewriting this gives

$$1 - w(1) > g \cdot 1 - w(0)$$

$$1 - g \cdot 1 > w(1) - w(0).$$

Given that we need $w(1) \geq c$ and $w(0) \leq 0$ to ensure that the informed types Qs sign the contract but the uninformed do not, it must be true that $w(1) - w(0) \geq c$.²⁴ We now see that $1 - g > w(1) - w(0) \geq c$ which gives $1 - g > c$ which in turn implies $1 > g + c$ is the condition

²³Assuming that Q’s outside option is set to zero then getting $\epsilon > 0$ means they will reveal their information since this is costless to them and not doing so results in them getting zero $< \epsilon$. Thus there is no point in them saying they are uninformed. The uninformed can not lie and say they are informed because they can not increase profits. The owner will not skim because not skimming result in profits of $1 - \epsilon$ while skimming all profits results in $g - \epsilon$ which is smaller since $g < 1$. The payment to Q must always be ϵ since Q knows their “type” and thus knows they can increase profits by 1.

²⁴This has to hold given that the lowest $w(1)$ can be is c and the largest $w(0)$ can be is 0 and thus the difference between them has to be at least c .

need for there to exist a separating incentive contract. It also tells us that if $g + c > 1$ then there does not exist an efficient incentive contract that only the informed type Qs will accept.

Assume now that R hires both informed and uninformed types of Q. If so a contract to induce the Qs to reveal any information they have is straightforward: just pay them a small amount if profits increase. Remember it is costless for informed Qs to reveal their information. Consider a contract where R will not skim any profits. If $w(1) = c$ (the minimum wage that attracts informed Qs), then the no incentive to skim condition worked out above can be written, $1 - c \geq g - w(0)$. Rearranging this inequality gives the result that $w(0) \geq g + c - 1$.²⁵ The expected cost of the contract is at least:

$$\begin{aligned}
 & p \cdot w(1) + (1 - p) \cdot w(0) \\
 &= p \cdot c + (1 - p)(g + c - 1) \\
 &= p \cdot c + g - p \cdot g + (1 - p)c - (1 - p) \\
 &= p \cdot c + (1 - p)g + (1 - p)c - (1 - p) \\
 &= p \cdot c + (1 - p)g + c - c \cdot p - (1 - p) \\
 &= c + (1 - p)g - (1 - p) \\
 &= c - (1 - p)(1 - g).
 \end{aligned}$$

Expected profits would be $p \cdot 1 + (1 - p) \cdot 0 = p$. Thus the contract could be signed if

$$\begin{aligned}
 p &\geq c - (1 - p)(1 - g) \\
 &\geq c + (1 - p)g - (1 - p) \\
 &\geq c + g - p \cdot g - 1 + p \\
 \Rightarrow 1 &\geq c + g - p \cdot g \\
 \Rightarrow &c + (1 - p)g \leq 1.
 \end{aligned}$$

This is the condition needed for a “pooling” contract to be feasible. Thus, if p is “small” – very few informed Qs – then $c + (1 - p)g \approx c + g$ which means that **no** pooling contract would be

²⁵Why pay $w(0) > 0$? Note that the benefit from skimming is $g - w(0)$ so the higher is $w(0)$, the less is the incentive to skim.

signed if $c + g > 1$. But this is the condition found above for no separating contract as well.²⁶ The upshot of this that when the informed outsiders demand a premium over the uninformed it is possible, for some parameter values, that no contract with R employing Q, resulting in efficient production is feasible and thus to achieve efficiency we need the outsider Q to own the factory.

Section 3 of the paper considers “A Model Combining Moral Hazard and Adverse Selection”. Above it has been shown that asset ownership can be important for efficient production in two ways: “(a) if there is moral hazard in a party R’s effort, then he should own the factory; and (b) if there is adverse selection concerning the quality of a party Q’s information, then she might have to buy a productive asset when informed in order to make more money than uninformed parties.” (Rabin 1993: 57). The models Rabin now presents combine these two issues, by considering bargaining over the control of a factory between the factory’s current owner, a “moral-hazard party”, R, and an outside “adverse-selection party”, Q.

The framework for all of the following models is: the factory is currently owned and run by an owner/manager R. Profits depend on his level of effort, choosing effort level $e = e^*$ results in a profit level of 1 while choosing $e = 0$ gives a profit level of zero. It is also assumed that $e^* < 1$ which means that efficient level of effort is high effort. Zero effort produces zero profit but with $e^* < 1$ high effort produces $1 - e^* > 0$ of profit. With an informed outsider, Q, productivity and profits of the factory are increased by $b > 0$. Thus with her information, total profit will be $1 + b$ if the manager sets $e = e^*$ and b if he sets $e = 0$. The factory’s profits are unchanged if the outsider, Q, is uninformed. Rabin assumes that the manager, R, faces a **single outsider** and the manager believes that the outsider is informed with probability p .

This information is formalised in the following manner. Q observes a signal about the state of the world from the set $S = \{s_0, s_1, \dots, s_M\}$, where M is the number of potentially productive actions. This signal is private information to Q. Signal s_0 is observed by Q with probability $1 - p$ and for each $k \geq 1$ she observes s_k with probability p/M . These signals tell Q the state of the world and she then knows which action to choose to be productive from the set $A = \{a_1, a_2, \dots, a_M\}$. Action a_i is productive in state s_i and unproductive in all other states. There is no action in A which is productive in state s_0 and thus Q is uninformed as far as increasing

²⁶If p large then $c + (1 - p)g \approx c$ and so no pooling contract would be signed if $c > 1$. But this implies $c + g > 1$. If the proportion of the informed and uninformed are more equal in the population, p is, say, $\frac{1}{2}$ then $c + (\frac{1}{2})g \leq 1$ and $c + g > 1$ could both hold.

productivity is concerned in s_0 . Q is informed – productive – as long as $s_i \in \{s_1, \dots, s_M\}$ and the probability of s_i coming from this subset is p , that is $\underbrace{\frac{p}{M} + \frac{p}{M} + \dots + \frac{p}{M}}_{M \text{ times}} = M \frac{p}{M} = p$. R is indifferent between all s_i 's as long as $i \geq 1$. Basically Q is told the true state of nature, one of the s_i 's, and thus knows which a_i , if any, is the productive one. In addition Rabin assumes that R is unable to observe any of the signals (states) in S and that M is so large that he has no information about which action in A is productive in each state.

On the other hand the manager's effort e^* is productive in all $M + 1$ states of nature. The factory's total productivity in state s_j is therefore given by $\pi(e, a_i, s_j) = 1 + b(a_i, s_j)$ if $e = e^*$ and if $e = 0$ then $\pi(e, a_i, s_j) = b(a_i, s_j)$, where $b(a_i, s_j) = b$ if $i = j$, and $b(a_i, s_j) = 0$ if $i \neq j$, ($b(a_i, s_j) = 0$ iff $j = 0$; there is no moral hazard problem with Q).

As noted above, in Section 2 of the paper, Rabin shows that a contract written on observable profits, π , may not be a totally adequate substitute for a complete contract given that the owners of the factory can skim $\$x$ of profit and receive $g \cdot x$ in unobservable profit. From now on Rabin assumes that $g = 1$ so that it is impossible to contract on profits at all because the owner can costlessly skim all of the factory's profits. While this extreme case is useful in terms of notational and analytic ease it does raise a problem. If $g < 1$ then the owner, R , can provide an incentive for Q to truthfully reveal her information. All he has to do is offer her a small percentage of the profits that he will not skim. The problem is that with $g = 1$ no such incentive is feasible and Q will be indifferent between revealing and not revealing her information. Rabin just assumes that Q will reveal when there is no strict incentive not to do so.

In contrast, if it is Q who owns the factory and therefore has to hire R , R would never engage in costly effort. We know from Section 2 that if $1 - g < e^*$ then there is *no* incentive contract such that $e = e^*$. With $g = 1$ the requirement $1 - g < e^*$ amounts to $e^* > 0$ and then there will no incentive contract such that $e = e^*$. In other words, if Q buys the factory, then efficient production would not be possible since $e = 0$. This is, in fact, the only reason for inefficiency in the models that Rabin presents. Thus, inefficiency occurs *iff* Q is the factory's owner and therefore Rabin's major focus is on whether or not Q does in fact gain control of the firm.

For his first model Rabin assumes that both contracting on and even conveying information during bargaining is impossible. In this situation the only possible option is for one of the two

parties to own the factory and possibly employ the other. Rabin claims that this model, Model 1 as he calls it, “[...] applies naturally to the question of whether an innovative firm will take over a noninnovative firm.” (Rabin 1993: 58). It is pointed out that the actions necessary to improve the profits of the noninnovative firm are to a large degree tacit knowledge and thus can not be easily communicated during bargaining. The only way to exploit Q 's information is for R and Q to form a long term relationship.

When $g = 1$ the one option open to the parties is to determine ownership and a fixed transfer to the nonowner. Remember we know that because $g = 1$ it is impossible to contract on profits at all because the owner can costlessly skim all of the factory's profits and thus the only way to provide incentives is via ownership. So either R can remain the owner and hire Q at a set wage w or Q can buy the factory in addition to hiring R as manager for a combined price P .

Rabin assumes that R and Q are bilateral monopolists involved in bargaining game with the following structure:

“Model 1

- (i) Q makes an offer to buy the factory for price P , or to work for R at wage w .
- (ii) R accepts or rejects the offer. If he accepts, trade takes place, and production occurs, with R choosing effort level if he retains control.
- (iii) If R rejects Q 's offer, R can make a counteroffer or choose to operate the factory alone.
- (iv) Q accepts or rejects R 's offer. If Q rejects the offer, then R can choose to operate the factory alone, or not operate. If Q accepts the offer, production takes place under the terms of the contract, with R choosing the effort level if he controls the factory. In either case, payoffs are discounted by a factor δ if production occurs in this period.” (Rabin 1993: 59).

Within this context the factor δ represents the bargaining power of agent R . The higher is δ the greater is the bargaining power of R since he can with little costly delay make a take-it-or-leave-it offer. When δ is low, R must be willing to accept greatly diminished profits in order to get this final offer.

The models 1-3 are all dynamic, incomplete-information games and thus Rabin uses the perfect Bayesian equilibrium (PBE) as the solution concept.²⁷ Rabin focuses on PBEs which satisfy two further restrictions: Assumptions 1 and 2. The first part of Assumption 1 has already been noted, but all parts are required only because Rabin assumes that $g = 1$.

Assumption 1 *If an informed Q signs a contract in which she is indifferent between revealing her information and not doing so, she reveals her information; if she is indifferent between signing a contract and not signing it, she will sign it. If an uninformed Q is indifferent between accepting a contract and not doing so, she rejects it. (Rabin 1993: 60).*

More substantial behavioural restrictions are imposed under Assumption 2. “Suppose Q makes a contract offer that, if accepted by R , would yield the same expected payoff to each informed type of Q . Assumption 2 says that R places equal probability on each of those types making the offer. This rules out R believing (out of equilibrium) that he knows exactly which type of Q would offer to buy a factory, and thus deterring all types from offering to buy the factory. Because I am attempting to model the idea that R is uninformed, it seems natural to eliminate equilibria in which R threatens to learn information when Q behaves in a way that has no natural relationship to her private information.” (Rabin 1993: 60).

Assumption 2 *Suppose Q makes a contract offer that, if accepted, would yield Q of each type $s_k, k \geq 1$, the same expected payoff. Then R puts equal probability on each of those types making the offer. (Rabin 1993: 60).*

The basic results of Model 1 follow. In all of the models Rabin presents use is made of the variable h , where $h = 1 - e^*$ and can be thought of as representing the agency costs of having Q own the factory, in preference to having R own it. Note that from the above we know that $0 < e^* < 1$ and thus $0 < h < 1$. This means Rabin only considers the situations where moral hazard is a problem and high effort is more efficient than low effort. If e^* is thought of as being the most efficient level of effort then the important assumption is that minimal effort is not the most efficient.

²⁷A perfect Bayesian equilibrium is a concept that incorporates sequential rationality and consistency of beliefs: consider a strategy for the players, as well as beliefs over the nodes at all information sets in the extensive form of a game. These are called a perfect Bayesian equilibrium if: (1) each player's strategy specifies optimal actions, given his beliefs and the strategies of the other players, and (2) the beliefs are consistent with Bayes' rule wherever possible.

Proposition 1 *If $b - \text{Max}[h, \delta(h + b)] > h + pb - \text{Max}[h, \delta(h + pb)]$, then in any PBE meeting Assumptions 1 and 2, Q buys the asset if she is informed, and R operates the asset without Q if Q is uninformed. Furthermore, such a PBE exists. (Rabin 1993: 60).*

The intuition behind Proposition 1 is as follows. If, after seeing an offer by Q to buy the factory, R is certain that Q is informed then his payoff by rejecting the offer is $\text{Max}[h, \delta(h + b)]$ – his payoff from running the firm himself, h , or from making a counteroffer under which Q works for R at a wage of $w = 0$, $(h + b)$, discounted by δ . This payoff will be lower, the less sure R is that Q is informed. Thus R will accept any offer to purchase the factory for an amount $P > \text{Max}[h, \delta(h + b)]$. Therefore assuming that Q is informed, she can guarantee herself a return of $b - \text{Max}[h, \delta(h + b)]$ by attempting to purchase the factory. The offer price will be $P = \text{Max}[h, \delta(h + b)]$ and the return to production will be b since under Q 's ownership R will set $e = 0$ – see above.

Next consider what is the best that Q can do by working for R . If Q was to offer to work for a wage w , R would also assume that the uninformed Q types would be making the same offer given that they would profit from doing so. The expected payoff for R from accepting Q 's offer is $pb + (1 - p)0 + h - w = pb + h - w$, if he thinks all of the informed types of Q would be making the offer in addition to the uninformed types. The payoff would be even less if R thought not all the informed types were making the offer. R 's payoff from rejecting Q 's offer is the maximum of either running the firm himself, h , or from making a counteroffer under which Q works for R at a wage of $w = 0$, $(h + pb)$; that is, $\text{Max}[h, \delta(h + pb)]$. This means that R would accept an offer from Q only if $pb + h - w \geq \text{Max}[h, \delta(h + pb)]$. Therefore, the most that an informed type of Q can get by offering to work for R is $w \leq pb + h - \text{Max}[h, \delta(h + pb)]$. If this w is less than the payoff from Q owning the factory then Q will buy the factory, which gives us Proposition 1.

Proof of Proposition 1:

Consider an equilibrium where Q (of an unknown type) offers to buy the asset and R 's services in period 1 for price $P \geq \text{Max}[h, \delta(b + h)]$. If R accepts this offer he will receive a payoff of P . If he rejects the offer he can either receive h by producing alone or he can make a counteroffer.

As to a counteroffer, made in period 2 by R , the best he can do given that he believes he is facing an informed Q is to hire an informed Q at a wage of $w = 0$. (R would not make a counteroffer if he believed that the Q was of the uninformed type since such a Q could add

nothing to the profits of the firm and thus is not worth hiring. In this case R would just produce alone. Given that the uninformed type can generate zero additional profits the best offer, to buy the factory, they can make is zero. Thus R would reason that any offer greater than zero must come from an informed type of Q .) This will result in a payoff for R of $b + h - 0 = b + h$. Discounted this yields $\delta(b + h)$. Therefore if $P \geq \text{Max}[h, \delta(h + b)]$, R will accept the offer to sell the factory.

Next Rabin shows that there does not exist an equilibrium in which Q receives an expected payoff larger than $b - \text{Max}[h, \delta(h + b)]$. (Q the buys factory, get productivity increase of b but $P = \text{Max}[h, \delta(h + b)]$ so the net payoff is $b - \text{Max}[h, \delta(h + b)]$) First, if Q does not make an offer (of w) which is accepted with some positive probability then her expected payoffs are zero. In addition R does not have to accept any offer to sell the factory for a price less than $\text{Max}[h, \delta(h + b)]$. Therefore the range of possible equilibria in which Q makes a higher payoff are those in which Q makes an offer to work for R for which there is a positive probability that R will agree (and $P < \text{Max}[h, \delta(h + b)]$ otherwise R would have sold the factory.).

This will be a pooling equilibrium in that both informed and uninformed types of Q could make an offer of w . Let Q offer to work for R at a wage w . Having seen w , R attributes probability q to Q being of the informed type. Then R will accept Q 's offer if $q \cdot b + h - w \geq \text{Max}[h, \delta(qb + h)]$, where $\text{Max}[h, \delta(qb + h)]$ is R 's payoff from from rejecting Q 's offer. This equation holds iff $w \leq q \cdot b + h - \text{Max}[h, \delta(qb + h)]$.

Q has a probability function, $t(w)$, which gives Q 's probability that a wage offer of w will be accepted by R . Let W be the set of wage offers that R will accept with positive probability. Define W^{**} as $W^{**} = \{w^* \in \text{argmax}_{w \in W} t(w) \cdot w\}$. So if Q is uninformed then she will make a wage offer at some $w^* \in W^{**}$ since this will maximise her expected payoff. As an offer of any $w \in W^{**}$ will be made by an uninformed type, seeing such a w will not lower R 's probability that he faces an uninformed type, that is, $1 - q \geq 1 - p$. This implies that p can not go up, thus $q \leq p$. To put this another way, while the uninformed will make an offer from W^{**} not all the informed types necessarily will and thus p can not increase.

Therefore, R will accept this particular offer only if $w \leq pb + h - \text{Max}[h, \delta(pb + h)]$.

Note that by assumption $(1 - p) \cdot b - \text{Max}[h, \delta(b + h)] > h - \text{Max}[h, \delta(pb + h)]$ (see footnote

28) which implies $b - \text{Max}[h, \delta(h + b)] > pb + h - \text{Max}[h, \delta(h + pb)]$ ²⁸ which in turn implies that an informed Q can guarantee a higher payoff from buying the factory than she can get from any such wage offer. Thus an informed type will not make a wage offer, they will always buy the firm, and therefore in any PBE $q = 0$, that is R would believe that any wage offer with $w > 0$ can only come from an uninformed type and R will not accept the contract with positive probability. This contradicts the definition of the set W^{**} .

Therefore, in any PBE that satisfies Assumptions 1 and 2, Q offers to buy the factory if she is informed.

Now turning to the second part of Proposition 1, to prove this we must find such a PBE. Rabin gives the following equilibrium. If Q is informed she offers to buy the factory and hire R at a price, $P = \text{Max}[h, \delta(h + b)]$. If she is uninformed then she makes no offers to buy the factory or work for R , and accepts none. R 's strategy is to sell the factory for any price $P \geq \text{Max}[h, \delta(h + b)]$, to accept any wage contract which specifies $w < 0$, and reject all other offers. If no contract is reached in period 1, he begins production alone if $h \geq \delta(h + b)$ and makes a wage offer of $w = 0$ if $h < \delta(h + b)$. ■

If $b < \text{Max}[h, \delta(h + b)]$, then R would reject any offers to purchase the factory that gave Q positive profits, since this would mean that $P < \text{Max}[h, \delta(h + b)]$ and thus R would be better off retaining ownership of the factory. Obviously in this case Q never gains control of the factory. Rabin states this formally as Proposition 2.

²⁸ An implication of this equation is that Rabin assumes that the cost of adverse selection in the model is greater than the cost of moral hazard. To see this note that we know from the paper that the cost of moral hazard is given by h . The question therefore is, What is the cost of adverse selection in the model?

This cost I would argue would be borne by the informed types and can be estimated by the difference between the wage an informed type would get if it was known that he was in fact informed, minus the wage he gets when it is not known that he is informed. (The uninformed actually gain from their type being unknown.)

The wage he would get if it is known he is informed would be $w_{inf} = b + h - \text{Max}[h, \delta(b + h)]$. The wage he gets when his type is not known is, from the proof, $w_{unk} = p \cdot b + h - \text{Max}[h, \delta(pb + h)]$. So the cost of adverse selection is $w_{inf} - w_{unk}$ where

$$\begin{aligned} w_{inf} - w_{unk} &= b + h - \text{Max}[h, \delta(b + h)] - (p \cdot b + h - \text{Max}[h, \delta(pb + h)]) \\ &= (1 - p) \cdot b - \text{Max}[h, \delta(b + h)] + \text{Max}[h, \delta(pb + h)] \end{aligned}$$

Let us assume that the adverse selection cost $w_{inf} - w_{unk}$ is greater than the moral hazard cost, h . This gives

$$(1 - p) \cdot b - \text{Max}[h, \delta(b + h)] + \text{Max}[h, \delta(pb + h)] > h$$

which we can rearrange to give the equation in the proof

$$\begin{aligned} (1 - p) \cdot b - \text{Max}[h, \delta(b + h)] &> h - \text{Max}[h, \delta(pb + h)] \\ \Rightarrow b - \text{Max}[h, \delta(b + h)] &> p \cdot b + h - \text{Max}[h, \delta(pb + h)] \end{aligned}$$

Proposition 2 *If $b < \text{Max}[h, \delta(h + b)]$, then in any PBE, R owns the factory. (Rabin 1993: 61).*

Proof of Proposition 2:

Assume that there is an PBE in which Q sometimes buys the factory at a price $= P$. If $P > 0$, the uninformed will never make such a offer if there is a positive probability that it will be accepted. Thus, in any PBE, R must believe that only informed types of Q will make such an offer if he accepts the offer.

If R believes Q is informed, he will not accept an offer if $P < \text{Max}[h, \delta(h + b)]$. But if $P \leq \text{Max}[h, \delta(h + b)]$, then the informed Q gets a payoff of $b - P$. But $b - P \leq b - \text{Max}[h, \delta(h + b)] < 0$, so she will not make this offer. ■

The results described in Propositions 1 and 2 provide a range over which the informed types of Q will always buy the factory, a range where they never will and a range where either outcome could hold. See Figure 139.1 below which is a reproduction of Rabin's Figure 1.²⁹

Next Rabin considers what equilibria are possible in the Indeterminate region of Figure 139.1. In this region neither Proposition 1 nor Proposition 2 hold. That is, $b - \text{Max}[h, \delta(h + b)] \leq h + pb - \text{Max}[h, \delta(h + pb)]$ and $b \geq \text{Max}[h, \delta(h + b)]$. In the first equilibrium, an offer by Q to work for R is interpreted by R to mean that Q is uninformed. In this situation the only way in which an informed Q can therefore make money is to buy the factory, and so she makes an offer to do so. Here (1) $b - \text{Max}[h, \delta(h + b)] = h + pb - \text{Max}[h, \delta(h + pb)]$ and (2) $b > \text{Max}[h, \delta(h + b)]$.

²⁹The line separating the "Q buys" from the "Indeterminate" regions is found by the following. For Q to buy it must be that $b - \text{Max}[h, \delta(h + b)] > pb + h - \text{Max}[h, \delta(h + pb)]$. Assume that $\delta(h + pb) > h$ then this equation can be written

$$\begin{aligned} b - \delta(h + b) &> pb + h - \delta(h + pb) \\ b - pb - h &> \delta(h + b) - \delta(h + pb) \\ (1 - p)b - h &> \delta(1 - p)b \\ 1 - \frac{h}{(1 - p)b} &> \delta \end{aligned}$$

If $\delta(h + pb) < h$ then

$$\begin{aligned} b - \delta(h + b) &> pb + h - h \\ b - pb &> \delta(h + b) \\ \frac{(1 - p)b}{h + b} &> \delta \end{aligned}$$

Both these lines are downward sloping, but in the first case the "line" would in fact be a curve. If $h > b$ then R retains control of the factory no matter what the values of p and δ are. This makes Figure 139.1 irrelevant. If $h > b$ then $h > b \geq P$ so that producing alone is better than selling the factory, which is sufficient for R to retain control.

If (1) was an inequality then R would have no reason to interpret an offer by Q as him being uninformed and (2) must be an inequality to make sure Q has a reason to want to buy the firm. In the second equilibrium, offers from Q to work for R are interpreted as being made by both types of Q. Thus an informed Q is willing to work for R in this case. Here Q's share of the increased profits, h , due to the alleviation of the moral hazard problem is greater than the cost of in terms of lost wages due to the fact that uninformed Q's are being employed. Note that in this case (1) $b - \text{Max}[h, \delta(h + b)] < h + pb - \text{Max}[h, \delta(h + pb)]$ and (2) $b \geq \text{Max}[h, \delta(h + b)]$. From (1) and an argument similar to that of Footnote 28 on page 137, we know the cost of moral hazard will be greater than the cost of adverse selection. (1) also explains why R assumes a wage offer could come from either type of Q.

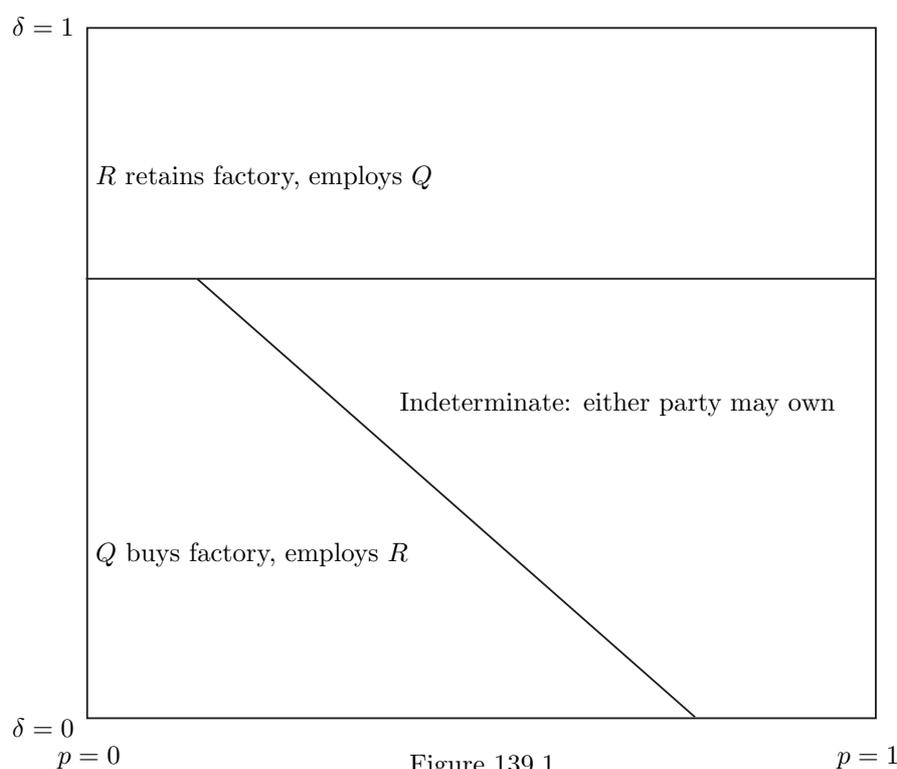


Figure 139.1
(Rabin 1993: Figure 1)

Rabin's discussion of the comparative statics begins with consideration of δ . If δ is near 0 agent Q has most of the bargaining power while if it is near 1 R has the bargaining power. [Proposition 2] says that if R has most of the bargaining power, then Q will never buy the firm no matter how significant the adverse-selection problems. Note that [Proposition 2] is independent

of p . The argument is that Q buys the firm because she can not otherwise show that she is truly informed. But because R will set $e=0$ when Q owns the factory, purchasing the factory is inefficient in terms of total profits. R can extract all the surplus since he has all the bargaining power and he gets the largest payoff when expected profits are maximised. Given that these profits are higher than what Q can pay him if she buys the firm, Q will not try to buy the factory from R . Next consider p , the probability that Q is informed. Q is more likely to buy the factory when p is small since in this case the adverse-selection problems are large. As p becomes smaller, the other parameters for which [Proposition 1] holds becomes larger. This means that when the adverse-selection problems are large an informed Q has to buy the firm to be able to take advantage of her information. When p is near to 1, the adverse-selection problems are less of an issue, but there is still an equilibrium in which Q can not earn any profits without owning the factory. In the case where it is expected that any informed Q will offer to buy the factory, an offer to sell information will demonstrate that the Q making the offer is uninformed and thus the offer will always be rejected. This means that expectations will be fulfilled. In such an equilibrium, as long as the conditions of [Proposition 2] do not hold, any amount of adverse-selection can cause inefficient buying of the firm. Next Rabin looks at the effects of changes in the value of h . If h is increased, which means that the moral-hazard problem of having R work for Q becomes more severe, then the range of parameter values for which Result 1.1 holds is smaller, and the range for which [Proposition 2] holds is larger. In this case Q is less likely to buy the factory. This follows from the fact that an important factor in the determination of who owns the firm is the inefficiency of production and this can not always be overcome by strategic or informational advantages.

Section 4 of Rabin's paper looks at "Two More Models". Thus far in the paper Rabin has assumed that Q has been unable to reveal her information during bargaining. Model 1 simply ruled this possibility out. In Models 2 and 3 it is assumed that Q can easily make claims about her private information. The ability to convey information during bargaining give rise to the possibility that, instead of the parties "integrating" as in Model 1, they may be able to profitably transfer information without becoming one firm. So Models 2 and 3 allow for nonintegration.

In Model 2 it is assumed that while information can be conveyed, whether productive information has been transferred between the parties is not verifiable by the courts and therefore cannot

be directly contracted on. This means that Q cannot, without becoming the owner, directly receive profits from any action taken by R at the suggestion of Q .

Information can be verified by the firm but only at a cost of $d \geq 0$. In both Models 2 and 3 the variable k represents the additional productivity of Q beyond her information alone. Agent Q can either buy the factory or contract to provide a service \bar{a} to R that is productive only if R performs the productive selection $a_i \in A$. The total productivity of the factory can now be written

$$\pi(s_j) = 1 + \bar{b}(a_i, s_j) \text{ if } e = e^* \text{ and } \pi(s_j) = \bar{b}(a_i, s_j) \text{ if } e = 0$$

The function $\bar{b}(a_i, s_j) = 0$ if $i \neq j$, equals b if $i = j$ and Q performs action \bar{a} , and equals $b - k$ if $i = j$ and Q does not perform action \bar{a} . Thus k is the additional productivity of Q performing task \bar{a} if she is informed. Once R becomes informed he can make $b - k$ without Q . Model 2's features can be summarised as follows:

“Model 2

- (i) Q makes an offer to buy the factory for price P , or she makes an offer to work for R at wage w , or she states that some action $a_i \in A$ is productive and offers to perform activity \bar{a} for a fixed price.
- (ii) R accepts or rejects the offer. If he accepts, trade takes place, and production occurs, with R choosing effort level if he maintains control.
- (iii) If R rejects Q 's offer, R can make a counteroffer or choose to operate the factory alone.
- (iv) Q accepts or rejects R 's offer. If Q rejects the offer, then R can choose to operate the factory alone, or not operate. If Q accepts the offer, production takes place under the terms of the contract, with R choosing effort level if he controls the factory. In either case, payoffs are discounted by factor δ if production occurs in this period.” (Rabin 1993: 64-5).

Again the agents cannot directly contract on the profits of the factory and thus their only choice is to determine ownership of the factory and contract directly on what they can, the performance

of the activities. Most importantly, if Q does not buy the firm, then she can still sell her services \bar{a} . Rabin notes that it will turn out that the agents will not want to contract directly on the actions $a_i \in A$ in this model, since they cannot contract on the profits produced by these actions.

The focus here is on the case where p is low which means the adverse selection problem is large and thus the option of Q working for R is unrealistic. This is due to the fact that the wage would have to reflect the overwhelming probability that Q is uninformed. If p is close to zero the question becomes whether Q will reveal her information during bargaining or buy the factory.

Proposition 3 gives sufficient conditions for Q to buy the factory.

Proposition 3 *If $b - \text{Max}[h, \delta(h + b)] > \text{Max}[0, \text{Min}[b - d, k, (1 - \delta) \times (h + b) - d]]$, then there exists a \bar{p} such that, for all $p < \bar{p}$, in PBE meeting Assumptions 1 and 2, the informed types of Q buy the factory. Furthermore, such a PBE exists. (Rabin 1993: 65).*

The intuition behind Proposition 3 is as follows. Assume that Q makes a claim that some activity, $a_i \in A$ is productive, and offers to perform action \bar{a} for a price P . The question is, Will R accept such an offer? There cannot be an equilibrium in which R accepts the offer without research. If he did all the uninformed types would make the claim as well. Thus, in order for R to be willing to accept Q's offer, he must be willing to both do the research and to purchase \bar{a} if the information is verified.

If R does the research, and confirms the claim by Q, then the maximum he would be willing to pay would be P such that $b + h - P > \text{Max}[b - k + h, \delta(b + h)]$, remember that d is a sunk cost at this point. Note also that $b - k + h$ is the amount R can get working alone using his new information, while $\delta(b + h)$ is what he receives from his counter offer to get Q to work for him. This tells us that the maximum that Q can receive for her information is

$$P < \text{Min}[k, (1 - \delta)(b + h)]^{30} \quad (3.20)$$

However R must also be willing to carry out the research to verify Q's claim in the first place. This means that the returns to research have to be greater than the returns to not having the information at all, that is, $b + h - P - d > \text{Max}[h, \delta(b + h)]$. This implies the maximum R will pay is³¹

$$\begin{aligned} P &< b + h - d - \text{Max}[h, \delta(b + h)] \\ &\equiv \text{Min}[b - d, (1 - \delta) \times (b - d) - d] \end{aligned} \quad (3.25)$$

Taking equation (3.20) and (3.25) together, these requirements amounts to "subgame perfection",³² gives the result that Q **cannot** make profits $P > \text{Min}[b - d, k, (1 - \delta)(b + h) - d]$ ³³ from revealing her information and taking action \bar{a} . Thus an informed Q will buy the factory if the purchase yields (positive) profits greater than $\text{Min}[b - d, k, (1 - \delta)(b + h) - d]$.

Proof of Proposition 3:

The proof as given by Rabin is wrong in that equation (3.29) cannot be derived from equation

³⁰This result can be found as follows.

$$\begin{aligned} b + h - P &> \text{Max}[b - k + h, \delta(b + h)] \\ \Rightarrow P &< b + h - \text{Max}[b - k + h, \delta(b + h)] \end{aligned}$$

This implies either

$$\begin{aligned} P &< b + h - b + k - h \\ \Rightarrow P &< k \end{aligned} \quad (3.21)$$

or

$$\begin{aligned} P &< b + h - \delta(b + h) \\ \Rightarrow P &< b(1 - \delta) + h(1 - \delta) \\ \Rightarrow P &< (b + h)(1 - \delta) \end{aligned} \quad (3.22)$$

whichever is the smaller of 3.21 or 3.22.

Thus $P < \text{Min}[k, (b + h)(1 - \delta)]$

³¹This follows from

$$\begin{aligned} P &< b + h - d - \text{Max}[h, \delta(b + h)] \end{aligned}$$

which implies either

$$\begin{aligned} P &< b + h - d - h \\ \Rightarrow P &< b - d \end{aligned} \quad (3.23)$$

or

$$\begin{aligned} P &< b + h - d - \delta(b + h) \\ \Rightarrow P &< (1 - \delta)b + (1 - \delta)h - d \\ \Rightarrow P &< (1 - \delta)(b + h) - d \end{aligned} \quad (3.24)$$

whichever is the smaller of 3.23 or 3.24

Thus $P < \text{Min}[b - d, (1 - \delta)(b + h) - d]$

³²The price P has to be such that in the "subgame" after having done the research R is willing to buy and in the larger (sub)game, before having done the research, R must also be willing to buy.

³³Note that $(1 - \delta)(b + h) - d$ is, obviously, always less than $(1 - \delta)(b + h)$ for $d > 0$.

(3.28) and even if it were correct the proof does not prove the proposition as stated.

Rabin's proof is:

R must accept any offer to buy the factory for price $P < \text{Max}[h, \delta(h + b)]$ as argued in Proof of Proposition 1. (Note that the condition shown in the proof of Proposition 1 is $P \geq \text{Max}[h, \delta(h + b)]$.) Also, as shown in Proof of Proposition 1, as $p \rightarrow 0$, the maximum wage Q could get for working for R goes to 0. (This is not shown in the proof, but using information in the proof of Proposition 1 we can conclude that $p \rightarrow 0$, the maximum wage Q could receive for working for R goes towards 0. $w \leq p \cdot b + h - \text{Max}[h, \delta(pb + h)]$ the righthand side of which goes to 0 as $p \rightarrow 0$.) Thus, if $b - \text{Max}[h, \delta(h + b)] > 0$ there exists a \bar{p} such that buying the factory is strictly preferred by Q.

What is the best Q could do in a PBE by revealing her information and offering to perform task \bar{a} ? Assume there is some positive probability that R accepts such an offer without doing research. From the proof of Proposition 1 we know that the only wage offer that R will accept is $w < 0$ and thus any offer that entails revealing information and offering to perform task \bar{a} , which gives profits of greater than 0 will be offer by all types, both informed and uninformed. Thus it must be that there exists an offer at a price P such that the proportion of the claims that are true is less than or equal to $\bar{p}(1 + \frac{1}{M})$.³⁴ Thus, R's expected return to accepting the offer without doing any research is less than or equal to $\bar{p}(1 + \frac{1}{M})(1 + b) - e^* - P$.³⁵ But this will be negative for a small enough \bar{p} . So, for small enough \bar{p} , there cannot be a PBE in which R accepts any offers without researching them all the time.

Now assume that Q makes a claim and offers to perform action \bar{a} at a price P . Then R can reject the offer outright and gain $\text{Max}[h, \delta((q + r)b + h)]$, where q is the probability that R places on the claim being true and r being the probability that R places on Q being informed but the statement being false.³⁶ The alternative is that R can in fact research the claim and if he finds it to be true he can then accept or reject the offer. He might accept the offer if

$$b + h - P \geq \text{Max}[b - k + h, \delta(b + h)] \quad (3.26)$$

³⁴ $\bar{p}(1 + \frac{1}{M}) = \bar{p} + \frac{\bar{p}}{M}$. The \bar{p} is the probability if all informed types tell the truth and the $\frac{\bar{p}}{M}$ is the probability that the uninformed will guess right.

³⁵Remember P is the payment from R to Q for Q carrying out \bar{a} .

³⁶The first entry in $\text{Max}[\cdot]$ is h since the information has not been verified and thus can not be used to produce with and thus getting $(b - k) + h$ is not possible. The claim being true implies that $\pi(s_j) = 1 + \bar{b}(a_j, s_j) = 1 + b$ since $e = e^*$ and \bar{a} is carried out. Remember $h = 1 - e^*$.

and he will definitely reject it otherwise. If the claim is discovered to be false then R will reject the offer and get the payoff $Max \left[h, \delta \left(\frac{rb}{1-q} + h \right) \right]$.³⁷ If R does not do any research and rejects the offer he can get $Max[h, \delta((q+r)b + h)]$.

Thus from equation (3.26) a necessary requirement for R to be willing to accept the offer is

$$P \leq b + h - Max[b + h - k, \delta(b + h)] = Min[k, (1 - \delta) \times (b + h)] \quad (3.27)$$

In addition for R to be willing to research an offer it must be true that

$$\begin{aligned} q(b + h - P) + (1 - q)Max \left[h, \delta \left(\frac{rb}{1-q} + h \right) \right] - d \\ \geq Max[h, \delta((q+r)b + h)] \end{aligned} \quad (3.28)$$

At this point Rabin claims that equation (3.28) reduces to

$$\begin{aligned} P \leq b + h + (1 - q)\frac{h}{q} - (1 - q)Max \left[h, \frac{\delta(rb + h)}{(1 - q)} \right] - \\ Max[h, \delta((q+r)b + h)] - d \end{aligned} \quad (3.29)$$

but it's not obvious that it does. Equations (3.28) and (3.29) are not in general the same. To see this consider the case where h is the maximum of each of the $Max[\cdot]$ functions. In this case equation (3.29) reduces to

$$\begin{aligned} P &\leq b + h + \frac{1 - q}{q}h - (1 - q)h - h - d \\ &\leq b + \left(\frac{1 - 2q + q^2}{q} \right) h - d \end{aligned}$$

³⁷We know that q is the probability that R places on the claim being true and r being the probability that R places on Q being informed but the statement being false. So $1 - q$ is the probability that R places on the claim being false and $1 - r$ is the probability that R places on Q being informed and the statement being true. Let y be the probability that R places on Q being uninformed and the statement being false. Then

$$\begin{aligned} r + y &= 1 - q \\ \Rightarrow r + y + q &= 1 \\ \Rightarrow r + q &\leq 1 \text{ since } y \geq 0 \\ \text{and } r &\leq 1 - q \\ \text{and thus } \frac{r}{1 - q} &\leq 1. \end{aligned}$$

We can interpret $\frac{r}{1 - q}$ as being the proportion of informed types among the false claims.

$$\leq b + \frac{(1-q)^2}{q}h - d$$

while equation (3.28) becomes

$$\begin{aligned} q(b+h-P) + (1-q)h - d - h &\geq 0 \\ qb - qP - d + (q+1-q-1)h &\geq 0 \\ \Rightarrow qP &\leq qb - d \\ \Rightarrow P &\leq b - \frac{d}{q} \end{aligned}$$

These versions of equations (3.28) and (3.29) will be equal iff

$$\begin{aligned} b - \frac{d}{q} &= b + \frac{(1-q)^2}{q}h - d \\ d - \frac{d}{q} &= \frac{(1-q)^2}{q}h \\ d\left(\frac{q-1}{q}\right) &= \frac{(1-q)^2}{q}h \\ -d(1-q) &= h(1-q)^2 \\ -d &= h(1-q) \end{aligned}$$

This last equation can only be true if both sides of the equation are zero, that is, if $d = 0$ and $q = 1$ since $0 < h < 1$, $d \geq 0$ and q is a probability. This means the equation can only hold if there are no costs to verifying a claim and the probability of a claim being true is one.³⁸ In general this equality will not hold and thus (3.29) can not be derived from (3.28).

In fact equation (3.28) reduces to equation (3.30).

$$\begin{aligned} P \leq b + h + \frac{(1-q)}{q} \text{Max} \left[h, \delta \left(\frac{rb}{1-q} + h \right) \right] - \frac{d}{q} \\ - \frac{1}{q} \text{Max} [h, \delta((q+r)b + h)] \end{aligned} \quad (3.30)$$

Evidence, from numerical evaluations, that shows equations (3.29) and (3.30) are not equivalent appears in Appendix 3. From this point on the rest of the proof offered here will follow from

³⁸These two condition go together since if there are zero costs to verification all claims will be true as any false claim will be, at zero cost, shown to be false.

equation (3.30) and not from equation (3.29). Following Rabin's method of proof we assume that the righthand side of equation (3.30) is maximised when $r + q = 1$, which implies $r = 1 - q$. With $r + q = 1$ the probability of Q being able to produce the productivity increase, b , is maximised. But see discussion following the end of the "proof".

Using the fact that $q + r = 1$ equation (3.30) can be rewritten as

$$\begin{aligned}
 P &\leq b + h + \frac{(1-q)}{q} \text{Max}[h, \delta(b+h)] - \frac{d}{q} - \frac{1}{q} \text{Max}[h, \delta(b+h)] \\
 &\leq b + h - \frac{d}{q} + \left(\frac{1-q}{q} - \frac{1}{q} \right) \text{Max}[h, \delta(b+h)] \\
 &\leq b + h - \frac{d}{q} - \text{Max}[h, \delta(b+h)]
 \end{aligned} \tag{3.31}$$

We now consider two cases: one where $h > \delta(b+h)$ and the other where $h < \delta(b+h)$.

When $h > \delta(b+h)$ equation (3.31) reduces to

$$P \leq b - \frac{d}{q}. \tag{3.32}$$

When $h < \delta(b+h)$ equation (3.31) reduces to

$$\begin{aligned}
 P &\leq b + h - \frac{d}{q} - \delta(b+h) < b + \delta(b+h) - \frac{d}{q} - \delta(b+h) \\
 \Rightarrow P &\leq b - \frac{d}{q}.
 \end{aligned} \tag{3.33}$$

The righthand sides of equations (3.32) and (3.33) are maximised when $q = 1$, which gives

$$P \leq b - d. \tag{3.34}$$

Combining equation (3.34) with equation (3.27) we see that the informational claim will only be accepted if

$$P \leq \text{Min}[b - d, \text{Min}[k, (1 - \delta) \times (b + h)]] \equiv \text{Min}[b - d, k, (1 - \delta) \times (b + h)]. \tag{3.35}$$

Since an informed Q can get $b - \text{Max}[h, \delta(b + h)]$ by buying the firm it must be that Q will always offer to buy the factory if she can do better than she can do with both no offer and revealing her information. That is, Q will buy the firm if

$$b - \text{Max}[h, \delta(b + h)] > \text{Max}[0, \text{Min}[b - d, k, (1 - \delta) \times (b + h)]]. \blacksquare$$

This “proof” follows Rabin’s line of reasoning correcting, where needed, algebraic errors. But two problems still remain. First, while the “proof” derives the result that Rabin claims to show, this result does not prove Proposition 3 as it is stated. As

$$\text{Max}[0, \text{Min}[b - d, k, (1 - \delta) \times (b + h)]] \geq \text{Max}[0, \text{Min}[b - d, k, (1 - \delta) \times (b + h) - d]]$$

it is possible that

$$\begin{aligned} \text{Max}[0, \text{Min}[b - d, k, (1 - \delta) \times (b + h)]] &> \\ b - \text{Max}[h, \delta(b + h)] &> \\ \text{Max}[0, \text{Min}[b - d, k, (1 - \delta) \times (b + h) - d]] & \end{aligned}$$

which means the condition of Proposition 3 is satisfied but the final condition of the proof is violated. For the proposition to be shown to be correct by the proof provided the condition for Proposition 3 would have to be

$$b - \text{Max}[h, \delta(b + h)] > \text{Max}[0, \text{Min}[b - d, k, (1 - \delta) \times (b + h)]]. \quad (3.36)$$

It should be noted that equation (3.36) is the condition stated in the version of Proposition 3 appearing in the working paper version of Rabin’s paper; see Result 2.1, Rabin (1991: 18). The discussion of the intuition behind Proposition 3 that Rabin gives in his paper does not seem to match his formal proof insofar as the intuitive argument involves the condition $\text{Min}[b - d, k, (1 - \delta)(b + h) - d]$ and the formal proof uses $\text{Min}[b - d, k, (1 - \delta)(b + h)]$. The difference can be explained by the fact that equation (3.28) reduces to equation (3.25) when $q = 1$ and $r = 0$ which implies that Rabin’s intuitive argument implicitly assumes that R believes that the statement

made by Q is true with probability one.

Secondly, and more importantly, the argument that the righthand side of equation (3.30) is maximised when $q + r = 1$ is not in general true as the example in Table 149.1, taken from the numerical evaluations discussed in Appendix 3, shows.

b	h	q	d	δ	r	q+r	eqn 3.30
1.0	1.0	0.9	1.0	0.9	0.0	0.9	-0.900000
1.0	1.0	0.9	1.0	0.9	0.1	1	-0.911111

Table 149.1. Example from evaluation results.

The Rabin method of proof for Proposition 3 holds only if the righthand side of equation (3.30) is maximised when $q + r = 1$, a condition which in general is not met. Therefore Proposition 3 must be considered, at best, unproven.

The next result is the same as Proposition 2 and is true for the same reasons. Under the condition specified, Q cannot make profits by buying the factory.

Proposition 4 *If $b < \text{Max}[h, \delta(h + b)]$, then in any PBE, R owns the factory. (Rabin 1993: 66).*

Proof of Proposition 4: This proof is the same as for Proposition 2. ■

These two results give rise to several comparative statics. Assume equation (3.36) holds. But given that we have no proof of Proposition 3 these comparative static results must be approached with caution.

First, Proposition 3, with d being large, reduces to Proposition 1 with p being low. That is, it does not matter that Q can make claims about her private information if any such claim cannot be verified at a reasonable cost. Such claims by Q do not circumvent the adverse-selection problem, because Q could just pretend to have information she does not have and it is too expensive for R to check. This is basically the same situation as that of Model I – that of not being able to convey the information at all.

On the other hand when d is low, R can confirm claims by Q relatively cheaply. But it can not be guaranteed that credible information revelation will take place, even here. If R believes that any informational claims are being made by a Q who is uninformed, if p is low enough, then

he may not even bother to investigate the option no matter how low d is. Thus, for $d > 0$, it is possible that Q will not reveal her information.

Note that Proposition 4 corresponds to Proposition 2: Although the extra option of information revelation expands the range over which R *might* retain control, it does not expand the range over which R *surely* retains control of the factory.

In this version of the model, k is an important variable. k represents that portion of Q 's potential productive contribution which is not information. If k is close to the value of b , then even when Q reveals her information, R will want to work with Q . In this case the information itself isn't worth much, its main value is that it makes Q 's action productive. If on the other hand, k is low then revealing her information leaves Q of minimal addition value to R .

Assume that $k = 0$ then Proposition 3 reduces to the condition that Q will purchase the firm if $b - \text{Max}[h, \delta(b + h)] > 0$.³⁹ This is the same result as we get from Proposition 1 with p being low. This arises because in this case if Q reveals her information then she makes herself superfluous. All her value is in her information. Also when $k = 0$ Proposition 3 is the opposite of Proposition 4, and thus for almost all parameter values it is clear who will own the firm.

At the other extreme, $k = b$. That is, all Q 's value is in her non-information component. This means that Q is needed even after she has revealed her information. Let the cost for R of verifying a claim by Q be small, i.e. d is small. Then Proposition 3 reduces to $b - \text{Max}[h, \delta(b + h)] > \text{Min}[b, (1 - \delta)(b + h)]$.⁴⁰ But $h > \delta(b + h)$ iff $b < (1 - \delta)(b + h)$.⁴¹ So the result amounts to either $b - h > b$, or $b - \delta(b + h) > (1 - \delta)(b + h)$. Clearly the first of these is false while

$$\begin{aligned} b - \delta(b + h) &> (1 - \delta)(b + h) \\ \Rightarrow b - \delta(b + h) &> b + h - \delta(b + h) \\ &\Rightarrow b > b + h \end{aligned}$$

³⁹With $k = 0$, $\text{Max}[0, \text{Min}[b - d, k, (1 - \delta) \times (h + b) - d]]$ reduces to 0.

⁴⁰This assumes, in fact, that $d = 0$ in addition to $k = b$.

⁴¹

$$\begin{aligned} b &< (1 - \delta)(b + h) \\ \Rightarrow b &< b + h - \delta(b + h) \\ \Rightarrow b - b - h &< -\delta(b + h) \\ \Rightarrow h &> \delta(b + h). \end{aligned}$$

is also false. Thus when $k = b$, Proposition 3 does not hold and Q will not buy the firm. But there is no need to do so to overcome the adverse selection problem. Revealing her information reveals her “type” and does so at no cost, in terms of her value working with R , to Q . Any equilibrium will therefore involve Q revealing her information and making a contract offer to work for R . R verifies the information and accepts offers involving true information and rejects those involving false information.⁴² This outcome is not guaranteed, however. If R believes that the informational claims by Q are always false then he will not bother to research them and will reject all offers made by Q . Thus as long as $d > 0$ there is no guarantee that information will be revealed before a contract is signed.⁴³

Next Rabin moves to his Model 3 which is the same as Model 2 except that specific contracts between the Q and R are now possible. More precisely, Q can costlessly contract to have R take any action $a_i \in A$ and can receive the profits from that action. That is, the two parties can write a contract such that Q pays R some amount f_i iff R performs the activity a_i and then Q gets to keep profits, $b(a, s)$, generated by the performance of the a_i . Here R keeps control of the factory and thus he can earn the profits derived from his action e^* . In this case the adverse selection problem is overcome by Q 's willingness to pay for an action. Q would not be willing to pay R to take action a_i unless she knew this action would result in profits. The important signalling feature here is the same as when Q offers to buy the factory from R : only the informed types would do it.

In Model 3, as in Model 2, k will represent the non-informational productivity of Q . Here agent Q can either buy the factory or contract to provide a service \bar{a} to R that is productive only if R takes the productive action $a_i \in A$. Or, and this is where Model 3 differs from Model 2, Q can pay R to perform action $a_i \in A$ and Q receives the profits $\bar{b}(a_i, s_j)$. The total productivity of the factory is as in Model 2.

$$\pi(s_j) = 1 + \bar{b}(a_i, s_j) \text{ if } e = e^* \text{ and } \pi(s_j) = \bar{b}(a_i, s_j) \text{ if } e = 0.$$

The function $\bar{b}(a_i, s_j) = 0$ if $i \neq j$, equals b if $i = j$ and Q performs action \bar{a} , and equals $b - k$ if

⁴²In this equilibrium the uninformed Q 's must also make a claim about some activity $a_i \in A$ being productive. If this was not the case it would not be sequentially rational for R to conduct the costly research on claims.

⁴³Note that when Proposition 4 applies then efficiency is guaranteed by Q working for R while not obtaining control.

$i = j$ and Q does not perform action \bar{a} . Thus k is the additional productivity of Q performing task \bar{a} if she is informed. Once R becomes informed he can make $b - k$ without Q . Model 3's features can be summarised as follows:

“Model 3

- (i) Q makes an offer to buy the factory for price P , or she makes an offer to work for R at wage w , or she states that some action $a_i \in A$ is productive and offers to perform activity \bar{a} for a fixed price, or she offers to pay R a price for performing some activity $a_i \in A$.
- (ii) R accepts or rejects the offer. If he accepts, trade takes place and production occurs, with R choosing effort level if he maintains control.
- (iii) If R rejects Q 's offer, R can make a counteroffer or choose to operate the factory alone.
- (iv) Q accepts or rejects R 's offer. If Q rejects the offer, then R can choose to operate the factory alone, or not operate. If Q accepts the offer, production takes place under the terms of the contract, with R choosing effort level if he controls the factory. In either case, payoffs are discounted by factor δ if production occurs in this period.” (Rabin1993: 68).

Note that because in Model 3, Q can offer specific contracts for the performance of action a_i , revealing the information and offering to perform action \bar{a} is no longer a feasible alternative. This would entail R having to verify at cost d whether Q 's claim is true before agreeing to the contract. If Q offers to purchase service a_i from R , no such research cost is incurred.

The important point following on from this is that in Model 3, unlike both Models 1 and 2, there is an opportunity for the informed party to become residual claimant of the profits produced by an activity she believes to be productive without having to gain control over the factory. The main results from Model 3 reflect the fact that the severity of the adverse selection problem will thus be mitigated.

Proposition 5 *If $b - \text{Max}[h, \delta(b + h)] > \text{Min}[k, (1 - \delta)(b + h)]$, then there exists \bar{p} such that, if $p < \bar{p}$, then in any PBE meeting Assumptions 1 and 2, the informed type of Q buys the factory. Furthermore, such a PBE exists. (Rabin 1993: 69).*

This result is the same as Proposition 3 when the value of d is low. The proof is, basically, Q , if informed, can offer to purchase the task $a_i \in A$, which she knows to be productive, and can earn profits of $\text{Min}[k, (l - \delta)(b + h)]$. Alternatively, she can make profits of $b - \text{Max}[h, \delta(b + h)]$ by offering to purchase the factory.

Proof of Proposition 5: R must accept any offer to buy the factory for price $P \geq \text{Max}[h, \delta(h + b)]$ as argued in Proof of Proposition 1. Also, as can be shown from working in the Proof of Proposition 1, as $p \rightarrow 0$, the maximum wage Q could get for working for R goes to 0. Thus, if $b - \text{Max}[h, \delta(h + b)] > 0$ there exists a \bar{p} such that buying the factory is strictly preferred by Q .

Does there exist an equilibrium in which an informed Q purchases the task a_i given that she knows it to be productive? Suppose there did. If R accepts an offer for Q to purchase activity a_i at price $P > 0$, then only type s_i would make that offer: All other types, that is all other s_j 's, would earn a negative payoff if the offer is accepted by R , since $\bar{b}(a_i, s_j) = 0$ when $i \neq j$ and $P > 0$, and zero payoff otherwise. Therefore, R will have beliefs probability = 1 that an offer to buy activity a_i is coming from type s_i . She will then accept the offer iff $P + h > \text{Max}[h, h + (b - k), \delta(b + h)]$.⁴⁴ In the $\text{Max}[\cdot]$ part of the condition, h is the payoff R would get if they worked alone without a s_j type, where $j \neq i$, Q ; $h + (b - k)$ is the payoff R would get if they worked alone without a s_i type Q ; and $\delta(b + h)$ is the payoff R would get if she made a counteroffer to Q . Thus, there does not exist an equilibrium in which an *informed* Q gets more than⁴⁵

$$\begin{aligned} b - P &= b - (\text{Max}[h + (b - k), \delta(b + h)] - h) \\ &= b + h - \text{Max}[h + (b - k), \delta(b + h)] \\ &= \text{Min}[k, (1 - \delta)(b + h)]. \end{aligned}$$

But the condition of Proposition 5 is $b - \text{Max}[h, \delta(b + h)] > \text{Min}[k, (l - \delta)(b + h)]$ which means Q would make more from buying the factory than from purchasing the action, a_i from R , that she knows to be productive, and thus such an equilibrium does not exist.

A PBE meeting Assumptions 1 and 2 exists in which Q offers to buy the factory at price $P = \text{Max}[h, \delta(b + h)]$, and any offer by Q to buy the activity for $P > \text{Max}[b - k, \delta(b + h)]$ would

⁴⁴Given that $b - k \geq 0, h + (b - k) \geq h$.

⁴⁵ $b + h - \text{Max}[h + (b - k), \delta(b + h)]$ reduces to the minimum of either $b + h - h - (b - k) = k$ or $b + h - \delta(b + h) = (1 - \delta)(b + h)$.

be accepted if made, and all other offers are rejected.⁴⁶ ■

Proposition 6 *If $\text{Min}[k, (1 - \delta)(b + h)] > b - \text{Max}[h, \delta(b + h)]$, then in any PBE R retains control of the factory, and, if Q is informed, the efficient action is performed. (Rabin 1993: 69).*

Proof of Proposition 6: Suppose that Q offers to purchase activity a_i for price P . Such an offer will be accepted by R if

$$P + h > \text{Max}[h, q(b - k) + h, \delta((q + r)b + h)],$$

where q is R 's beliefs about the probability that Q is of type s_i and r is the probability that Q is informed but not of type s_i . The right-hand side is maximised when $q = 1$ and thus $r = 0$ and $q + r = 1$, so that R will accept any such offer when

$$P > \text{Max}[b + h - k, \delta(b + h)] - h.$$

This means that if the payoff to Q of such an offer,⁴⁷

$$b - P > b + h - \text{Max}[b + h - k, \delta(b + h)] = \text{Min}[k, (1 - \delta)(b + h)],$$

exceeds the profits from buying the firm, $b - \text{Max}[h, \delta(b + h)]$, Q will never purchase the factory. Depending on the level of p , she may instead offer to work for R or to purchase the activity a_i , but in both these situations R will retain control of the factory and efficient production will take place when Q is informed. ■

In his discussion of Propositions 5 and 6 Rabin writes that in Proposition 5, unlike in Proposition 3, R is guaranteed to retain control of the factory. This is because if she is willing to reveal her information Q can be sure that R will accept a specific contract. R would never reject a specific contract out of fear that Q is uninformed because Q will pay R a fixed amount regardless of the profitability of the task. This means that Q must choose between revealing her information, or preserving it through buying the factory. What Proposition 6 guarantees is that if k is close enough to b , then R will definitely maintain control of the factory. If $k = b$,

⁴⁶ $P > \text{Max}[b - k, \delta(b + h)]$ implies $P + h > \text{Max}[h, h + (b - k), \delta(b + h)]$.

⁴⁷ $b + h - \text{Max}[b + h - k, \delta(b + h)]$ reduces to either $b + h - (b + h - k) = k$ or $b + h - \delta(b + h) = (1 - \delta)(b + h)$.

the conditions of Proposition 6 always hold if $h > 0$. This means that if Q is still needed even after information is revealed, then there is no reason for Q to purchase the firm. On the other hand assume that k is low. Then if Q offers a specific contract R is able to reject the offer and produce on his own. Thus Q could inefficiently buy the factory despite her ability to overcome the adverse selection problems. If $k = 0$, Proposition 5 reduces to the case where Q buys the factory if $b \geq \text{Max}[h, \delta(b + h)]$. In such a situation if most of the bargaining power lies with Q she will buy the firm. Keep in mind, however, that Proposition 5 holds for only low values of p . If there were no adverse selection issues to begin with, then Q may prefer to work for R rather than purchase the firm. Again we see that, if the adverse-selection problem is not too severe, there will not be inefficient control of assets.

“We have seen that the adverse-selection problem is somewhat mitigated in Model 3 relative to Models 1 and 2 because of the assumption that the informed party can both convey its private information and write contracts contingent on this information. Yet the basic adverse-selection problem discussed at the beginning of this paper is not *fully* mitigated—an informed party will still be somewhat reluctant to reveal her information during bargaining. By doing so, she loses much of her bargaining power and thus she cannot fully take advantage of her superior information.” (Rabin 1993: 69-70).

The fifth and last section of Rabin’s paper is a discussion of some of the shortcomings of his approach. Rabin notes that the models presented in his paper have obviously omitted some important issues. He ignores the fact that there are many complicated relational contracts available to economic agents. Long-term contracts such as franchising and joint ventures mix some of the features of market exchange with some of the features of internal organisations. Some such contracts might have advantages in solving the information problems that are discussed in the Rabin paper.

The possibility of long-term relationships between agents and organisations also suggests that reputation might play a role in mitigating informational problems. The implications of the models in the paper are also influenced by the assumption that informed parties do not suffer from the moral-hazard problems that uninformed parties do. This assumption clearly exaggerates the feasibility in all of the models of R gaining control over Q . In addition the models rely on the

assumption that an informed party cannot be productive without the uninformed party. Relying on this assumption, Rabin is able to ignore the possibility that the informed party could enter an industry as a separate firm and compete with the incumbent uninformed party. Even if in equilibrium such entry never occurred, the threat of doing so by the informed party would surely strengthen her bargaining power.

All of these simplifications result in the fact that the normative implications of the models are to some degree exaggerated. In all models presented in the paper, there is the possibility of an inefficient market allocation of control over assets. These inefficiencies arise because of the adverse selection problems and thus raise the possibility, as with adverse selection models in general, that government intervention could enhance efficiency. As an example Rabin suggests that we consider a marketing firm which is well informed, and in a strong bargaining position, but other than its information has little to contribute to the production of goods. The reasoning of Model 3 suggests that the marketers will buy factories and produce goods internally when in fact it would be more efficient if they were to purchase the goods from external manufacturers. Rabin argues that the government could enhance efficiency by banning integration between marketing firms and manufacturers.

A more serious limitation with Rabin's models is the assumption that agents are exogenously informed. A more realistic approach would model agents as being informed on the basis of their own efforts to become informed. In this situation the welfare effects of government intervention could be altered. If parties can invest in better information, such investment will depend on the incentives faced by the parties. Any government policy which reduces the profits of any party that is well-informed could decrease the level of innovation in the economy.

3.4 conclusion

It was noted in Chapter 2 that while the Brynjolfsson model is distinct from the Rabin model, they are complementary. The relationship between information, ownership and authority is central to both papers. Rabin works within a framework utilising an adverse selection model and shows that the adverse selection problems can be such that, in some cases, an informed party has to take over the firm to show that their information is indeed useful. The Brynjolfsson model is a

moral hazard type framework which deals with the issue of incentives for an informed party to maximise uncontractible effort.

Brynjolfsson argues that the increased importance of information technology will result in reduced integration and smaller firms insofar as this increased reliance on IT leads to better informed workers, who need incentives; enables more flexibility and less lock-in in the use of physical assets, and allows direct coordination among agents, reducing the need for centralised coordination. On the other hand, the Brynjolfsson framework suggests that more integration will result from information technology where network externalities or informational economies of scale support the centralised ownership of assets, and it facilitates the monitoring, and thus contractibility, of agent's actions. Clearly in any given case more than one of these phenomena may be important.

Within the Rabin framework it is suggested that firms are more likely to trade through markets when informed parties are also superior providers of productive services that are related to their information. But if, on the other hand, information is a firm's only competitive advantage, it is likely to obtain control over assets, possibly by buying firms that currently own those assets.

Importantly it was also noted in Section 2.5 above, that a potential problem with both papers is that part of what may be driving the results of models is the implicit restriction of the GHM framework that the owner is also the manager.

appendix 3: numerical evaluations of equations 3.29 and 3.30

As was noted in the “proof” of Rabin’s Proposition 3, see page 146, equations (3.29) and (3.30) are not equivalent. Numerical evaluations of the two equations were carried out to show this result. The first section of this Appendix contains a summary of those evaluations. A small sample of the results of the evaluations are given in Table 158.1 below.

A file of the full results is available on request. Of the 718,740 iterations in the full set of results, 1080 (0.15%) show the equations to be the same while the remaining 717,660 (99.85%) iterations show them to be different.

The evaluations were carried out by Dr. Vladimir Mencl, BlueFern, University of Canterbury. The *C* code for the evaluations is given at the end of this section.

Table 158.1 Sample of evaluation results

b	h	q	d	δ	r	eqn 3.30	eqn 3.29	comparison
0.0	0.0	0.1	0.1	0.0	0.0	-1.000000	-0.100000	different
0.0	0.0	0.1	0.1	0.0	0.1	-1.000000	-0.100000	different
0.0	0.0	0.1	0.1	0.0	0.2	-1.000000	-0.100000	different
0.0	0.0	0.1	0.1	0.0	0.3	-1.000000	-0.100000	different
0.0	0.0	0.1	0.1	0.0	0.4	-1.000000	-0.100000	different
0.0	0.0	0.1	0.1	0.0	0.5	-1.000000	-0.100000	different
0.0	0.0	0.1	0.1	0.0	0.6	-1.000000	-0.100000	different
0.0	0.0	0.1	0.1	0.0	0.7	-1.000000	-0.100000	different
0.0	0.0	0.1	0.1	0.0	0.8	-1.000000	-0.100000	different
0.0	0.0	0.1	0.1	0.0	0.9	-1.000000	-0.100000	different
1.0	1.0	0.9	0.8	0.4	0.0	0.111111	-0.088889	different
1.0	1.0	0.9	0.8	0.4	0.1	0.111111	-0.128889	different
1.0	1.0	0.9	0.8	0.5	0.0	0.111111	-0.188889	different
1.0	1.0	0.9	0.8	0.5	0.1	0.111111	-0.238889	different
1.0	1.0	0.9	0.8	0.6	0.0	-0.044444	-0.428889	different
1.0	1.0	0.9	0.8	0.6	0.1	-0.088889	-0.548889	different

b	h	q	d	δ	r	eqn 3.30	eqn 3.29	comparison
1.0	1.0	0.9	0.8	0.7	0.0	-0.255556	-0.718889	different
1.0	1.0	0.9	0.8	0.7	0.1	-0.288889	-0.858889	different
1.0	1.0	0.9	0.8	0.8	0.0	-0.466667	-1.008889	different
1.0	1.0	0.9	0.8	0.8	0.1	-0.488889	-1.168889	different
1.0	1.0	0.9	0.8	0.9	0.0	-0.677778	-1.298889	different
1.0	1.0	0.9	0.8	0.9	0.1	-0.688889	-1.478889	different
1.0	1.0	0.9	0.9	0.0	0.0	0.000000	0.111111	different
1.0	1.0	0.9	0.9	0.0	0.1	0.000000	0.111111	different
1.0	1.0	0.9	0.9	0.1	0.0	0.000000	0.111111	different
1.0	1.0	0.9	0.9	0.1	0.1	0.000000	0.101111	different
1.0	1.0	0.9	0.9	0.2	0.0	0.000000	0.011111	different
1.0	1.0	0.9	0.9	0.2	0.1	0.000000	-0.008889	different
1.0	1.0	0.9	0.9	0.3	0.0	0.000000	-0.088889	different
1.0	1.0	0.9	0.9	0.3	0.1	0.000000	-0.118889	different
1.0	1.0	0.9	0.9	0.4	0.0	0.000000	-0.188889	different
1.0	1.0	0.9	0.9	0.4	0.1	0.000000	-0.228889	different
1.0	1.0	0.9	0.9	0.5	0.0	0.000000	-0.288889	different
1.0	1.0	0.9	0.9	0.5	0.1	0.000000	-0.338889	different
1.0	1.0	0.9	0.9	0.6	0.0	-0.155556	-0.528889	different
1.0	1.0	0.9	0.9	0.6	0.1	-0.200000	-0.648889	different
1.0	1.0	0.9	0.9	0.7	0.0	-0.366667	-0.818889	different
1.0	1.0	0.9	0.9	0.7	0.1	-0.400000	-0.958889	different
1.0	1.0	0.9	0.9	0.8	0.0	-0.577778	-1.108889	different
1.0	1.0	0.9	0.9	0.8	0.1	-0.600000	-1.268889	different
1.0	1.0	0.9	0.9	0.9	0.0	-0.788889	-1.398889	different
1.0	1.0	0.9	0.9	0.9	0.1	-0.800000	-1.578889	different
1.0	1.0	0.9	1.0	0.0	0.0	-0.111111	0.011111	different

b	h	q	d	δ	r	eqn 3.30	eqn 3.29	comparison
1.0	1.0	0.9	1.0	0.0	0.1	-0.111111	0.011111	different
1.0	1.0	0.9	1.0	0.1	0.0	-0.111111	0.011111	different
1.0	1.0	0.9	1.0	0.1	0.1	-0.111111	0.001111	different
1.0	1.0	0.9	1.0	0.2	0.0	-0.111111	-0.088889	different
1.0	1.0	0.9	1.0	0.2	0.1	-0.111111	-0.108889	different
1.0	1.0	0.9	1.0	0.3	0.0	-0.111111	-0.188889	different
1.0	1.0	0.9	1.0	0.3	0.1	-0.111111	-0.218889	different
1.0	1.0	0.9	1.0	0.4	0.0	-0.111111	-0.288889	different
1.0	1.0	0.9	1.0	0.4	0.1	-0.111111	-0.328889	different
1.0	1.0	0.9	1.0	0.5	0.0	-0.111111	-0.388889	different
1.0	1.0	0.9	1.0	0.5	0.1	-0.111111	-0.438889	different
1.0	1.0	0.9	1.0	0.6	0.0	-0.266667	-0.628889	different
1.0	1.0	0.9	1.0	0.6	0.1	-0.311111	-0.748889	different
1.0	1.0	0.9	1.0	0.7	0.0	-0.477778	-0.918889	different
1.0	1.0	0.9	1.0	0.7	0.1	-0.511111	-1.058889	different
1.0	1.0	0.9	1.0	0.8	0.0	-0.688889	-1.208889	different
1.0	1.0	0.9	1.0	0.8	0.1	-0.711111	-1.368889	different

C code written by Vladimir Mencl

```

#include <stdlib.h>
#include <stdio.h>
typedef long double num_t;
num_t max(num_t a, num_t b)
{
    return (a>b) ? a : b;
};
num_t funcPaul(num_t b,num_t h,num_t q,num_t d,num_t delta ,num_t r)
{
    return b + h + ( ( 1-q ) / q ) * max(h, delta*( r*b/(1-q) + h)) - d/q - max(h,
        delta*((q+r)*b+h))/q;
}

```

```

}
num_t funcRabin(num_t b,num_t h,num_t q,num_t d,num_t delta ,num_t r)
{
    return b + h + ( ( 1-q ) * h / q ) - ( 1 - q ) * max(h, delta*( r*b+h ) / (1-q) ) -
        max(h, delta * ( ( q+r ) * b + h ) ) -d;
}
int main(int argc, char **argv)
{
    int countSame = 0;
    int countDiff = 0;
    int min_val = 0;
    int max_val = 10;
    int increment = 1;
    num_t scale = 0.1;
    int bi, hi, qi, di, deltai, ri;
    num_t b,h,q,d,delta ,r;
    for (bi= min_val; bi <= max_val; bi+= increment) {
        b=scale*bi;
        for (hi= min_val; hi <= max_val; hi+= increment) {
            h=scale*hi;
            for (qi= min_val+increment; qi <= max_val-increment; qi+= increment) {
                q=scale*qi;
                for (di= min_val; di <= max_val; di+= increment) {
                    d=scale*di;
                    for (deltai= min_val; deltai <= max_val-increment; deltai+= increment) {
                        delta=scale*deltai;
                        for (ri= min_val; ri <= max_val-qi; ri+= increment) {
                            r=scale*ri;
                            num_t valPaul = funcPaul(b,h,q,d,delta ,r);
                            num_t valRabin = funcRabin(b,h,q,d,delta ,r);
                            int isSame = ( valPaul == valRabin);
                            if (isSame) {
                                countSame+=1;
                            } else {
                                countDiff+=1;
                            }
                        };
                        printf(" Iter : \u0304b=%0.1Lf \u0304h=%0.1Lf \u0304q=%0.1Lf \u0304d=%0.1Lf \u0304delta=%0.1Lf \u0304r
                            =%0.1Lf \u0304ValPaul=%0.1Lf \u0304valRabin=%0.1Lf \u0304(%s)\n", b, h, q, d, delta , r,

```

```

        valPaul, valRabin, (isSame?"same":"different") );
    };
};
};
};
};
};
printf(" All done. countSame=%d, countDiff=%d\n", countSame, countDiff );
return 0;
}

```

In this section we consider in more detail the maximisation of equation (3.30) showing that in general we can not guarantee that it will be maximised when $q + r = 1$. Again equation (3.30) was numerically evaluated and the *C* code by Vladimir Mencl is given at the end of the section.

Table 162.1 Equation 3.30 is not always maximised at $q + r = 1$

b	h	q	d	δ	r	q+r	$\delta\left(\frac{rb}{1-q} + h\right)$	$\delta((q+r)b + h)$	eqn value
10	9.9	0.1	0	0.5	0.8	0.9	9.39444	9.45	10
10	9.9	0.1	0	0.5	0.9	1	9.95	9.95	9.95
⋮									
10	9.9	0.9	0.6	0.5	0	0.9	4.95	9.45	9.333333
10	9.9	0.9	0.6	0.5	0.1	1	9.95	9.95	9.283333
⋮									
10	9.9	0.9	0.7	0.5	0	0.9	4.95	9.45	9.222222
10	9.9	0.9	0.7	0.5	0.1	1	9.95	9.95	9.172222
⋮									
10	9.9	0.9	0.9	0.5	0	0.9	4.95	9.45	9
10	9.9	0.9	0.9	0.5	0.1	1	9.95	9.95	8.95

C code written by Vladimir Mencl

```

#include <stdlib.h>
#include <stdio.h>

```

```

typedef long double num_t;
num_t max(num_t a, num_t b)
{
    return (a>b) ? a : b;
};
num_t funcPaul(num_t b,num_t h,num_t q,num_t d,num_t delta ,num_t r)
{
    return b + h + ( ( 1-q) / q ) * max(h, delta*( r*b/(1-q) + h)) - d/q - max(h,
        delta*((q+r)*b+h))/q;
}
num_t funcRabin(num_t b,num_t h,num_t q,num_t d,num_t delta ,num_t r)
{
    return b + h + ( ( 1-q) * h / q ) - (1 - q) * max(h, delta*( r*b+h ) / (1-q) ) -
        max(h, delta * ( ( q+r) * b + h ) ) -d;
}
int main(int argc, char **argv)
{
    int min_val = 0;
    int max_val = 10;
    int max_val_bh = 100;
    int increment = 1;
    int increment_b = increment;
    int increment_h = increment;
    num_t scale = 0.1;
    int bi, hi, qi, di, deltai, ri;
    num_t b,h,q,d,delta ,r;
    for (bi= min_val; bi <= max_val_bh; bi+= increment_b) {
        if (bi>=max_val) increment_b=9*increment;
        b=scale*bi;
        for (hi= min_val; hi <= max_val_bh; hi+= increment_h) {
            if (hi>=max_val) increment_h=9*increment;
            h=scale*hi;
            for (qi= min_val+increment; qi <= max_val-increment; qi+= increment) {
                q=scale*qi;
                for (di= min_val; di <= max_val; di+= increment) {
                    d=scale*di;
                    for (deltai= min_val; deltai <= max_val-increment; deltai+= increment) {
                        delta=scale*deltai;

```

```

for (ri= min_val; ri <= max_val-qi; ri+= increment) {
    r=scale*ri;
    num_t valPaul = funcPaul(b,h,q,d,delta,r);
    printf(" Iter : \b=%0.1Lf \h=%0.1Lf \q=%0.1Lf \d=%0.1Lf \delta=%0.1Lf \r
        =%0.1Lf"
        "\r+q=%0.1Lf \delta*(r*b/(1-q)+h)=%0.5Lf \delta*((q+r)*b+h)
        =%0.5Lf"
        "\ ValPaul=%Lf\n" ,
        b, h, q, d, delta, r,
        r+q, delta*(r*b/(1-q)+h), delta*((q+r)*b+h),
        valPaul);
    };
};
};
};
};
};
printf(" All done .(c) I.T.S.C.\n");
return 0;
}

```

Chapter 4

Reference points and the theory of the firm

“As we move from the industrial age into the information age, knowledge is becoming an ever more central force behind the competitive success of firms and even nations.”

Bohn (1994: 61).

4.1 introduction

So far in Chapters 2 and 3 a number of shortcomings with the Grossman Hart Moore approach to the theory of the firm, especially when applied to the human-capital based firm, have been noted.¹ However given that this approach utilises an incomplete contracts framework there is a more general problem with the GHM theory which has been highlighted by the Maskin and Tirole (1999a) critique of incomplete contracts. A standard explanation as to why contracts are incomplete is that while all relevant contractual information is known to the contracting parties at least some of it is not verifiable to the courts and thus can not be contracted upon. What Maskin and Tirole suggest is that in a world of symmetric information there are ways of making this commonly known information verifiable to outsiders, such as the courts. This means, of course, that enforceable contracts can be made contingent on such information.

To see how this could work in the case of the GHM approach to the firm consider this simple example from Hart and Moore (2007: 182-3). Let a buyer B purchase a service from a seller S at a future date, 1. The exact nature of this service will become known to the parties at date 1 but is unknown at date 0 when the parties agree to a contract. At some time between the dates 0 and 1, B makes a noncontractible relationship-specific investment which increases the value she receives from the service. The cost of providing the service is assumed to be unaffected by B 's investment and is assumed to be constant. It is also assumed that there are gains from trade, that is, B 's value is always greater than S 's costs.

¹For a discussion of a number of other features that have limited the applicability of the GHM approach see Holmström (1999) and Holmström and Roberts (1998).

Next consider what happens if contracting is postponed until date 1, at which point B 's investment is sunk. Assume that there is symmetric information about the values and costs at this time. The ex post gains from trade, it is normally argued, will be realised via bargaining and this will result in the ex post surplus being split in some way, say, a 50-50 split. Such a split means, however, that B receives only half of the increase in the value of the service caused by her noncontractible investment. Anticipating this B rationally underinvests.

The solution to this underinvestment that the GHM theory exploits is the allocation of ownership rights over non-human assets. The ownership of the assets with which S works can be allocated to B . This will strengthen B 's bargaining position at date 1 since the option is now available to B to replace S with someone else who can operate the assets. This will result in B receiving a greater proportion of the ex post surplus and thus will strengthen her investment incentives.

The problem with this is that the parties may be able to construct clever mechanisms to overcome the uncertainty as to the nature of trade at date 0.² Hart and Moore (2007: 183) point out that in the model above, the parties could, as part of the date 0 contract agree that B can choose any service she wants at date 1 but she has to pay S her costs. S has to announce her cost, which because of the symmetric information assumption B observes. B can choose to challenge S 's cost statement. If a challenge is made then S pays a large fine to a third party. B 's challenge is then "tested" by seeing whether S supplies the service at a price slightly below the cost S announced. If S does supply at such a cost then B 's challenge is "validated" and the third party passes S 's fine over to B . If not, then B 's challenge is "invalidated" and B also pays a large fine to the third party. You can show that the unique subgame perfect equilibrium of this game is for S 's reported cost to be the true cost.

In an effort to circumvent the Maskin and Tirole argument³, Hart and Moore (2008) develop

²For an informal, by Eric Maskin's standards, discussion of indescribable contingencies and incomplete contracts see Maskin (2002). For a more technical discussion of the relationship between nonverifiability and contract incompleteness see Hart and Moore (1999), Maskin (1999), Maskin and Moore (1999), Maskin and Tirole (1999a), Maskin and Tirole (1999b) and Segal (1999). These six papers form part of a special issue of *The Review of Economic Studies* (66(1) No. 266 January 1999) on 'Contracts'. These articles are "[...] concerned with situations where the contracting parties are better informed than third parties (the courts) but otherwise share the same information. That is to say, they can observe the realization of some relevant event, but are unable to describe it precisely in a contract, so that the courts are not able to verify it directly. The inability of courts to verify some variable has been suggested as an explanation of the observed incompleteness of contracts." (Attanasio, Bolton, and Shin 1999: 1). For a textbook discussions of mechanism design see Diamantaras et al (2009) and Hurwicz and Reiter (2006).

³See in particular the discussion in Hart and Moore (2008: 17-19).

a theory of contracts in which contracts are seen as “reference points” for a trading relationship involving the contracting parties. This approach focuses on ex post inefficiencies rather than the ex ante inefficiencies more commonly found in the literature. The ideas of Hart and Moore (2008) have been applied to the theory of the firm in Hart (2008), Hart (2009), Hart and Holmström (2009) and Hart and Moore (2007). We discuss the theoretical aspects of each of these papers in the following sections.

4.2 Hart (2008)

Hart (2008) is made up of two parts. In the first part Hart looks briefly at Coase’s famous 1937 paper ‘The Nature of the Firm’ and the literature that followed from it. The second part looks at the recent work on contracts as reference points and applies it to the theory of the firm. The basic ideas underlying the “reference point” approach to the firm can be gathered from a simple example which is a slightly modified version of an example taken from the second part of Hart (2008). Hart assumes that a seller, S , can provide a good, costing 10, to a buyer, B , who is willing to pay 20. Let us assume that we are talking about a public lecture on some aspect of microeconomics which B is organising and which B wants S to give. A successful lecture is worth 20 to B and it costs 10 for S to give the lecture.

At this stage Hart ignores the fact that B could engage other economists or that S could give lectures elsewhere. While trade could proceed smoothly, it is also possible that it will not. We will assume that B and S each have some discretion over the ‘quality’ of performance. For example, S could give a witty, lively, entertaining lecture or a very boring one. B on the other hand could treat S well, give her a nice dinner and pay quickly, or treat her badly.

In the language of Hart and Moore (2008) each party is able to provide basic (perfunctory) or exemplary (consummate) performance. It is further assumed that only the basic (perfunctory) level of performance can be legally enforced: exemplary (consummate) performance is entirely discretionary. It is assumed that each party is more or less indifferent between providing each level of performance – exemplary performance costs only a little more than basic or may even be slightly more pleasurable – and will provide exemplary performance if they feel they are being ‘well treated’ but not if they feel they are being ‘badly treated’. Cutting back on exemplary

performance is called ‘shading’. Such behaviour cannot be observed or punished by an outsider. Shading hurts the other party.

Hart emphasises that each party will feel ‘well treated’ if they receive what they think they are entitled to; that a contract between the parties is a reference point for perceived entitlements; and that should there be no reference point, then entitlements can diverge, wildly in some cases.

To return to the example above. First, we will add a time line, see Figure 168.1. The time line tells us that B and S will write a contract some months before the lecture is given, at date 0, rather than at the last minute, date 1. One reason for this is that each party has more options earlier on. In fact it is assumed that there is a competitive market for sellers, at date 0.

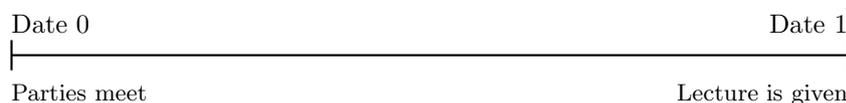


Figure 168.1. Time line.

(Hart 2008: Figure 1).

Assume, further, that although B and S sign a contract at date 0, they leave the question of how much B will pay S open until the night before the lecture, date 1. This may seem a bad idea, and later it will be shown that it is. If no price is specified, then any p between 10 and 20 is possible. What might each party feel entitled to?

Hart and Moore (2008) take the view that entitlements can diverge. S may feel that the whole success of the talk will be due to her giving it and thus she feels entitled to $p = 20$. On the other hand B may have a somewhat different view of S 's abilities and likely contribution and thus feel that S is worth much less, say, $p = 10$.

Even though they disagree as to what p should be, they are rational enough to arrive at a compromise, say $p = 15$. According to Hart and Moore (2008) each party will feel short-changed and therefore aggrieved. Since B is aggrieved by 5, (15-10), B shades to the point where S 's payoff falls by 5θ , where θ is the constant of proportionality. And since S is also aggrieved by 5, (20-15), S shades to the point where the payoff for B falls by 5θ .

The end result of this is that if S and B leave the determination of the price until the night before the lecture, there will be a deadweight loss of 10θ due to the shading activities of each party. This reduces the value of the relationship between S and B from 10 to $10 - 10\theta = 10(1 - \theta)$.

Next Hart asks the question: Can anything be done to avoid this deadweight loss? His answer is yes. But first note an answer that doesn't do the job. Ex post Coasian bargaining at date 1 doesn't work. The reason is that shading is not contractible and thus an agreement not to shade is not enforceable. Or to put this another way, if B offers to pay S more to reduce her shading, say B offers to pay $p = 16$ to S rather than 15, then this will indeed reduce S 's shading, from 5θ to 4θ , since S will now feel less aggrieved, but it will also increase B 's shading from 5θ to 6θ , since he now feels more aggrieved. Total deadweight loss does not change, it remains at 10θ . However there is a simple solution; the parties just put the price in the contract at date 0. Since it has been assumed that the market for lectures is competitive at date 0, B will be able to hire S for a price $p = 10$. With this price specified in the contract, there is nothing for B and S to disagree about at date 1. The fact that B and S may disagree about the contribution that S makes to the success of the lecture no longer matters. B and S have agreed that B will pay S 10, and neither B nor S will be disappointed or aggrieved when that happens. Importantly, agreeing in advance, at date 0, to a payment of 10 eliminates ex post argument and aggrievement, and thus both parties will be willing to provide exemplary performance. Here we have the first best being achieved and zero deadweight losses as a result. This does raise an obvious question: What changes between dates 0 and 1? Why does a date 0 contract that fixes p avoid aggrievement, whereas a date 1 contract that fixes p does not? The crucial point here is the role of the ex ante market at date 0. This market gives an objective measure of what B and S bring to the relationship. Given the assumption of a competitive date 0 market, there are many sellers willing to supply at $p = 10$ and thus S accepts that she cannot expect to receive more than 10, while B understands that he can't expect to pay less, as no one would be willing to give the lecture for less. Thus, neither party is aggrieved by $p = 10$. This gives us a model of the contractual relationship between B and S , but, as Hart explains, we need one further ingredient to create a theory of the firm.

Now let us add a little more realism by assuming that not all of the details of the lecture can be anticipated at date 0. To keep things simple we will assume that two different lectures can be given. Table 170.1 gives the payoffs and costs of each lecture.

Lecture 1 - say, a theory of the firm lecture - is the same as above, with a value of 20 and costs of 10. Lecture 2 - say, a microeconomics lecture - yields value of 14 and costs of 8. Note

that lecture 1 is more efficient in that it generates a greater surplus. Assume that the lectures can not be specified in the date 0 contract, since thinking about econometrics is sooooo boring that no one can stay awake long enough to write the contract! At date 1, however, the choice between them becomes clear.

	Lecture 1	Lecture 2
Value	20	14
Cost	10	8
Surplus	10	6

Table 170.1. Payoffs to lectures
(Hart 2008: Figure 2).

Now we have to compare two organisational forms: an employment contract and an independent contractor. First, let B and S fix the price of the good at date 0, at say 10, and let B and S agree at date 0 that S will be an independent contractor. This is, in other words, a market exchange between two separate economics agents. Independent contractor means here that S gets to pick which lecture to give.⁴

Hart then asks, What will S do? Given that the price has been fixed by the date 0 contract, S will pick lecture 2, since it is cheaper for her. But note this is inefficient. B will be aggrieved because S didn't choose lecture 1, which B feels entitled to; B is short-changed by 6 (20-14), and he will therefore shade enough to reduce S 's payoff by 6θ . Total surplus in this case will be $6 - 6\theta$.

The second organisation form to be considered is an employment contract. B and S agree at date 0 that S is an employee of B . This we take to mean that S will work for B at a fixed wage, again assume 10. B , being the employer, has the right to decide on which lecture is to be given. As the wage is fixed B will choose lecture 1, as this gives him the greater value. This is efficient. S will be aggrieved since lecture 2 wasn't chosen, but S 's aggrievement is only 2. This induces S to shade by enough to reduce B 's payoff by 2θ . Total surplus is therefore $10 - 2\theta$.

Under the conditions specified, the employment contract is better. This is true for two related reasons. First, the lecture matters more to B than to S . B will lose $20 - 14 = 6$ if his favoured

⁴That is S has the residual control rights.

lecture is not chosen while S only loses $10 - 8 = 2$ if her favoured lecture is not chosen. This means it is efficient for B to choose the lecture. Second, and related, S 's aggrievement is low since she doesn't care very much.

Hart now changes the numbers in Table 170.1 to create Table 171.1. Keep lecture 1 as it is, but change lecture 2 so while it still yields 14, it now costs only 2. Lecture 2 is now the more efficient (12 v's 10). Under employment, lecture 1 will be chosen, yielding a total surplus of $10 - 8\theta$. If S is an independent contractor, lecture 2 will be chosen resulting in a total surplus of $12 - 6\theta$.

	Lecture 1	Lecture 2
Value	20	14
Cost	10	2
Surplus	10	12

Table 171.1. Modified payoffs to lectures

(Hart 2008: Figure 3).

What this suggests is that employment is good if the lecture matters more to B than to S , while independent contracting is good if the lecture matters more to S than to B .

Hart goes on to say,

“[o]ne point worth emphasizing is that in neither of the above examples is the following contract optimal: to leave the choice of price and method until date 1, i.e. to rely on unconstrained Coasian bargaining. This would always yield the efficient method, but the aggrievement costs would be high. In [Table 170.1] the parties would agree on method 1; however, since there are 10 dollars of surplus to argue over, shading costs equal 10θ : net surplus = $10(1 - \theta)$, which is less than that obtained under the employment contract. In [Table 171.1] there are 12 dollars of surplus to argue over and net surplus = $12(1 - \theta)$, which is less than that obtained under independent contracting.” (Hart 2008: 409).

Clearly the examples above are toy ones, but Hart argues they contain the basic ingredients of a theory of the firm in that they consider the choice between carrying out a transaction in the

market, using an independent contractor, and ‘inside the firm’, via an employment contract. This was the tradeoff at the heart of Coase (1937).⁵

4.3 Hart and Moore (2007)

Hart and Moore (2007) (HM) is an attempt to broaden the property rights literature in such a manner as to move this literature away from its use of renegotiation of an incomplete contract to achieve ex post efficiency and its focus on distortions in ex ante investments. Section 1 of the paper discusses a simple version of the standard property rights approach to the firm. HM show that hold-up can occur and that the standard approach to dealing with it is via the allocation of non-human assets among the contracting parties. HM also point out weaknesses with the standard model including the Maskin and Tirole critique; the model’s reliance on noncontractible, relationship-specific investments which are by their very nature problematic in that they are hard to measure empirically; and the assumption that parties always bargain to to an ex post efficient outcome. HM argue that the use of side payments to achieve such an efficient outcome is a poor description of what goes on inside real firms.

All of this suggests to HM that it is worth trying to develop an alternative model. This they do in Section 2 of the paper.

HM open Section 2 by noting that Hart and Moore (2008) develop a theory of incomplete contracts based on the idea that a contract can act as a reference point for the contracting parties’ feelings of entitlement and that such feelings of entitlement can affect contractual performance. The basic ideas underlying the theory can be outlined as follows: consider a situation where a buyer B wants a good or service from a seller at some future date 1. Assume the good is a homogeneous widget. Also assume that there is a ‘fundamental transformation’ between dates 0 and 1, that is, what starts as a situation of perfect competition at date 0 evolves into one of bilateral monopoly by date 1.

The parties meet and contract at date 0 but there is uncertainty about the state of the world at this time. This uncertainty is resolved shortly before date 1. There is symmetric information throughout but the state of the world is not verifiable. A date 0 contract can be thought of as

⁵For an overview of Coase (1937) see Appendix 1.B.

specifying a set of possible price-quantity pairs which form the set of possible outcomes of B and S 's date 1 transaction. Note that the outcomes cannot be state contingent since the state itself is not verifiable. A mechanism for choosing from among the set of possible outcomes may also be included as part of the date 0 contract.

Importantly for the HM story, the date 0 contract acts of a reference point for the contracting parties' feelings of entitlement at date 1. Neither party feels entitled to an outcome not included in the contract. The contract is seen as "fair" since it was negotiated under the competitive conditions prevailing at date 0. Problems can arise, however, when choosing among the different outcomes allowed under the contract. HM suppose that each party feels entitled to the best possible outcome allowed under the contract. This means that it is likely that at least one of the parties, if not both, will feel disappointed or aggrieved by the actual outcome.

There are significant implications that flow from this aggrievement. A second important assumption built into the HM theory is that outcome is not perfectly contractible even at date 1. Each party has the freedom to choose between "perfunctory" performance or "consummate" performance.

To make matters a little more precise, suppose that if the outcome that is chosen from those available under the contract causes S to feel aggrieved by $\$k$, that is, S 's actual payment is $\$k$ less than the best possible outcome, then S will shade on her performance to such a degree that B 's payoff falls by θk . θ being an exogenously given parameter where $0 < \theta \leq 1$. A similar situation with regard to shading pertains to B . There a symmetry here, both B and S can shade and θ is the same for both. Shading can not occur if there is no trade.

Assume further that B 's value of the widget at date 1 is v and that S 's cost of production is zero but there is an opportunity cost of r . Thus, trade is efficient if and only if $v \geq r$. At date 0, v and r are random variables with a probability distribution that is common knowledge. Also no third party is able to tell who is at fault if trade does not take place at date 1. This means that trade is voluntary. Given these assumptions Hart and Moore (2008) are able to show that it is only the difference between the trade price and the no-trade price that matters and that is possible to normalise the no-trade price to be zero. HM also assume that lump-sum transfers can be used to carry out any redistribution of surplus at date 0.

The simplest case to consider is that where there is no uncertainty as to the value of v and

r , they are constants, and $v > r$. In this situation the first-best can be achieved. All that has to happen is that the parties agree, at date 0, that S will supply the widget to B at date 1 for a given price, p , where $r < p < v$. This contract would ensure trade and would result in no aggrievement because both parties receive the best outcome permitted under the contract. Note the contract only specifies one outcome, trade at price p .

While this form of contract achieves the first-best not all contracts, even in this no uncertainty world, do so. For example, consider a contract that specifies that the trade price can be anything in the range $[r, v]$ and that B will choose the price. Here B will choose the lowest price possible, $p = r$, at date 1. Note however that this will cause S to be aggrieved since the best possible price for her, $p = v$, was not chosen and thus she will shade resulting in a deadweight loss of $\theta(v - r)$.⁶

Things are more interesting, however, if v and r are uncertain. In this case any contract which specifies a single trading price, p , will ensure trade if and only if $v \geq p \geq r$, that is, if and only if both parties gain from trade. The problem is that as v and r are now stochastic, it can not be guaranteed that it is possible to find a single p that lies between v and r whenever $v > r$. HM point out that under such conditions specifying a range of prices could be superior.

Under uncertainty a contract that specifies a range of trading price $[\underline{p}, \bar{p}]$ can be superior to a single price contract. Hart and Moore (2008) show that it is not necessary to go beyond a contract which specifies a no-trade price of zero, as above, a trading price range of $[\underline{p}, \bar{p}]$ and lets B choose the price. The advantage of the large price range is that it makes it more likely that B can find a price between v and r whenever $v \geq r$. The cost is that there are typically many feasible prices between v and r when $v \geq r$ and B will pick the lowest price. This means that S will feel aggrieved that B did not pick the highest price and will therefore shade, resulting in a deadweight loss. The optimal contract will trade off these two effects.

Thus far one important issue has been ignored. If $v > r$ but there is no price in the range $[\underline{p}, \bar{p}]$ such that $v \geq p \geq r$, it would be expected that the parties would renegotiate their contract. But renegotiation doesn't change the analysis in any fundamental ways as is shown in Hart and Moore (2008).

Next HM turn to the issue of ownership. Up to this point HM have implicitly assumed that B

⁶ S 's best outcome is $p = v$ while the actual outcome is $p = r$ and thus S is aggrieved by the amount $v - r$ which means she shades, thereby lowering B 's payoff, by an amount $\theta(v - r)$. This is the deadweight loss. B does not shade as she receives her best outcome.

and S are separate entities, that is, they are “nonintegrated”. Now suppose that B acquires S ’s firm (non-human assets) at date zero. This is interpreted as “integration”. It amounts to saying that B now owns and possesses the widget. HM take this to mean that B can get someone other than S to produce the widget, at zero cost, at date 1. It is assumed that S ’s human capital is still needed to realise the opportunity cost, r . In effect to earn r , B must sell the widget back to S . If no trade occurs B earns v since she already owns the widget, while if trade does occur, S earns r but pays p . Trade is now efficient if and only if $r \geq v$; trade is still voluntary. In this situation a contract consists of a zero no-trade price and a range of trading prices $[\underline{p}, \bar{p}]$, with S choosing the price. S will choose the smallest price such that $r \geq p \geq v$, whenever $r > v$.

In place of a complete analysis of nonintegration versus integration HM makes a number of observations on the difference between them. Assume that $v > r$ with probability 1. Then as was noted above, it may be impossible to achieve the first-best. The reason being that in order to ensure trade with probability 1 it may be necessary to have a range of trading prices, but this results in aggrivement and shading whenever there is more than one price satisfying $v \geq p \geq r$. On the other hand integration can achieve first-best because the status-quo has been transformed into one where B owns the widget, which is the efficient outcome. S is irrelevant and does not or cannot shade.

The situation is reversed if $v < r$ with probability 1: now integration is inefficient as a range of prices is required to ensure that B trades the widget to S . This results in aggrivement and thus shading whenever there is a number of feasible prices in the range while for nonintegration the status-quo point has S possessing the widget which is efficient and does not give rise to shading.

The HM model can be thought of as capturing the idea that integration is useful for ensuring input supply in an uncertain world. When $v > r$ but v and r vary, nonintegration is usually inefficient, that is, either trade will not take place when it should or there will be shading, while integration results in the first-best outcome.

4.4 Hart (2009)

Hart opens his article by saying that the paper will reexamine some of the themes of the incomplete contracts literature – by which he means the hold-up problem and asset ownership –

actions are chosen simultaneously by both parties at date 1. The time line is given in Figure 176.1 above.

Next Hart (2009: 272) makes the following assumptions

- “A1. If at date 1 all helpful actions are taken, the value of the widget to B is v and the cost to S is c , where $v > c$. Hence net surplus equals $v - c$ in this case.
- A2. If at date 1 all the contractible, but none of the noncontractible, helpful actions are taken, the value of the widget to B is $v - \frac{1}{2}\lambda(v - c)$ and the cost to S is $c + \frac{1}{2}\lambda(v - c)$, where $0 < \lambda < 1$. Hence net surplus is $(1 - \lambda)(v - c)$ in this case.
- A3. If at date 1 none of the helpful actions (contractible or otherwise) are taken, B 's value is very low (approximately, $-\infty$) and S 's cost is very high (approximately, $+\infty$). In this case each party walks away from the contract (neither party has an incentive to enforce it) and no trade occurs; that is, the parties earn their outside options. The no-trade price has been normalised to zero.”

The importance of A2 is that withholding noncontractible helpful actions moves v and c towards $\frac{1}{2}(v + c)$.⁸

The next question is, What determines whether a party is helpful? That is, When do the parties act cooperatively? Following Hart and Moore (2008), Hart assumes that being helpful does not cost, to any significant degree, more than not being helpful: either it costs slightly more, or it may cost a little less—which means that a party could enjoy being helpful. To simplify things Hart supposes that each party is indifferent between being helpful and not.

Given this indifference, a party will be helpful if they feel they have been “well treated” by the other party, but not otherwise. In this context, “well treated” refers to receiving what that party feels they are entitled to, where the date 0 contract acts as a “reference point” for date 1 entitlements. This is to say that neither party feels entitled to an outcome other than those permitted by the date 0 contract. However, among the outcomes provided for under the contract there can be disagreement about the appropriate outcome.

Hart starts his analysis by considering the case where the parties write a “simple” date 0 contract, that is, one which specifies a single trading price p . When date 1- is reached and the

⁸As $\lambda \rightarrow 1$, $v - \frac{1}{2}\lambda(v - c) \rightarrow \frac{1}{2}(v + c)$ and $c + \frac{1}{2}\lambda(v - c) \rightarrow \frac{1}{2}(v + c)$.

uncertainty is resolved each of the parties has a choice, either they can stick to the contract as agreed or they can try to force the other party to renegotiate the contract. This renegotiation is interpreted here as “hold-up”.

First Hart deals with the scenario where the parties stick to the contract. Here each party feels well-treated by the other since they are getting exactly what the contract said they would: the contract specifies a single trading price p . Given that each feels well-treated, they are willing to be helpful and all cooperative actions are taken. The buyer’s and seller’s payoffs are given by

$$U_b = v - p \quad (4.1) \quad U_s = p - c \quad (4.2)$$

Note that there are also two participation constraints to satisfy here: $v - p \geq r_b$ and $p - c \geq r_s$. This means that we have $v - r_b \geq p$ and $p - c \geq r_s \Rightarrow c + r_s \leq p$ which gives $v \geq v - r_b \geq p \geq c + r_s \geq c$.

The second scenario considered is where one party engages in hold-up. This they do by trying to force the other party to renegotiate the contract by threatening to withhold all helpful actions unless given a sidepayment. Such an action is considered, by the other party, to be a breach of the spirit of the date 0 contract and leads to the end of cooperation. The result is a Nash equilibrium where neither party cooperates.⁹ This is the no-trade outcome of A3, with payoffs to B and S of r_b and r_s .

But renegotiation is possible and thus even if the relationship is soured the parties can, and will, consent to carry out the **contractible** helpful actions at date 1. But there is a cost to renegotiation in that neither party will carry out the noncontractible helpful actions. Their relationship will be impersonal, if correct. The result is that renegotiation yields a surplus of $(1 - \lambda)(v - c)$ by A2.

Thus whenever

$$A4. (1 - \lambda)(v - c) > r_b + r_s$$

the parties will renegotiate their contract away from the no-trade outcome. A4 is assumed to hold in what follows.

In summary, hold-up leads to a loss of surplus of $\lambda(v - c)$.

Hart assumes that there will be a 50:50 split of the surplus from renegotiation (this could be,

⁹This is a Nash equilibrium because each party is indifferent between cooperating and not doing so.

for example, the result of applying the Nash bargaining solution) so after hold-up the parties' payoffs are given by

$$U_b = r_b + \frac{1}{2}G \quad (4.3)$$

$$U_s = r_s + \frac{1}{2}G \quad (4.4)$$

$$\text{where } G = (1 - \lambda)(v - c) - r_b - r_s. \quad (4.5)$$

Having r_i in the equations (4.3) and (4.4) means that the participation constraint is satisfied.

From this it is possible to determine when hold-up occurs. Define p_L to be the price such that S is indifferent between receiving p , i.e. being helpful, and holding B up and let p_H be the price at which B is indifferent between paying p and holding S up. Then from (4.1)–(4.4) we get

$$p_L - c = r_s + \frac{1}{2}G \quad (4.6)$$

$$v - p_H = r_b + \frac{1}{2}G \quad (4.7)$$

and thus

$$p_L = c + r_s + \frac{1}{2}G \quad (4.8)$$

$$p_H = v - r_b - \frac{1}{2}G. \quad (4.9)$$

Note that

$$p_H - p_L = \lambda(v - c) > 0. \quad (4.10)$$

Equation (4.10) reflects the fact that there are frictions in the renegotiation process. If the renegotiation could be achieved without acrimony, that is if $\lambda = 0$, then $p_H = p_L$. However since hold-up causes some dissipation of surplus, $p_H > p_L$: the price at which B is just willing to hold-up S is strictly greater than the price at which S is just willing to hold-up B .

So we have $v \geq v - r_b \geq v - r_b - \frac{1}{2}G = p_H > p_L = c + r_s + \frac{1}{2}G \geq c + r_s \geq c$.

Note that since S is indifferent between holding B up and not doing so at a price $p = p_L$, S will strictly prefer to hold up B when $p < p_L$. Similarly, if $p > p_H$ then B will strictly prefer to

hold up S . Thus hold-up is avoided if and only if

$$p_L < p < p_H \tag{4.11}$$

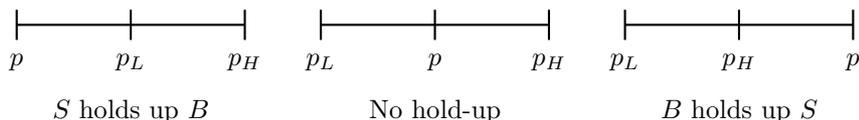


Figure 180.1. Hold-up.

(Hart 2009: Figure 2)

It is worth noting that p_H and p_L vary with the state of the world, they are random variables, but p is not since it is chosen ex ante.

Note that if $p_H < p_L$ the diagram would look like

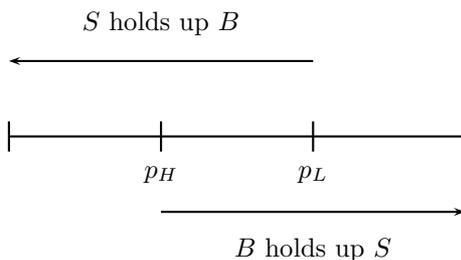


Figure 180.2. Hold-up.

and thus there is no region in which hold-up does not occur, that is, in this case hold-up would always take place. But this would imply $c > v$ so that $\lambda(v - c) < 0$.

To make progress Hart places more structure on the random variables, r_b and r_s . In particular he assumes

$$r_b = \alpha_b + \beta_b v + \varphi + \gamma_b \varepsilon \tag{4.12}$$

$$r_s = \alpha_s - \beta_s c + \gamma_s \eta \tag{4.13}$$

$$\text{where } 1 - \lambda > \beta_b > 0, 1 - \lambda > \beta_s > 0, \gamma_b > 0, \gamma_s > 0. \tag{4.14}$$

Here $\alpha_b, \beta_b, \gamma_b, \alpha_s, \beta_s,$ and γ_s are constants (later they will depend on the assets that each party owns) and φ, ε and η are independent random variables with zero mean. (4.12), (4.13) and (4.14)

capture the idea the outside options for both B and S co-vary with v and c , respectively, but not too strongly, and are also subject to exogenous noise (ε, η) . The noise term φ is a smoothing device: its rationale will become clear in the following section.

Using (4.12) and (4.13), it is possible to represent the state of the world as a 5-tuple $\omega = (v, c, \varphi, \varepsilon, \eta)$. Both B and S observe ω at date 1-. Note that a simple contract refers to a contract consisting of a single price p , where p is chosen before the state of the world ω is known.

It is useful to rewrite p_L, p_H as functions of ω , a process that gives

$$p_L(\omega) = \frac{1}{2}[\alpha_s + \gamma_s \eta - \alpha_b - \varphi - \gamma_b \varepsilon + ((1 - \lambda) - \beta_b)v + ((1 + \lambda) - \beta_s)c] \quad (4.15)$$

$$p_H(\omega) = \frac{1}{2}[\alpha_s + \gamma_s \eta - \alpha_b - \varphi - \gamma_b \varepsilon + ((1 + \lambda) - \beta_b)v + ((1 - \lambda) - \beta_s)c]. \quad (4.16)$$

Clearly both $p_L(\omega)$ and $p_H(\omega)$ are increasing in v, c .¹⁰ Remember that hold-up occurs when $p_L(\omega) > p$ or $p_H(\omega) < p$, or, in other words, when either $p_L(\omega)$ is high or $p_H(\omega)$ is low. Thus it is clear that hold-up occurs, *ceteris paribus*, if v is exceptionally high or low or c is exceptionally high or low. This is intuitive: if v is high, S does relatively well in the renegotiation process because there is a lot of surplus available, even accounting for the λ loss, and so S has an incentive to hold up B . Similarly, should the value of c be low, B does relatively well in the renegotiation process and thus will have an incentive to hold-up S . From (4.15) and (4.16) we see that the effects of extreme values of v and c are less pronounced if β_b and β_s are large, since p_L and p_H will be less sensitive to v and c if they are.

Hart now looks at the optimal simple contract. Since date 0 lump-sum transfers can be applied to allocate surplus, an optimal contract is one which maximises expected net surplus.

¹⁰For $p_H(\omega) > p_L(\omega)$ it must be that $((1 + \lambda) - \beta_b)v + ((1 - \lambda) - \beta_s)c > ((1 - \lambda) - \beta_b)v + ((1 + \lambda) - \beta_s)c$ as everything else in equations 4.15 and 4.16 cancels.

$$\begin{aligned} ((1 + \lambda) - \beta_b)v + ((1 - \lambda) - \beta_s)c &> ((1 - \lambda) - \beta_b)v + ((1 + \lambda) - \beta_s)c \\ \Rightarrow v + \lambda v - \beta_b v + c - \lambda c - \beta_s c &> v - \lambda v - \beta_b v + c + \lambda c - \beta_s c \\ \Rightarrow \lambda v - \lambda c &> -\lambda v + \lambda c \\ \Rightarrow v - c &> -v + c \\ \Rightarrow v - c &> c - v \text{ which is true by assumption.} \end{aligned}$$

$$\begin{aligned}
 \underset{p}{Max} &= \int (v - c) dF(\omega) + \int (1 - \lambda)(v - c) dF(\omega) \\
 p_L(\omega) \leq p \leq p_H(\omega) & \quad \begin{array}{l} p < p_L(\omega) \\ \text{or } p > p_H(\omega) \end{array}
 \end{aligned} \tag{4.17}$$

where F is the distribution function of ω .

It is straightforward to see that under certainty the first-best can be achieved: just pick any price p in the interval $[p_L(\omega_0), p_H(\omega_0)]$, where ω_0 is the state of the world. However, the first-best typically cannot be achieved under uncertainty, because it is not generally possible to find a single price that lies in the intersection of a number of different $[p_L(\omega), p_H(\omega)]$ intervals.

Hart notes a shortcoming with the analysis so far:

“[s]uppose that the parties write a simple contract at date 0. Then, as we have observed, with uncertainty it is very likely that p will lie outside the $[p_L(\omega), p_H(\omega)]$ range for some ω , and so one party will hold up the other to get a better price. Why don’t the parties anticipate this and build the renegotiated price into the original contract? For example, the initial contract could state that the price will normally be 10 but can rise to 20 in unusual circumstances. Or the contract might give one party the right to choose the price from a menu of prices.” (Hart 2009: 277).

In the Appendix to his paper Hart deals with (some of) these possibilities. Here Hart allows for the parties to specify a range of possible trading prices, $[\underline{p}, \bar{p}]$, in their contract at date 0. For each state of the world the parties negotiate over which price in the range to choose. As long as they stay within the agreed range hold-up is avoided. Hold-up avoidance is the advantage of a large price range. The cost of such a range is that at date 1— each party may feel entitled to a different price within the price range. As in Hart and Moore (2008) not receiving what you think you are entitled to results in aggrivement and “shading”, that is, partial withholding of cooperation. If it were not for shading a price range of $\underline{p} = -\infty$, $\bar{p} = \infty$ would result in the first-best being able to be achieved. Given that this amounts to placing no restrictions on price, this is equivalent to no contract being written at date 0.

If, however, aggrivement and shading exists, a very large price range is not optimal since it will lead to shading in all states of the world. Thus there is a trade-off between the risk of hold-up and the cost of shading. The parties may accept a risk of hold-up by limiting the price range, to avoid shading. In the extreme case a fixed price contract will be signed. It can be shown, see the

Appendix to Hart (2009), that all the results of Sections 2 and 3 carry over to the case of price ranges.

Hart closes this section by discussing indexation. Assume there is a verifiable signal, σ , that is correlated with the state of the world. Then the parties can do better than the optimal contract given by (4.17) by indexing the price to σ . Suppose that σ takes the values $\sigma_1, \dots, \sigma_n$ with associated strictly positive probabilities π_1, \dots, π_n . An indexed contract consists of a vector of prices (p_1, \dots, p_n) where p_i is the trading price that will occur if $\sigma = \sigma_i$. Define, by analogy with (4.17), $S_i(p)$ to be expected surplus conditional on the signal $\sigma = \sigma_i$; in other words

$$S_i(p) = \int (v - c) dF(\omega/\sigma_i) + \int (1 - \lambda)(v - c) dF(\omega/\sigma_i) \\ p_L(\omega) \leq p \leq p_H(\omega) \quad \begin{array}{l} p < p_L(\omega) \\ \text{or } p > p_H(\omega) \end{array} \quad (4.18)$$

where $F(\omega/\sigma_i)$ is the distribution function of ω conditional on σ_i . It follows from this that total expected surplus is given by $\sum_{i=1}^n \pi_i S_i(p_i)$ and an optimal indexed contract solves the problem

$$\max_{p_1, \dots, p_n} = \sum_{i=1}^n \pi_i S_i(p_i). \quad (4.19)$$

A necessary and sufficient condition for (p_1, \dots, p_n) to solve (4.19) is that

$$p_i \text{ solves } : \max_p S_i(p) \text{ for all } i. \quad (4.20)$$

Hart assumes that the solution to (4.20) is unique.

Return now to consider the case of nonindexation. An optimal nonindexed contract maximises (4.19) but with the constraint that $p_1 = \dots = p_n$; that is, it solves the problem

$$\max_p = \sum_{i=1}^n \pi_i S_i(p). \quad (4.21)$$

Assume that the solution to this is p^* . Given that p^* is a feasible choice in (4.20) it is clear that $S_i(p_i) \geq S_i(p^*)$ for all i . Hence,

$$\sum_{i=1}^n \pi_i S_i(p_i) \geq \sum_{i=1}^n \pi_i S_i(p^*). \quad (4.22)$$

Notice that the only way that (4.22) can hold with equality is if

$$S_i(p_i) = S_i(p^*) \text{ for all } i. \quad (4.23)$$

In other words, as long as the solutions to (4.20) are not the same, indexation strictly dominates nonindexation. Thus Hart has proved

Proposition 7 *Assume that the (unique) solution to 4.20 varies with i . Then an indexed contract is strictly superior to a nonindexed contract. (Hart 2009: 279).*

A special case of of Proposition 7 is when σ is perfectly correlated with the state of the world ω . The first-best can then be achieved under indexation by selecting $p_i \in [p_L(\omega_i), p_H(\omega_i)]$ where ω_i is the unique state of the world corresponding to σ_i . In this situation hold-up can be avoided completely by the use of an indexed contract. In general, however, we are not so lucky since indexation will not achieve the first-best.

In Section 3 Hart introduces assets into the model. Asset ownership matters because it determines which assets a given party can walk away with if trade does not take place. This affects each party's outside options and their incentives to engage in hold-up.

Hart denotes by A the set of all assets at B and S 's command. A is assumed to be fixed and finite. Let A_b be those assets which B owns and A_s to be the assets S owns. It is assumed that,

$$A_b \cap A_s = \emptyset, \quad A_b \cup A_s \subseteq A. \quad (4.24)$$

The first part of (4.24) tells us that both B and S can't walk away with the same asset. The second section of (4.24) states that if an asset is jointly owned then neither party can walk away with it.¹¹ This means that joint ownership gives each of the parties veto rights on the use of the asset.

Now assume that the coefficients $\alpha_b, \beta_b, \gamma_b, \alpha_s, \beta_s, \gamma_s$ depend on the ownership of assets. In particular $\alpha_b = \alpha_b(A_b), \beta_b = \beta_b(A_b), \gamma_b = \gamma_b(A_b), \alpha_s = \alpha_s(A_s), \beta_s = \beta_s(A_s)$ and $\gamma_s = \gamma_s(A_s)$. It is also assumed that asset ownership increases the *marginal* payoffs of r_b, r_s with respect to v

¹¹If $A_b \cup A_s \subset A$ then there must be some asset not owned solely by one of B or S . Such an asset is assumed to be under joint ownership.

and c . That is,

$$\beta_b \text{ is nondecreasing in } A_b \quad (4.25)$$

$$\beta_s \text{ is nondecreasing in } A_s. \quad (4.26)$$

The idea being captured by (4.25) and (4.26) is that the assets are specific to the trading that B and S are engaged in. An alternative would be to suppose that each party's total payoff increases in the assets they own, that is, α_b, α_s are increasing in A_b, A_s . But this is not needed in what follows. (4.14) and A4 are assumed to hold for all ownership structures.

Hart also assumes that the assets can be traded at date 0. Therefore a contract is now a 3-tuple made up of assets and a price, that is, (A_s, A_b, p) which specifies an ownership allocation, (A_s, A_b) and a date 1 price, p , where A_s, A_b satisfy (4.24). As was the case in Section 2, date 0 lump-sum transfers are possible, and thus an optimal contract maximises expected net surplus.

$$\text{Max}_{(A_b, A_s, p)} \left\{ \begin{array}{l} \int (v - c) dF(\omega) \quad + \int (1 - \lambda)(v - c) dF(\omega) \\ p_L(\omega; A_b, A_s) \leq p \leq p_H(\omega; A_b, A_s) \quad p < p_L(\omega; A_b, A_s) \\ \text{or} \quad p > p_H(\omega; A_b, A_s) \end{array} \right\} \quad (4.27)$$

where p_L and p_H are indexed by both the state of the world, ω , as before, and the asset ownership allocation, (A_b, A_s) .

Consider what happens if, *ceteris paribus*, assets are taken, at date 0, from S and given to B . Then from (4.25) and (4.26), we know that β_b rises and β_s falls. This in turn means that p_L and p_H will be less sensitive to v than they were before, note that from (4.15) and (4.16) we get,

$$\frac{\partial p_L}{\partial v} = \frac{1}{2}((1 - \lambda) - \beta_b) \quad (4.28)$$

$$\frac{\partial p_H}{\partial v} = \frac{1}{2}((1 + \lambda) - \beta_b) \quad (4.29)$$

and both of these decrease. On the other hand, it is also clear that p_L and p_H become more sensitive to c , since

$$\frac{\partial p_L}{\partial c} = \frac{1}{2}((1 + \lambda) - \beta_s) \quad (4.30)$$

$$\frac{\partial p_H}{\partial c} = \frac{1}{2}((1 - \lambda) - \beta_s) \quad (4.31)$$

and these two increase.

It seems sensible to consider a reduction in sensitivity in p_L and p_H as good since if the interval $[p_L, p_H]$ does not vary to any great degree it will be easier to find a price p which lies within $[p_L, p_H]$ for many ω . This reduces the opportunity for hold-up. This suggest that it is optimal for B to own all of the assets if only v varies, because such an ownership structure minimises the sensitivity of p_L and p_H with respect to the state of the world. It also suggests that it is optimal to have S owning all the assets if only c varies. Proposition 8 notes this.

Proposition 8 (1) *Suppose that $\varphi = \epsilon = \eta \equiv 0$ and $c \equiv c_0$ where c_0 is a constant. Then there exists an optimal contract in which B owns all the assets, that is, $A_b = A$, $A_s = \emptyset$.*

(2) *Suppose that $\varphi = \epsilon = \eta \equiv 0$ and $v \equiv v_0$ where v_0 is a constant. Then there exists an optimal contract in which S owns all the assets, i.e., $A_s = A$, $A_b = \emptyset$. (Hart 2009: 282).*

Hart proves a more general version of Proposition 8, and the other propositions of this section, in the Appendix to his paper. The more general versions allow for a range of prices to be specified in the date 0 contract. The proofs are also given in the Proofs subsection below.

Proposition 8 has an obvious limitation in that it only tells us when one party should own everything. In general both v and c will vary. Hart makes progress by introducing the idea of an idiosyncratic asset. Define an asset to be idiosyncratic to B if B 's ownership of it increases the sensitivity of r_b to v and S not owning it has no effect on the sensitivity of r_s to c . An asset which is idiosyncratic to S is defined in a similar manner.

DEFINITION (i) Asset a is idiosyncratic to B if $\beta_b(A_b \cup \{a\}) > \beta_b(A_b)$ for all $A_b \subseteq A$, $A_b \cap \{a\} = \emptyset$ and $\beta_s(A_s \cup \{a\}) = \beta_s(A_s)$ for all $A_s \subseteq A$.

(ii) Asset a is idiosyncratic to S if $\beta_s(A_s \cup \{a\}) > \beta_s(A_s)$ for all $A_s \subseteq A$, $A_s \cap \{a\} = \emptyset$ and $\beta_b(A_b \cup \{a\}) = \beta_b(A_b)$ for all $A_b \subseteq A$. (Hart 2009: 283).

Hart explains this definition as

“[i]n other words, an asset is idiosyncratic to B if it is specific to B 's business and not to S 's, and vice versa for an asset idiosyncratic to S . Note that one reason an asset may be idiosyncratic to a party is that that party has human capital that is

complementary to the asset; for example, he is the only person who knows how to operate it. Under these conditions, taking away the asset from the other party is unlikely to affect the sensitivity of that party's outside option to the state of the world." (Hart 2009: 283).

While it would seem that allocating an asset to the party for whom it is idiosyncratic is desirable, since it reduces variability in the $[p_L, p_H]$ range, actually proving such a result requires making strong assumptions about the stochastic structure. In Proposition 9 Hart assumes that with high probability v, c take on "normal" values $v = v_0, c = c_0$, whereas with a low probability, v, c , can each take on "exceptional" values. Hart further assumes, that because exceptional values are very unlikely, the possibility that v and c will take on exceptional values simultaneously can be ignored. It is also assumed that there is a small amount of exogenous noise via the random variable φ , but $\varepsilon = \eta = 0$.

Proposition 9 *Assume that $\varepsilon = \eta = 0$ and that φ is uniformly distributed on $[-k, k]$. Suppose that with probability $0 < \pi < 1$, event 1 occurs: $v = v_0, c = c_0$; with probability $(1 - \pi)\alpha_v$ event 2 occurs: $c = c_0$, v has support $[v_L, v_H]$, where $v_L \leq v_0$ and*

$$v_H \geq \frac{-\beta_b(A)v_0 + (1 + \lambda)v_0 - 2\lambda c_0}{1 - \lambda - \beta_b(A)};$$

with probability $(1 - \pi)\alpha_c$ event 3 occurs: $v = v_0$, c has support $[c_L, c_H]$, where $c_H \geq c_0$ and

$$c_L \leq \frac{-\beta_s(A)c_0 - 2\lambda v_0 + (1 + \lambda)c_0}{1 - \lambda - \beta_s(A)}.$$

Here $\alpha_v > 0, \alpha_c > 0, \alpha_v + \alpha_c = 1, k > 0$, and φ is independent of v and c in events 2 and 3, respectively. Then, for small enough k , the following is true: if π is close to 1, it is uniquely optimal for B to own asset a if a is idiosyncratic to B and for S to own asset a if a is idiosyncratic to S . (Hart 2009: 283-4).

Proof: In the Appendix to Hart (2009). See also the Proofs subsection below.

Hart explains the use of such strong assumptions on the probability distribution of v and c as follows,

“[i]t is useful to understand why Proposition [9] requires such strong assumptions about the probability distribution of v and c . The reason is the following. Let p be the optimal price for the general case where v , c are uncertain. Suppose that we transfer an asset that is idiosyncratic to B from S to B . (In what follows, we suppress assets in the notation.) We know that this will reduce the variability of $p_L(\omega), p_H(\omega)$ with respect to v . But this might reduce the probability that p lies in $[p_L(\omega), p_H(\omega)]$ if, for example, $p \in [p_L(\omega_1), p_H(\omega_1)], p \notin [p_L(\omega_2), p_H(\omega_2)]$, and $[p_L(\omega_1), p_H(\omega_1)]$ moves closer to $[p_L(\omega_2), p_H(\omega_2)]$. The stochastic structure in Proposition [9] avoids this kind of situation.” (Hart 2009: 284)

Hart uses, as an example of an application of Proposition 9, the case of strictly complementary assets. Assume that assets a_1 and a_2 are strictly complementary, in the sense that they are valuable only when they are used together. So a_2 by itself is of no use to S , but a_1 and a_2 combined are of use to B . Suppose that B owns a_1 . Now we can define a new economy such that a_1 is always owned by B , i.e. a_1 is inalienable, and thus the set of alienable assets is $A \setminus \{a_1\}$. For this economy a_2 is idiosyncratic by Definition (i). Thus by Proposition 9 B should own a_1 and a_2 . The same basic argument will also show that if S owns a_1 it is optimal for S to own a_2 as well. The conclusion of this reasoning is that complementary assets should be held together. A similar line of reasoning results in the conclusion that joint ownership is suboptimal under the requirements of Proposition 9.

Thus far, Hart has emphasised the notion that ownership of an asset is good for one of the parties since it reduces the variability of that party’s payoff, via changes to v or c , relative to its outside option. It is, however, possible that asset ownership increases the variability of outside options relative to inside values. In such a situation, it may be better to take assets away from people. To consider this case, Hart holds the values of v and c constant and lets the values of φ and ε or η vary. Here he shows that joint ownership may be optimal.

Proposition 10 *Assume γ_b, γ_s are strictly increasing in A_b, A_s , respectively, and φ is uniformly distributed on $[-k, k]$. Suppose that with probability $0 < \pi < 1$, event 1 occurs: $v = v_0, c = c_0, \varepsilon = 0, \eta = 0$; with probability $(1 - \pi)\alpha_\varepsilon$, event 2 occurs: $v = v_0, c = c_0, \eta = 0, \varepsilon$ has support $[\varepsilon_L, \varepsilon_H]$,*

where

$$\varepsilon_L \leq \frac{2\lambda(c_0 - v_0)}{\gamma_b(\emptyset)}$$

and $\varepsilon_H > 0$; with probability $(1 - \pi)\alpha_\eta$, event 3 occurs: $v = v_0, c = c_0, \varepsilon = 0, \eta$ has support $[\eta_L, \eta_H]$, where

$$\eta_L \leq \frac{2\lambda(c_0 - v_0)}{\gamma_s(\emptyset)}$$

and $\eta_H > 0$. Here $\alpha_\varepsilon \geq 0, \alpha_\eta \geq 0, \alpha_\varepsilon + \alpha_\eta = 1, k > 0$, and φ is independent of ε and η in events 2 and 3, respectively. Then, for small enough k , the following is true: if π is close to 1, it is uniquely optimal for all assets to be jointly owned by B and S. (Hart 2009: 285).

Proof: In the Appendix to Hart (2009). See also the Proofs subsection below.

Section 4 of the paper deals with a discussion of the model and considers extensions of it. An important assumption used in the models above is that the date 0 contract is incomplete to such a degree that one party can threaten to violate it by refusing any form of cooperation and that it is impossible for a court to determine which party is at fault. This means that a party can, should they wish, threaten breach and thereby begin a lengthy and uncertain judicial process as a way of forcing renegotiation. This assumption is extreme in that outsiders have no information about who breached and so the default outcome (see A3) is independent of who holds up whom. Hart believes that the model generalises to cases where outsiders have some information and the default outcome can vary depending on who breaches.

Another assumption is that when hold up occurs the parties continue trading rather than going their separate ways. Dropping this condition leads to two new possibilities: first renegotiation is costless, so that after hold up and the trading relationship being terminated, the parties can renegotiate asset ownership. In this case the surplus obtained after hold up is independent of the date 0 allocation of assets. This case is unlikely to change Hart's result to any great degree due to A4. The second case is where there are frictions in the asset renegotiation process. Here the date 0 asset allocation will matter for not only when hold up occurs but also for how ex post surplus is determined when it does.

Another assumption Hart makes is that the parties can not commit not to renegotiate their contract. Without renegotiation, hold-up will not occur since it is not possible to change the terms of the original contract. But the parties would have the incentive to quit by refusing any

cooperation whenever their payoffs from their relationship are lower than their outside options, that is, when either $v - p < r_b$ for the buyer or $p - c < r_s$ for the seller. Inefficiency will still occur and asset ownership will still matter, but for different reasons. A no-renegotiation model would most likely look similar to the second case noted by where $A4$ does not hold. This is because in this case asset ownership will affect ex post surplus when the relationship breaks down.

Another assumption made above was that hold up sours the parties' relationship by the same amount regardless of the reasons leading to it. As an example consider two cases of seller hold-up. One case would be where the seller holds the buyer up because the buyer's value, v , has increased. Another case would be when the seller holds up the buyer because the seller's cost, c , have risen. While price rises in both these circumstances it could be argued that the buyer will view the seller's behaviour as less opportunistic in the second case than the first. The buyer may, therefore, be less angry in the second situation because without the price increase, the seller's profits would be negative and she would quit the relationship. Hart takes the alternative view that should the seller want the price to increase in certain situations they could have written this into the initial contract and thus the buyer thinks of both cases of hold-up as equally opportunistic.

The last section of Hart's paper is the Appendix in which he provides proofs for what have been referred to above as Propositions 8, 9 and 10. These proofs are outlined in the following section.

4.4.1 proofs

Hart opens his Appendix by noting that anticipating the possibility of hold-up, the contracting parties could build flexibility into their date 0 contract by specifying a range of possible prices $[p, \bar{p}]$. The idea being that the parties will agree on a price in the range $[p, \bar{p}]$ once the uncertainty is resolved at date 1-

Assume that the range $[p, \bar{p}]$ is agreed to by the parties, then the question that arises is, What happens at date 1- once ω is known. Hart considers two cases, one where hold-up can be avoided and the other where it can not.

First he defines

$$H(\omega, p, \bar{p}; A_b, A_s) = [p_L(\omega; A_b, A_s), p_H(\omega; A_b, A_s)] \cap [p, \bar{p}]$$

Clearly if $H \neq \emptyset$ then hold-up can be avoided by choosing a price in H . Such a price would be consistent with the date 0 contract and give no incentive to either party to hold-up the other. However should $H = \emptyset$ then hold-up can not be avoided.

In the first case, $H \neq \emptyset$, even though no hold-up occurs, there will still be disagreement about which outcome, from within those allowed by the contract, should be chosen. Hart assumes that each party will be aggrieved to the extent that they do not receive the outcome which they feel they are entitled to. They will respond to this by cutting back on helpful actions, that is, by shading. Hart makes the assumption that each party feels entitled to their best outcome from among those specified in the contract. But each party also recognises that they are constrained by the fact that the other party can trigger hold-up; and thus B does not expect to pay less than p_L or S to receive more than p_H . Moving outside of the $[p_L, p_H]$ range means that hold-up will be triggered. This means that B will feel entitled to the lowest price available in H , that is, $Max(p_L, \underline{p})$, while S feels entitled to the highest price in H , i.e. $Min(p_H, \bar{p})$.

To keep things simple Hart assumes that the parties split the difference and set the price, \hat{p} , midway between their entitlements, that is,

$$\hat{p} = \frac{1}{2} \{Max(p_L(\omega; A_b, A_s), \underline{p}) + Min(p_H(\omega; A_b, A_s), \bar{p})\} \quad (4.32)$$

In this case the parties agree to carry out all contractible helpful actions but as there is aggrievement each party shades by cutting back on the noncontractible helpful actions. Such a cut back is in proportion to each party's level of aggrievement. Here aggrievement is the difference between the actual payoff the party receives and the amount that party feels entitled to. Thus B is aggrieved by

$$a_b = \hat{p} - Max(p_L(\omega; A_b, A_s), \underline{p}) \quad (4.33)$$

and shades to the point where S 's payoff falls by θa_b . Similarly S is aggrieved and thus shades to the point where B 's payoff falls by θa_s . S 's aggrievement is given by

$$a_s = Min(p_H(\omega; A_b, A_s), \bar{p}) - \hat{p} \quad (4.34)$$

Note that θ is assumed to be exogenous and the same for both B and S , and $0 < \theta \leq 1$.

In the case where $H \neq \emptyset$, net surplus will be,

$$\begin{aligned} W_1(\omega, \underline{p}, \bar{p}; A_b, A_s) &= v - c - \theta(a_b + a_s) \\ &= v - c - \theta\{Min(p_H(\omega; A_b, A_s), \bar{p}) \\ &\quad - Max(p_L(\omega; A_b, A_s), \underline{p})\}. \end{aligned} \quad (4.35)$$

In the second case Hart considers, $H = \emptyset$ and thus hold-up occurs followed by renegotiation which results in net surplus of

$$W_2(\omega) = (1 - \lambda)(v - c). \quad (4.36)$$

One thing to note is that since hold-up results in all of the non-contractible helpful action being withdrawn while shading leads to the withdrawal of some of these actions, there is an implicit constraint that total shading costs can not be greater than total hold-up costs. This means that

$$W_1(\omega, \underline{p}, \bar{p}; A_b, A_s) \geq W_2(\omega). \quad (4.37)$$

Fortunately (4.37) has to hold since it implies that

$$\begin{aligned} v - c - \theta\{Min(p_H(\omega; A_b, A_s), \bar{p}) - Max(p_L(\omega; A_b, A_s), \underline{p})\} &\geq (v - c) - \lambda(v - c) \\ \Rightarrow -\theta\{Min(p_H(\omega; A_b, A_s), \bar{p}) - Max(p_L(\omega; A_b, A_s), \underline{p})\} &\geq -\lambda(v - c) \\ \Rightarrow \theta\{Min(p_H(\omega; A_b, A_s), \bar{p}) - Max(p_L(\omega; A_b, A_s), \underline{p})\} &\leq \lambda(v - c) \end{aligned}$$

and note that

$$\begin{aligned} Min(p_H(\omega; A_b, A_s), \bar{p}) - Max(p_L(\omega; A_b, A_s), \underline{p}) &\leq p_H(\omega; A_b, A_s) - p_L(\omega; A_b, A_s) \\ &= \lambda(v - c) \quad \text{using (4.10)} \end{aligned} \quad (4.38)$$

And given that $0 < \theta \leq 1$ the value of (4.35) must be even larger. This tells us that no matter how large the price range $[\underline{p}, \bar{p}]$ is, net surplus if hold-up does not occur is greater than if it is not avoided.

An optimal contract maximises expected net surplus, which means it solves,

$$\text{Max}_{(A_b, A_s, \underline{p}, \bar{p})} \left\{ \begin{array}{l} \int W_1(\omega, \underline{p}, \bar{p}; A_b, A_s) dF(\omega) + \int W_2(\omega) dF(\omega) \\ H(\omega, \underline{p}, \bar{p}; A_b, A_s) \neq \emptyset \quad H(\omega, \underline{p}, \bar{p}; A_b, A_s) = \emptyset \end{array} \right\} \quad (4.39)$$

where F is the distribution function of ω .¹² There is a trade-off in this optimisation problem as follows: As \underline{p} falls or \bar{p} rises, the range $[\underline{p}, \bar{p}]$ increases and the set H becomes larger and thus hold-up is less likely. This is advantageous since hold-up reduces surplus and thus hold-up being less likely increases the expected value. On the other hand, shading can also increase: $\theta\{\text{Min}(p_H, \bar{p}) - \text{Max}(p_L, \underline{p})\}$ rises and this means that surplus when hold-up does not occur falls; W_1 falls.

There is an obvious question to ask, Can the parties do better than specifying a price range as has been done above? For example, would a message game played after the state of the world has been revealed be of help? Or would it help if they agreed to an informal state-contingent contract using observable but not verifiable information? Hart and Moore (2008) argue that the answer in at least some circumstances is no.

Next Hart discusses the interpretation of the price range. The range can be seen in terms of the length of time over which the contract holds. Assume that date 1 trade is not instantaneous: that the parties trade over a length of time, say, between date 1 and 2. At date 0 they could agree on the length of their contract. An example would be where they agree on a trading price for a part of the period, say τ of the period, between dates 1 and 2. The parties can of course renegotiate their contract at date 1— at which time they can set a new price for the remaining $(1 - \tau)$ of the period. A low value for τ corresponds to a flexible contract. In this case there are many possible (average) prices over the period from an ex ante perspective. With a large value for τ the contract is much more rigid.

Next Hart turns to the proofs of what have been referred to as Propositions 8, 9 and 10 above.

Proof of Proposition 8: Part (1) of the Proposition will be proved. Let $(A_b, A_s, [\underline{p}, \bar{p}])$ be an optimal contract. Hart's proof proceeds in two steps. First he replaces $[\underline{p}, \bar{p}]$ with another price interval and shows that shading costs fall, if only weakly. Second, all the assets are allocated to

¹²Hart assumes that F has a bounded support. An optimal contract exists since the objective function is upper semicontinuous in $[\underline{p}, \bar{p}]$.

B and the price interval is changed again. It is shown that shading costs fall again and that the hold-up region becomes (weakly) smaller. This means that the new contract under which B is allocated all of the assets must also be optimal.

Index the state by v , the value of the widget to B . Let \underline{v} and \bar{v} be the smallest and largest values of v , respectively, in the support of F such that hold-up does not occur under the contract $(A_b, A_s, [\underline{p}, \bar{p}])$. Then

$$[p_L(v), p_H(v)] \cap [\underline{p}, \bar{p}] \neq \emptyset \quad (4.40)$$

for $v = \underline{v}$ and $v = \bar{v}$. Because $p_L(v)$ and $p_H(v)$ are increasing in v —see (4.15) and (4.16)—(4.40) must also hold for $\underline{v} \leq v \leq \bar{v}$. That is, hold-up does not occur for intermediate values of v . Note that (4.40) implies that $p_H(\underline{v}) \geq \underline{p}$ and $p_L(\bar{v}) \leq \bar{p}$.



Figure 194.1. Intersection of price ranges, with p_L, p_H increasing in v .

Next, define a new price interval, $[\underline{p}', \bar{p}']$, where

$$\underline{p}' = p_H(\underline{v}) \text{ and } \bar{p}' = \text{Max}(p_L(\bar{v}), p_H(\underline{v}))$$

Clearly, $\underline{p}' \geq \underline{p}$ since $p_H(\underline{v}) \geq \underline{p}$. Also, either $\bar{p}' \leq \bar{p}$ since $p_L(\bar{v}) \leq \bar{p}$, or $\bar{p}' = p_H(\underline{v}) = \underline{p}'$. In the first case, it is clear that the new price range is a subset of the previous price interval. In the second case, it is a singleton. In both of these cases

$$[p_L(v), p_H(v)] \cap [\underline{p}', \bar{p}'] \neq \emptyset$$

for $\underline{v} \leq v \leq \bar{v}$. Thus, the new price range avoids hold-up for $\underline{v} \leq v \leq \bar{v}$, just as the old interval did. Note also that aggrivement and shading costs are lower under the new price interval, given that either the new price range is a subset of the previous price interval or it is a singleton. Being a singleton means that shading costs are zero.

In the second part Hart assigns all the assets to B ; that is, he sets $A_b = A, A_s = \emptyset$. He calls

this the new ownership structure. He defines a new price interval $[\underline{p}'', \bar{p}'']$, where

$$\underline{p}'' = p_H^N(\underline{v}) \text{ and } \bar{p}'' = \text{Max}(p_L^N(\bar{v}), p_H^N(\underline{v})) \tag{4.41}$$

for which p_L^N and p_H^N are the values of p_L and p_H under the this new ownership structure. The price range $[\underline{p}'', \bar{p}'']$ avoids hold-up under the new ownership structure when $\underline{v} \leq v \leq \bar{v}$. To see this note that $\underline{p}'' = p_H^N(\underline{v})$ and either $\bar{p}'' = p_L^N(\bar{v})$ (A1) or $\bar{p}'' = p_H^N(\underline{v})$ (A2). Also we want

$$[p_L^N(\underline{v}), p_H^N(\underline{v})] \cap [\underline{p}'', \bar{p}''] \neq \emptyset \tag{A}$$

and

$$[p_L^N(\bar{v}), p_H^N(\bar{v})] \cap [\underline{p}'', \bar{p}''] \neq \emptyset \tag{B}$$

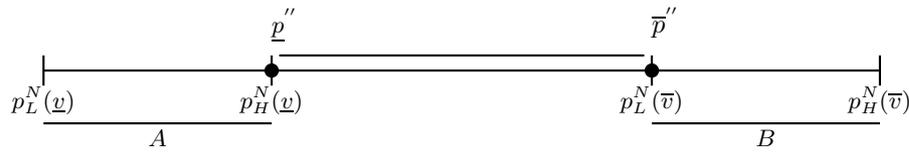


Figure 195.1. Intersection of price ranges, case A1.

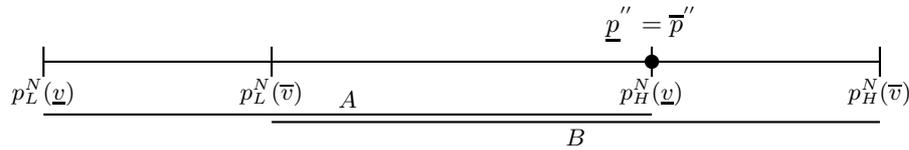


Figure 195.2. Intersection of price ranges, case A2.

Given that $p_L^N(v)$ and $p_H^N(v)$ are increasing in v the price range $[\underline{p}'', \bar{p}'']$ avoids hold-up under the new ownership structure when $\underline{v} \leq v \leq \bar{v}$.

Next it has to be shown that shading costs are lower for each $\underline{v} \leq v \leq \bar{v}$ under the new ownership structure and price range $[\underline{p}'', \bar{p}'']$ than under the previous ownership structure and $[\underline{p}', \bar{p}']$. Note that the previous ownership structure and price range $[\underline{p}', \bar{p}']$ has shading costs lower than under the previous ownership structure and the price range $[\underline{p}, \bar{p}]$. What needs to be shown is that

$$\begin{aligned} \text{Min}(p_H^N(v), \bar{p}'') & - \text{Max}(p_L^N(v), \underline{p}'') \\ & \leq \text{Min}(p_H(v), \bar{p}') - \text{Max}(p_L(v), \underline{p}') \end{aligned} \tag{4.42}$$

There are several cases that need to be dealt with. Note that if $\underline{p}' = \bar{p}' = p_H(\underline{v}) \geq p_L(\bar{v})$, that is, the RHS of (4.42) is zero; to see this note that the RHS will be equal to

$$\text{Min}(p_H(v), p_H(\underline{v})) - \text{Max}(p_L(v), p_H(\underline{v}))$$

As $p_H(v)$ is increasing in v and \underline{v} is the smallest v for which hold-up does not occur, $p_H(v) \geq p_H(\underline{v})$ and as $p_L(v) \leq p_H(\underline{v})$ we get

$$\begin{aligned} \text{Min}(p_H(v), p_H(\underline{v})) - \text{Max}(p_L(v), p_H(\underline{v})) &= p_H(\underline{v}) - p_H(\underline{v}) \\ &= 0. \end{aligned}$$

Then to determine which is the maximum of $p_H^N(\underline{v})$ and $p_L^N(\bar{v})$ note that

$$\begin{aligned} p_H^N(\underline{v}) - p_L^N(\bar{v}) &= p_H^N(\bar{v}) - p_H^N(\bar{v}) + p_H^N(\underline{v}) - p_L^N(\bar{v}) \\ &= -(p_H^N(\bar{v}) - p_H^N(\underline{v})) + p_H^N(\bar{v}) - p_L^N(\bar{v}) \\ &\geq -(p_H(\bar{v}) - p_H(\underline{v})) + p_H(\bar{v}) - p_L(\bar{v}) \\ &= p_H(\underline{v}) - p_L(\bar{v}) \\ &\geq 0. \end{aligned}$$

where we are using the fact that from (4.10) we know $p_H^N(\bar{v}) - p_L^N(\bar{v}) = p_H(\bar{v}) - p_L(\bar{v})$ and thus $p_H - p_L$ is independent of the ownership structure; and that $p_H^N(\bar{v}) - p_H^N(\underline{v}) \leq p_H(\bar{v}) - p_H(\underline{v})$ which is true since $\frac{\partial p_H}{\partial v}$ falls as B owns more assets, see (4.29) and Figure 197.1.

Thus $p_H^N(\underline{v}) \geq p_L^N(\bar{v})$. It follows therefore from (4.41) that $\underline{p}'' = \bar{p}'' = p_H^N(\underline{v})$ and so the LHS of (4.42) is zero. This means that (4.42) holds.

Next consider the case where $\underline{p}' = p_H(\underline{v}) < \bar{p}' = p_L(\bar{v})$ and $\underline{p}'' = \bar{p}'' = p_H^N(\underline{v}) \geq p_L^N(\bar{v})$. The LHS of (4.42) is

$$\begin{aligned} \text{Min}(p_H^N(v), \bar{p}'') - \text{Max}(p_L^N(v), \underline{p}'') &= \text{Min}(p_H^N(v), p_H^N(\underline{v})) - \text{Max}(p_L^N(v), p_H^N(\underline{v})) \\ &= p_H^N(\underline{v}) - p_H^N(\underline{v}) \\ &= 0. \end{aligned}$$

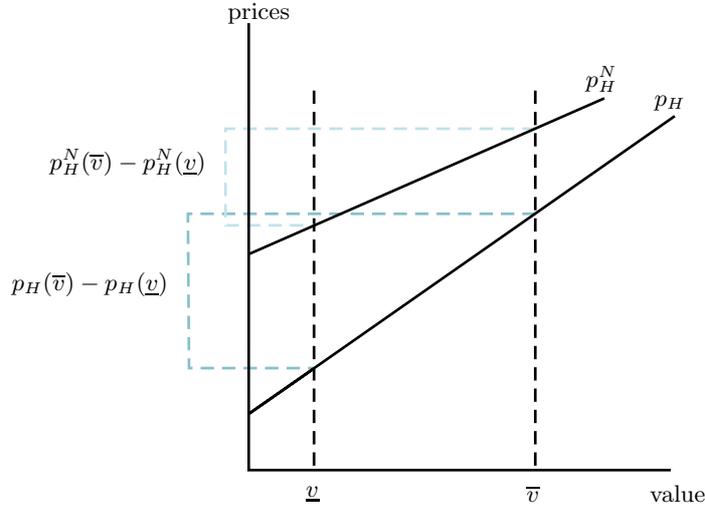


Figure 197.1.

This clearly is true for all $\underline{v} \leq v \leq \bar{v}$ since $p_H^N(v) \geq p_H^N(\underline{v})$ for $\underline{v} \leq v \leq \bar{v}$ and $p_H^N(\underline{v}) \geq p_L^N(\bar{v})$ by assumption. Thus for (4.42) to hold the RHS ≥ 0 .

The RHS of (4.42) is

$$\text{Min}(p_H(v), \bar{p}') - \text{Max}(p_L(v), \underline{p}') = \text{Min}(p_H(v), p_L(\bar{v})) - \text{Max}(p_L(v), p_H(\underline{v}))$$

with $p_H(v) \geq p_L(v)$ for $\underline{v} \leq v \leq \bar{v}$ and $p_H(v) \geq p_H(\underline{v})$ for $\underline{v} \leq v \leq \bar{v}$ along with $p_L(\bar{v}) \geq p_L(v)$ for $\underline{v} \leq v \leq \bar{v}$ and $p_L(\bar{v}) \geq p_H(\underline{v})$ by assumption. Thus RHS ≥ 0 and so (4.42) holds.

Now assume $\underline{p}' = p_H(\underline{v}) < \bar{p}' = p_L(\bar{v})$ and $\underline{p}'' = p_H^N(\underline{v}) \leq p_L^N(\bar{v}) = \bar{p}''$. Here we have to show that

$$\begin{aligned} \text{Min}(p_H^N(v), p_L^N(\bar{v})) - \text{Max}(p_L^N(v), p_H^N(\underline{v})) \\ \leq \text{Min}(p_H(v), p_L(\bar{v})) - \text{Max}(p_L(v), p_H(\underline{v})) \end{aligned} \quad (4.43)$$

(4.43) can be rewritten in the form

$$\begin{aligned} \text{Min}\{p_H^N(v) - p_H^N(\underline{v}), p_L^N(\bar{v}) - p_H^N(\underline{v}), \\ p_H^N(v) - p_L^N(v), p_L^N(\bar{v}) - p_L^N(v)\} \\ \leq \text{Min}\{p_H(v) - p_H(\underline{v}), p_L(\bar{v}) - p_H(\underline{v}), \\ p_H(v) - p_L(v), p_L(\bar{v}) - p_L(v)\} \end{aligned} \quad (4.44)$$

To demonstrate that (4.44) holds we need to show that each component in the min formula on the

LHS of (4.44) is no larger than the corresponding component in the min formula on the RHS of (4.44). This follows from the facts that the two partial derivatives $\frac{\partial p_H}{\partial v}$ and $\frac{\partial p_L}{\partial v}$ are nonincreasing in the assets that B is allocated and that $p_H - p_L$ is independent of the ownership structure for a given value of v . Thus (4.43) holds and therefore so does (4.42).

Hart summarizes the proof by saying that the new ownership structure (in which all assets are allocated to B) and price interval $[\underline{p}'', \bar{p}'']$ result in (weakly) lower shading costs than the original ownership structure and price range $[\underline{p}, \bar{p}]$. Also, the region in which hold-up does occur, remembering that hold-up does not occur for $\underline{v} \leq v \leq \bar{v}$, is no larger. This shows that allocating all assets to B is optimal. ■

Proof of Proposition 9: Assume that a is idiosyncratic to B . Hart shows that B should own a . His proof is by contradiction. If the proposition is false, then it can not be optimal for B to own the asset no matter how small we make k , and thus however small k is we can construct a sequence of optimal contracts $(A_{br}, A_{sr}, \underline{p}_r, \bar{p}_r)$ such that $a \in A_{sr}$ for all r ; that is S owns asset a , and $\pi_r \rightarrow 1$ as $r \rightarrow \infty$. Without loss of generality, (WOLG), assume that $A_{br} \rightarrow A_b(k)$, $A_{sr} \rightarrow A_s(k)$, $\underline{p}_r \rightarrow \underline{p}(k)$, and $\bar{p}_r \rightarrow \bar{p}(k)$. Then $(A_b(k), A_s(k), \underline{p}(k), \bar{p}(k))$ must be optimal for the case where event 1 occurs with probability 1. For small k , the first-best can be achieved (exactly) in event 1, because there is almost no uncertainty. A necessary condition for this is that there is a single trading price $p(k)$ in the limit, that is, $\underline{p}(k) = p(k) = \bar{p}(k)$ (so that shading costs are zero), and

$$p_L(\omega, A_b(k), A_s(k)) \leq \underline{p}(k) = p(k) = \bar{p}(k) \leq p_H(\omega, A_b(k), A_s(k)) \quad (4.45)$$

(so there is no hold-up) for all $-k \leq \varphi \leq k$, where $\omega = (v_0, c_0, \varphi)$ and we now suppress $\varepsilon = 0, \eta = 0$. Here, p_L, p_H are given by (4.15) and (4.16) and are indexed by the limiting ownership structure.

Next consider a new sequences of contracts, denoted $(A'_{br}, A'_{sr}, \underline{p}'_r, \bar{p}'_r)$ where the only difference between this sequence of contracts and the previous one is that asset a has been transferred from S to B , and

$$\underline{p}'_r - \underline{p}_r = \bar{p}'_r - \bar{p}_r$$

$$\begin{aligned}
&= \frac{1}{2}[\alpha_s(A_{sr} \setminus \{a\}) - \alpha_s(A_{sr}) \\
&+ \alpha_b(A_{br}) - \alpha_b(A_{br} \cup \{a\}) \\
&+ \beta_b(A_{br})v_0 - \beta_b(A_{br} \cup \{a\})v_0] \tag{4.46} \\
&= \Delta_r(k) \\
& (= \Delta p_L = \Delta p_H.)
\end{aligned}$$

In words, we adjust \underline{p}_r and \bar{p}_r by an amount equal to the change, $\Delta p_L, \Delta p_H$, in p_L and p_H that occurs as a result of the shift in ownership structure, where $\Delta p_L, \Delta p_H$ are being evaluated at $v = v_0$. Remember that because of the assumption that a is idiosyncratic to B , $\Delta p_L, \Delta p_H$ depend on v but not on c , or for that matter φ .

Next Hart asks: What happens to expected net surplus as a result of this change? The expected net surplus is the weighted average of the surplus in each of the three events 1,2,3. As all of $\underline{p}_r, \bar{p}_r, p_{Lr}(\omega), p_{Hr}(\omega)$, shift by the same amount, Δ_r , when $v = v_0$, nothing changes in event 1 and 3 for all r . That is, for each state, ω , hold-up occurs if and only if it did before and the level of shading costs if hold-up does not occur remains constant. Thus, net surplus is unchanged in events 1 and 3.

Note that the new contract can not result in higher net surplus than the original contract since the original contract was optimal. Thus it must be that the net surplus in event 2 must be (weakly) lower for the new contract. Let $r \rightarrow \infty$. WLOG $(A'_{br}, A'_{sr}, \underline{p}'_r, \bar{p}'_r) \rightarrow (A'_b(k), A'_s(k), \underline{p}'(k), \bar{p}'(k))$ and $\Delta_r(k) \rightarrow \Delta(k)$. Given (4.45) and (4.46) we must have,¹³

$$p_L(\omega, A'_b(k), A'_s(k)) \leq \underline{p}'(k) = p'(k) = \bar{p}'(k) \leq p_H(\omega, A'_b(k), A'_s(k)). \tag{4.47}$$

for all $-k \leq \varphi \leq k$, where $\omega = (v_0, c_0, \varphi)$. From the arguments given above we know that the contract $(\underline{p}'(k), \bar{p}'(k), A'_b(k), A'_s(k))$ delivers no greater surplus than the contract $(\underline{p}(k), \bar{p}(k), A_b(k), A_s(k))$ in event 2.

Next Hart shows this conclusion to be false. Because both the primed and the unprimed contracts have a single trading price – $p'(k)$ and $p(k)$ respectively – shading costs are zero for

¹³ $p_L(\omega, A'_b(k), A'_s(k)) = p_L(\omega, A_b(k), A_s(k)) + \Delta p_L, p_H(\omega, A'_b(k), A'_s(k)) = p_H(\omega, A_b(k), A_s(k)) + \Delta p_H, \underline{p}'(k) = \underline{p}(k) + \Delta(k), \bar{p}'(k) = \bar{p}(k) + \Delta(k)$ where $\Delta p_L = \Delta p_H = \Delta(k)$.

both contracts. Hart demonstrates that there is less hold-up for the primed contracts. Because we are in event 2, index the state by (v, φ) . Then from (4.46) we get

$$\begin{aligned}
p'(k) - p(k) &= p_L((v_0, \varphi), A'_b(k), A'_s(k)) - p_L((v_0, \varphi), A_b(k), A_s(k)) \\
&= p_H((v_0, \varphi), A'_b(k), A'_s(k)) - p_H((v_0, \varphi), A_b(k), A_s(k)) \\
&= \Delta(k).
\end{aligned} \tag{4.48}$$

for all φ . We know that hold-up occurs under the primed contract in state (v, φ) if and only if either $p'(k) < p_L((v, \varphi), A'_b(k), A'_s(k))$ or $p'(k) > p_H((v, \varphi), A'_b(k), A'_s(k))$. Consider the first case: given (4.47) and the fact that p_L is increasing in v , $p'(k) < p_L((v, \varphi), A'_b(k), A'_s(k))$ only if $v > v_0$. But, if $v > v_0$ then

$$\begin{aligned}
&p_L((v, \varphi), A'_b(k), A'_s(k)) - p_L((v_0, \varphi), A'_b(k), A'_s(k)) \\
&= \frac{1}{2}[(1 - \lambda) - \beta_b(A_b \cup \{a\})](v - v_0) \\
&< \frac{1}{2}[(1 - \lambda) - \beta_b(A_b)](v - v_0) \\
&= p_L((v, \varphi), A_b(k), A_s(k)) \\
&\quad - p_L((v_0, \varphi), A_b(k), A_s(k))
\end{aligned} \tag{4.49}$$

because a is idiosyncratic to B . From (4.48) and (4.49) we are able to conclude that $p'(k) < p_L((v, \varphi), A'_b(k), A'_s(k)) \Rightarrow p(k) < p_L((v, \varphi), A_b(k), A_s(k))$.¹⁴ This means that hold-up occurs in the unprimed contract if it occurs in the primed contract. A similar argument shows that $p'(k) > p_H((v, \varphi), A'_b(k), A'_s(k)) \Rightarrow p(k) > p_H((v, \varphi), A_b(k), A_s(k))$. Putting these two arguments together, we can conclude that hold-up costs are weakly lower in the primed contract than the unprimed one. In fact they are strictly lower: this follows from the assumption about the support

¹⁴From (4.49) we know

$$\begin{aligned}
p_L((v, \varphi), A'_b(k), A'_s(k)) - p_L((v_0, \varphi), A'_b(k), A'_s(k)) &< p_L((v, \varphi), A_b(k), A_s(k)) - p_L((v_0, \varphi), A_b(k), A_s(k)) \\
\Rightarrow p_L((v, \varphi), A'_b(k), A'_s(k)) - p_L((v, \varphi), A_b(k), A_s(k)) &< p_L((v_0, \varphi), A'_b(k), A'_s(k)) - p_L((v_0, \varphi), A_b(k), A_s(k)) \\
\Rightarrow p_L((v, \varphi), A'_b(k), A'_s(k)) - p_L((v, \varphi), A_b(k), A_s(k)) &< p'(k) - p(k) \quad \text{using (4.48)} \\
&\Rightarrow p_L((v, \varphi), A'_b(k), A'_s(k)) - p'(k) < p_L((v, \varphi), A_b(k), A_s(k)) - p(k).
\end{aligned}$$

thus if the LHS is positive then the RHS is as well and thus hold-up occurs in the unprimed contract if it occurs in the primed contract.

of v in Proposition 9, which ensures that $p_L((v, \varphi), A_b(k), A_s(k)) > p_H((v_0, \varphi), A_b(k), A_s(k))$ for large v and φ close to zero (i.e. hold-up does sometimes occur) but not for v close to v_0 (i.e., hold-up does not always occur).¹⁵ Contradiction. ■

Proof of Proposition 10: For Proposition 10 Hart just sketches the proof as its method of argument is very similar to that used in the proof of Proposition 9 which was just given. He starts by assuming that joint ownership is not optimal and then shows this results in a contradiction. For small k , choose a sequence of optimal contracts as $\pi \rightarrow 1$. The limiting contract is optimal for event 1. Thus it must be that (4.45) holds. Next consider a new sequence of contracts where all assets are jointly owned and \underline{p}_r and \bar{p} are adjusted to reflect the new ownership structure, that

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$$\begin{aligned}
p_L((v, \varphi), A_b(k), A_s(k)) &= \frac{1}{2}[\alpha_s - \alpha_b + \varphi + ((1 - \lambda) - \beta_b)v + ((1 + \lambda) - \beta_s)c_0] \\
&\text{since } \varepsilon = \eta = 0, c = c_0. \\
p_H((v_0, \varphi), A_b(k), A_s(k)) &= \frac{1}{2}[\alpha_s - \alpha_b + \varphi + ((1 - \lambda) - \beta_b)v_0 + ((1 + \lambda) - \beta_s)c_0] \\
p_L((v, \varphi), A_b(k), A_s(k)) &= p_H((v_0, \varphi), A_b(k), A_s(k)) \\
\Rightarrow ((1 - \lambda) - \beta_b)v + ((1 + \lambda) - \beta_s)c_0 &= ((1 - \lambda) - \beta_b)v_0 + ((1 + \lambda) - \beta_s)c_0 \\
&\text{since all other variables cancel.} \\
\Rightarrow ((1 - \lambda) - \beta_b)v &= ((1 - \lambda) - \beta_b)v_0 + ((1 + \lambda) - \beta_s)c_0 - ((1 + \lambda) - \beta_s)c_0 \\
&= (1 + \lambda)v_0 - \beta_b v_0 + (1 - \lambda)c_0 - \beta_s c_0 - (1 + \lambda)c_0 + \beta_s c_0 \\
&= (1 + \lambda)v_0 - \beta_b v_0 + c_0 - \lambda c_0 - c_0 - \lambda c_0 \\
&= (1 + \lambda)v_0 - \beta_b v_0 - 2\lambda c_0 \\
v &= \frac{(1 + \lambda)v_0 - \beta_b v_0 - 2\lambda c_0}{(1 - \lambda) - \beta_b}
\end{aligned}$$

Thus for $v \geq \frac{(1 + \lambda)v_0 - \beta_b v_0 - 2\lambda c_0}{(1 - \lambda) - \beta_b}$ we have $p_L((v, \varphi), A_b(k), A_s(k)) > p_H((v_0, \varphi), A_b(k), A_s(k))$ (‡).

From (4.48) we can deduce that $p_H((v_0, \varphi), A_b(k), A_s(k)) - p_L((v_0, \varphi), A_b(k), A_s(k)) = p_H((v_0, \varphi), A'_b(k), A'_s(k)) - p_L((v_0, \varphi), A'_b(k), A'_s(k))$.

From (4.49) we see that $p_L((v, \varphi), A'_b(k), A'_s(k)) - p_L((v_0, \varphi), A'_b(k), A'_s(k)) < p_L((v, \varphi), A_b(k), A_s(k)) - p_L((v_0, \varphi), A_b(k), A_s(k))$.

Thus for a large enough v – that is, close enough to v_H – and a small enough φ , using ‡, there will be no overlap between the ranges

$$[p_L((v_0, \varphi), A_b(k), A_s(k)), p_H((v_0, \varphi), A_b(k), A_s(k))]$$

and

$$[p_L((v, \varphi), A_b(k), A_s(k)), p_H((v, \varphi), A_b(k), A_s(k))],$$

and thus hold-up, but there will be overlap between the ranges

$$[p_L((v_0, \varphi), A'_b(k), A'_s(k)), p_H((v_0, \varphi), A'_b(k), A'_s(k))]$$

and

$$[p_L((v, \varphi), A'_b(k), A'_s(k)), p_H((v, \varphi), A'_b(k), A'_s(k))]$$

and thus no hold-up.

is,

$$\begin{aligned} \underline{p}'_r - \underline{p}_r &= \bar{p}'_r - \bar{p}_r \\ &= \frac{1}{2}[\alpha_s(\emptyset) - \alpha_s(A_{sr}) - \alpha_b(\emptyset) + \alpha_b(A_{br}) \\ &\quad - \beta_s(\emptyset)c_0 + \beta_s(A_{sr})c_0 - \beta_b(\emptyset)v_0 + \beta_b(A_{br})v_0]. \end{aligned}$$

Then the surplus does not change in event 1. Because the initial contract is optimal, surplus must weakly fall in either event 2 or 3. WLOG suppose it falls in event 2. Take limits as $r \rightarrow \infty$. The limiting joint ownership contract has the property the p_L and p_H very less with ε than under the original, but this makes hold-up less likely. Hence, the joint ownership contract creates higher net surplus. Contradiction. ■

4.5 Hart and Holmström (2009)¹⁶

In the Introduction to their paper Hart and Holmström, (HH), explain that they present a new model of the boundaries of the firm, which takes into account strategic decisions that are taken in the absence of *ex post* bargaining. The absence of bargaining being important because the assumption that *ex post* conflict is resolved via bargaining is one feature that has limited the applicability of the standard property rights approach to the firm. To justify the use of authority rather than bargaining HH follow Hart and Moore (2008) and take a “contracts as reference points” approach. Under this approach an organisational form or contract, which has been negotiated under competitive conditions, circumscribes the parties’ feelings of entitlement. The parties do not see themselves as being entitled to outcomes outside of the contract but may have very different ideas as to what they are entitled to within the contract. It is assumed that the parties will interpret the contract in a manner most advantageous to their own interests. Should it happen that they do not get their most favoured outcome, each party will feel aggrieved and will therefore shade on their performance by performing in a perfunctory rather than a consummate manner. Shading hurts the other party and results in a deadweight loss.

The HH model assumes there are two ‘units’ involved in a lateral relationship. A unit is

¹⁶The current discussion of this paper is based on the working paper version, Hart and Holmström (2009), while the published version has recently appeared as Hart and Holmström (2010).

thought of as an irreducible set of activities for which it would be pointless to break up any further. Each of the units is operated by a manager who has to take a decision which effects the other unit. What HH are considering is a decision so significant that it warrants the consideration as to the organisational form which best supports it. An example would be where the units are deciding on the adoption of a common standard or platform for their technology.

The two managers of the units have a binary, “Yes” or “No”, decision to make. HH assume that there are only two aggregate outcomes, which they denote as “coordination” and “non-coordination”. If, and only if, both units choose Yes do we get coordination. That is, either party can veto coordination by selecting No.

HH also assume that the decision by each unit is *ex ante* non-contractible but it is *ex post* contractible. Each unit has a boss. Importantly the boss has the right to make the decision in his unit *ex post*.¹⁷ In the simplest of the HH models the boss is equivalent to the owner but in later models HH allow the boss and the owner to differ. HH consider two forms of organisation: non-integration and integration. Under non-integration the units are separate firms and the managers of the units are the bosses which mean they make the Yes/No decisions. Integration means that the two units are part of the same firm and a third party manager is the boss and thus takes the Yes/No decision. In this case the boss instructs the unit managers to choose either Yes or No and the manager follow these orders, that is, such instructions are contractible. The two managers can, however, shade on performance.

An important factor in the HH model is the assumption that each unit creates two forms of benefits: monetary profit, which is transferable with ownership, and private benefits which are not transferable. These private benefits can be thought of as a measure of job satisfaction, broadly defined. The private benefits can also be thought of as representing the different beliefs held by managers and workers about the consequences of the strategic decisions taken by their firm.

The importance of the two types of benefits in the model can be illustrated in the following way. Let the pair (v_A, w_A) $[(v_B, w_B)]$ denote the profits and private benefits accruing to unit A [B]. HH assume that the manager of each unit is the only worker for that unit and thus the private benefits are measure of his job satisfaction. They also assume that the boss of the unit

¹⁷In other words, the boss has residual controls rights.

can divert all profit from that unit to themselves.

If the two units are non-integrated and the manager of unit A [B] is also the boss of unit A [B] then the payoff for the manager of A [B] is $v_A + w_A$ [$v_B + w_B$] since he diverts all profits to himself and cares about his own personal benefits. If, on the other hand, the two units are integrated, then, assuming an outside manager is the boss, her payoff will be $v_A + v_B$ since she diverts all profits to herself and does not care about any private benefits. HH use as a benchmark social surplus equal to $v_A + v_B + w_A + w_B$.

HH note that the key point is that under integration less weight is placed on private benefits than under non-integration. Under non-integration one of w_A, w_B appears in each of the boss's objective function while under integration neither w appears in the overall objective function. Offsetting this under appreciation of the importance of the private benefits is the fact that under integration, total profits, and not individual unit profits are maximised.

So far the effects of deadweight losses due to shading have been ignored. Taking these into account complicates the analysis somewhat. Shading does bring about some internalisation of externalities: a boss will place some weight on the payoff of the other parties given that they can shade.

HH assume that the ability to shade under non-integration depends on the relationship that exists between the two parties. If the relationship is one of "non-integration without cooperation" then shading is not possible. This is because the relationship between the units is limited and it will be terminated should non-coordination occur. In the case of "non-integration with cooperation" the relationship continues and shading can take place even under non-cooperation. Under integration HH suppose that shading is always possible.

In summary HH write,

"[. . .] under non-integration, bosses have the right balance between private benefits and profits, but are parochial (they do not take into account their effect on the other unit), while, under integration, they have the right balance between units, but ignore private benefits. In our model, where the only issue is whether the units coordinate, we show that non-integration and integration make the opposite kind of mistake. Non-integration can lead to too little coordination when the benefits from coordination are unevenly divided across the units. One unit may then veto coordination even though

it is collectively beneficial. In contrast, under a weak assumption—specifically, that coordination represents a reduction in “independence” and therefore causes a fall in private benefits—integration leads to too much coordination.” (Hart and Holmström 2009: 6-7).

In an extension to their model HH allow for delegation under integration. A reversal of delegation is seen as a “breach of promise” by subordinates and this results in aggrievement. Such aggrievement acts as a commitment device with the boss reversing herself only in “extreme” states of the world. HH show that delegation under integration is a useful intermediate organisational form situated between non-integration and integration. If the boss allows delegation, the managers will get their way in those states of the world where decisions matter significantly more to them than to the boss. On the other hand, in states of the world where the boss cares a lot about the outcome, either the managers will do what the boss wants of their own accord, given the threat of shading by the boss, or the boss will reverse her decision allowing delegation.

Section 2 of the HH paper is “A Basic Model of Coordination”. The HH model considers two units A and B that have a lateral relationship. The units operate in the same input or output markets. Each unit has no workers but does have a manager. A decision has to be made by each unit that affects the other unit. The strategic coordination decision is modelled as a binary “Yes” (Y), “No” (N) choice. HH assume there are two aggregate outcomes which they refer to as “coordination” or “non-coordination”. Coordination will occur if and only if both units choose Y.

The time line is given in Figure 205.1.

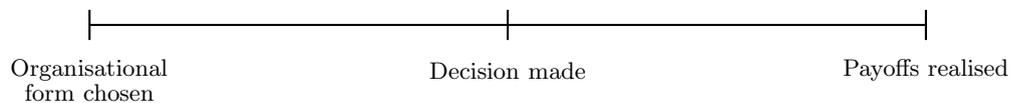


Figure 205.1. Time line.

(Hart and Holmström 2009: Figure I)

At the start an organisation form is chosen, then each unit gets to choose Y or N and lastly the payoffs are realised. The choice of organisation form is between having the two units as separate firms (non-integration, i.e. there are two bosses) or having just one firm with each unit being a division of that firm (integration, i.e. there is one boss).

There are two types of payoffs generated within each unit: a monetary profit, v , and private (and non-transferable) benefits, w . w are a (monetary) measure of the job satisfaction of the manager of each unit. Importantly HH assume that the boss of a unit can divert all profits generate by that unit to herself. Private benefits, on the other hand, must always remain with the manager. HH use Table 206.1 to represent the payoffs from the different outcomes. HH state that they assume that payoffs are non-transferable and perfectly certain. They normalise so that the monetary profits and private benefits under non-coordination are zero for both units.

		Unit B	
		Y	N
Unit	Y	A: $\Delta v_A, \Delta w_A$	A: 0,0
	B:	$\Delta v_B, \Delta w_B$	B: 0,0
A	A:	0,0	A: 0,0
	N	0,0	B: 0,0

Table 206.1. Payoff matrix.

(Hart and Holmström 2009: Table I)

In Table 206.1 Unit A is the row player and Unit B is the column player and v represents profit and w the private benefits. Subscripts denote the unit concerned.

HH now introduce some additional notation:

$$\Delta z_A \equiv \Delta v_A + \Delta w_A, \quad \Delta z_B \equiv \Delta v_B + \Delta w_B \quad (4.50)$$

Here Δz_A [Δz_B] represents the change in total surplus, profits plus private surplus, in unit A [unit B] from a move to coordination and $\Delta z_A + \Delta z_B$ equals the change in aggregate total surplus. Note that equation (4.50) does not take into account the costs due to aggrievement, which depends on the *ex ante* contract in addition to the *ex post* decision.

As noted above the private benefits can be seen as a measure of the job satisfaction or on-the-job consumption. HH suppose that part of job satisfaction is the ability to take an independent course of action and thus assume that coordination results in a reduction in private benefits.

That is,

$$\Delta w_A \leq 0, \Delta w_B \leq 0. \quad (4.51)$$

They place no restrictions on whether profits are greater or lower under coordination and, further more, they make no assumption as to whether even if profits are increased by coordination that increase is greater than the fall in private benefits.

HH's focus is on two main organisational forms:

1. Non-integration: Manager A is the boss of unit A and manager B is the boss of unit B with the payoff to manager A being $v_A + w_A$ and that of manager B being $v_B + w_B$. Each manager diverts all his units profits to himself and receives the private benefits from his unit.
2. Integration: An outsider manager is the boss of both of both units and managers A and B are subordinates. The boss receives $v_A + v_B$. The unit managers' remuneration amounts to a fixed wage and the private benefits of his unit.

Organisational form and contracts are determined *ex ante*. At this stage the coordination decision are assumed to be so complicated that they can not be contracted upon. However authority to make these decisions can be allocated. It is assumed that the boss of each unit has the residual rights of control and thus has the authority to take the Y/N decision for her unit. These Y/N decisions can be contracted upon *ex post*. Each of the unit managers chooses Y or N for his unit under non-integration while the overall boss instructs the two unit managers as to which of the two options they should choose under integration. HH suppose that the unit managers must follow the boss's commands as they are contractible but they also assume that the managers can shade. Shading can also take place under non-integration.

HH use the "contracts as reference points" approach of Hart and Moore (2008) to justify the particular contracting assumptions they make. Specifically HH assume that each party feels entitled to their most preferred outcome or the best decision allowed by the contract and any party which receives k_i less than that outcome will feel aggrieved by k_i . This aggrievement will result in shading that will lower the other parties payoff by θk_i . Here θ is an exogenous shading parameter which is assumed to be the same for all parties and $0 < \theta < 1$. The total deadweight loss from shading is therefore $\theta \sum_i k_i$.

The notion that contracts act as reference points provides a reason for the parties to wish to pin down as many things as possible in the initial contract. A contract which specifies too little leaves the door open for aggrievement and thus shading *ex post*. The problem with a very rigid contract is that it makes it hard for the parties to adjust to any changes in conditions. In the HH model there is no payoff uncertainty, however, their assumption that decisions are contractible only *ex post* means that changes in circumstances makes the *ex ante* choice of organisational form relevant for the deadweight losses that result from aggrievement.

The ability to shade can depend upon the nature of the transaction that the party is involved in. Under “non-integration without cooperation” the relationship between the parties ends if cooperation does not take place and thus the shading possibilities are greatly reduced. Under “non-integration with cooperation”, the broader relationship between the parties continues even if coordination fails and thus shading is possible. Under integration HH suppose that shading is always possible.

Given this framework *ex post* renegotiation is not costless. This follows because under the shading assumption each party will feel entitled to the best outcome in the renegotiation and all parties can not achieve that and thus some will shade. In addition, insofar as renegotiation revisits the terms and entitlements underlying existing contracts, renegotiation could make all the parties worse off. HH rules out *ex post* renegotiation on these grounds.

HH assume that bargaining at the *ex ante* stage results in the organisational that is chosen being the one which maximises expected future surplus net of *ex post* shading costs.¹⁸ At the *ex ante* stage it is assumed that at least one side of the market is competitive so that each side achieves the best outcome available in the negotiations. This means that there is no shading at the *ex ante* stage. At the *ex post* stage, the parties are locked in and thus there is the possibility of shading.

Bargaining at the *ex ante* stage also determines the wages of the managers. In the special case where the *ex ante* market for managers is competitive the wage for a manager plus the expected private benefits will equal the reservation utility for the manager. An implication of this is that should an organisational change reduce private benefits, there will be a compensating increase in the wage.

¹⁸Lump-sum transfers are assumed to be available to redistribute surplus.

Section 3 deals with the “Optimal Organisational Form”. In this section HH compare three organisational forms: “non-integration without cooperation”, “non-integration with cooperation” and “integration”. There is no renegotiation.

HH denote by S the social surplus net of shading costs. More precisely, S is the relevant payoff from Table 206.1 less any shading costs. S is referred to as social surplus. *First-best* refers to the cases where aggregate surplus is maximised and the costs of shading are zero. *First-best efficient* refers to situations where the decision maximises total surplus ignoring shading costs.

Non-integration without coordination: under non-integration the payoff for manager A [B] is $v_A + w_A$ [$v_B + w_B$] and either manager can veto coordination by selecting N . HH deal with three cases.

Case 1: $\Delta z_A \leq 0$, $\Delta z_B \leq 0$. Here the change in total surplus for both managers is negative (or zero) and thus the managers’ preferences are aligned, neither of them wants coordination. Given this, there is no disagreement and thus no aggrievement. Social surplus is given by

$$S = 0. \quad (4.52)$$

Case 2: $\Delta z_A \geq 0$, $\Delta z_B \geq 0$. Again the managers’ preferences are aligned, both parties want coordination and thus we get coordination without aggrievement. The social surplus is given by

$$S = \Delta z_A + \Delta z_B. \quad (4.53)$$

Case 3: $\Delta z_i < 0$, $\Delta z_j > 0$ ($i \neq j$). In this case the managers are in conflict, manager i doesn’t want coordination and can veto it via his choice of N . Remember that under “non-integration without cooperation” manager j can not shade since the parties do not have an on going relationship. Given this, manager i will use his veto and thus the outcome will be non-coordination.

$$S = 0. \quad (4.54)$$

We see that the first-best occurs in Case 1, non-coordination gives zero which is the best payoff the managers can get and there is no shading, and in Case 2. You get coordination if and

only if

$$\Delta z_A + \Delta z_B \geq 0. \quad (4.55)$$

that is, the change in aggregate total surplus is non-negative. Case 2 implies equation (4.55) and given equation (4.55) the only way you can get first-best is with $z_i \geq 0$, $i = A, B$. In Case 3 the first-best may not occur, it depends on who the winners and losers are. Even if aggregate surplus increases, the distributions of the gains may be such that one of the parties loses out and thus will veto coordination.

In short: there is too little coordination under “non-integration without cooperation”. Whenever coordination occurs it is first-best efficient, that is, Case 2 implies (4.55); but coordination may not occur when it is first-best efficient, that is, (4.55) does not imply Case 2. Last, note that there is no shading in equilibrium under “non-integration without cooperation”, whether the outcome is coordination or non-coordination.

Non-integration with coordination: The fact that cooperation will continue even if cooperation doesn't means that shading can occur even if non-cooperation is the outcome chosen. This clearly will not effect Case 1 or Case 2 as no shading takes place under either of these outcomes. Both are still first-best. Things can change, however, for Case 3. In particular, manager i may not choose to veto coordination because manager j will be aggrieved and thus may shade. The level of aggrievement will be the difference between manager j 's payoff under his most preferred outcome, that is coordination, and what he actually gets. Shading by j will be proportional to this. Thus j will be aggrieved by Δz_j and will therefore shade $\theta \Delta z_j$. Coordination will occur if manager i 's loss in total surplus under coordination is less than the cost of shading imposed on i by manager j , that is, $\Delta z_i \geq -\theta \Delta z_j$ which implies

$$\Delta z_i + \theta \Delta z_j \geq 0. \quad (4.56)$$

If equation (4.56) does hold, manager i coordinates with j but only reluctantly, and will be aggrieved by amount $-\Delta z_i$ since his most preferred outcome is not to coordinate. Shading by i will therefore be $-\theta \Delta z_i$ which results in a deadweight loss of this amount. Note that equation (4.56) implies

$$\Delta z_j + \theta \Delta z_i > 0. \quad (4.57)$$

This follows since

$$\Delta z_j + \theta \Delta z_i > \Delta z_i + \theta \Delta z_j \geq 0$$

which holds because $\Delta z_j > \theta \Delta z_j$ and $\theta \Delta z_i$ is less negative than Δz_i , remembering that $\Delta z_i < 0$ and $1 > \theta > 0$. Given (4.57) manager j is willing to coordinate in spite of the shading by i . If, however, equation (4.56) does not hold coordination does not occur and j shades by an amount $\theta \Delta z_j$.

Here social surplus is either,

$$\begin{aligned} S &= \Delta z_A + \Delta z_B + \theta \Delta z_i \quad \text{if (4.56) holds (that is, coordination)} \\ \text{or} & \\ &= -\theta \Delta z_j \quad \text{if (4.56) does not hold (that is, non-coordination)} \end{aligned} \tag{4.58}$$

So we end up with first-best being achieved in Cases 1 and 2 but not Case 3. Note that (4.56) implies (4.55) since $\Delta z_A + \Delta z_B > \Delta z_A + \theta \Delta z_B = \Delta z_i + \theta \Delta z_j \geq 0$ and so if (4.56) holds the condition for first-best coordination also holds, but (4.56) doesn't always hold and therefore there is too little coordination compared to the first-best. Also the social surplus given by (4.58) always involves a strictly positive shading cost, so no matter the decision made one side or the other will be unhappy.

In summary HH note that “non-integration with cooperation” is desirable only when [(4.56)] holds, that is, only if coordination is the outcome. If [(4.56)] does not hold, “non-integration without cooperation” is preferable. In a world with uncertainty it is possible for the parties to try “non-integration with cooperation” only to discover that [(4.56)] fails.

Integration: HH divide their analysis of integration into two cases. Remember equation (4.51): $\Delta w_A \leq 0, \Delta w_B \leq 0$.

Case 1: $\Delta v_A + \Delta v_B \leq 0$. Given equation (4.51) the managers' and the boss's preferences are aligned. In this case coordination does not occur since neither the boss nor the managers want it. Thus there is no aggrievement and no shading. Social surplus is

$$S = 0. \tag{4.59}$$

Case 2: $\Delta v_A + \Delta v_B > 0$. Here there is conflict since the boss wants coordination but the managers do not. As the managers do not want coordination they will be aggrieved by an amount $\Delta w_A + \Delta w_B$ and thus will shade by $\theta(\Delta w_A + \Delta w_B)$ if it occurs. The boss will therefore coordinate if and only if her payoff net of shading is greater than zero (her payoff from non-coordination).

$$\Delta v_A + \Delta v_B + \theta(\Delta w_A + \Delta w_B) \geq 0. \quad (4.60)$$

Here we see that the boss will partially internalise the preferences of her managers. If (4.60) does not hold then the boss will not coordinate and the managers get their preferred outcome. However if this is the case then the boss is not getting her most preferred outcome and thus she will be aggrieved, by $\Delta v_A + \Delta v_B$, and will shade by $\theta(\Delta v_A + \Delta v_B)$ thereby reducing the managers' payoffs by this amount.

The social surplus will be,

$$\begin{aligned} S &= \Delta z_A + \Delta z_B + \theta(\Delta w_A + \Delta w_B) \quad \text{if (4.60) holds (that is, coordination)} \\ \text{or} & \\ &= -\theta(\Delta v_A + \Delta v_B) \quad \text{if (4.60) does not hold (that is, non-coordination)} \end{aligned} \quad (4.61)$$

Case 1 results in the first-best outcome while Case 2 does not. For Case 2 there is too much coordination relative to the first-best since (4.55) implies (4.60) but not vice versa. We can see this from the fact that $\Delta v_A + \Delta v_B + \theta(\Delta w_A + \Delta w_B) > \Delta z_A + \Delta z_B = \Delta v_A + \Delta v_B + (\Delta w_A + \Delta w_B) \geq 0$ since $\Delta w_i \leq 0$, $i = A, B$ and $1 > \theta > 0$.

HH then state that they have established their Proposition 1, renumbered to be Proposition 11 here.

Proposition 11 *Non-integration errs on the side of too little coordination (when coordination occurs it is first-best efficient, but it may be first-best efficient and not occur), while integration errs on the side of too much coordination (when coordination is first-best efficient it occurs, but it may occur even when it is not first-best efficient). If non-coordination is first-best efficient, “non-integration without cooperation” achieves the first-best. If coordination is first-best efficient then (a) integration leads to coordination, but may not be optimal given the deadweight losses*

from shading; (b) integration is optimal if the changes in private benefits from coordination are sufficiently small; and (c) integration is uniquely optimal if in addition the distribution of profits is sufficiently uneven. (Hart and Holmström 2009: 21-2).

HH now consider an extension to their model in that they allow for the integrated firm to be run not by a professional outside manager but by one of the two unit managers, manager A , say. Under these circumstances Case 1 will not change but Case 2 will. As manager A is now the boss his payoff will be $v_A + v_B + w_A$ under coordination. Manager B will still not want coordination and thus will be aggrieved by Δw_B and thus will shade by $\theta\Delta w_B$ if coordination happens. Manager A will coordinate if and only if $\Delta v_A + \Delta v_B + \Delta w_A \geq -\theta\Delta w_B$ which implies

$$\Delta v_A + \Delta v_B + \Delta w_A + \theta\Delta w_B \geq 0. \quad (4.62)$$

Thus both the professional manager and manager A coordinate too often. However as (4.62) implies (4.60)¹⁹ manager A coordinates less than the professional manager, which is an improvement. The social surplus that results if manager A selects coordinate is

$$S = \Delta z_A + \Delta z_B + \theta\Delta w_B. \quad (4.63)$$

Comparing (4.63) with (4.61) shows that the social surplus is greater under manager A than it is when the professional outside manager runs the firm. This is because when manager A coordinates he does not shade against himself. The result of this is that it is at least as good to have one of the two unit managers running the firm than it is having the outside professional manager do it.

This result does raise the question of Why are firms run by professional managers at all? HH argue that one way to rationalise having a professional manager as the boss of the integrated firm is to assume there are additional 0-1 decisions over and above the coordination decision considered above. They argue that these decisions would be taken in an inefficient manner if one of the unit managers was head of the integrated firm. To illustrate this point HH suppose that

¹⁹This means $\Delta v_A + \Delta v_B + \theta(\Delta w_A + \Delta w_B) \geq \Delta v_A + \Delta v_B + \Delta w_A + \theta\Delta w_B \geq 0$ which implies $\theta\Delta w_A \geq \Delta w_A$ which is true since $0 < \theta < 1$ and $\Delta w_A < 0$. HH put the reduction in private benefits down to not being able to pursue an independent agenda under coordination. But if A is the boss then he can pursue his own agenda, so why is there a loss in private benefits for A ?

there is an *auxiliary decision* that has to be made but this decision has no financial consequences, just private ones. Assume that the effects of going ahead with the decision are

$$\Delta\hat{w}_A > 0 > \Delta\hat{w}_B \text{ and } \Delta\hat{w}_A + \Delta\hat{w}_B < 0. \quad (4.64)$$

So under these conditions manager *A* would want the decision taken even though it is inefficient. Being the boss he will go ahead with the decision whenever

$$\Delta\hat{w}_A + \theta\Delta\hat{w}_B > 0. \quad (4.65)$$

The social payoff from taking the decision is

$$\Delta\hat{w}_A + \Delta\hat{w}_B + \theta\Delta\hat{w}_B < 0. \quad (4.66)$$

The professional manager would not take the decision, there is nothing in it for her. Manager *A* would be aggrieved by his, but manager *B* would not. *A* would shade which results in social surplus of $-\theta\Delta\hat{w}_A < 0$. If we compare this to (4.66) we see that the social surplus from the auxiliary decision is strictly higher for the case when the professional manager runs the firm than it is when manager *A* is the boss. This means that $-\theta\Delta\hat{w}_A > \Delta\hat{w}_A + \Delta\hat{w}_B + \theta\Delta\hat{w}_B$. We know from (4.64) that $\Delta\hat{w}_A + \Delta\hat{w}_B < 0$ with $\Delta\hat{w}_A > 0$ and $\Delta\hat{w}_B < 0$ which implies $|\Delta\hat{w}_B| > \Delta\hat{w}_A$ and thus $-\theta\Delta\hat{w}_A > \theta\Delta\hat{w}_B$. This gives $-\theta\Delta\hat{w}_A > \Delta\hat{w}_A + \Delta\hat{w}_B + \theta\Delta\hat{w}_B$.

Given $\Delta\hat{w}_B < 0$ manager *B* would make the same choice as the professional manager with regard to the auxiliary decision and given the argument above *B* would be more effective than the professional manager as far as the strategic decision is concerned. Thus when both decisions are considered together manager *B* would be a better boss than either *A* or the professional manager. To avoid this conclusion HH introduction a second auxiliary decision which has the payoffs for *A* and *B* reversed. Of course this decision would be just as inefficient as the previous one but with the payoffs favouring manager *B* rather than *A*. With both auxiliary decisions taken into account it is clear that the professional manager could be the best boss. The advantage of the professional boss is that she will not make inefficient decisions which favour one or other of the managers. Lastly in this section HH note that strictly speaking the introduction of the auxiliary

decisions is unnecessary, they could have just added uncertainty about private benefits into the model and allow them to be negatively correlated. The means that the assumption that both A's and B's private benefits are reduced by coordination, condition ([4.51]), would have to be replaced by an assumption that said that the sum of the changes in private benefits is negative. With uncertainty and negatively correlated private benefits it is possible that the use of a professional manager is the optimal choice for reasons illustrated by considering auxiliary decisions.

Section 4 looks at "Delegation". By delegation HH mean a situation where the professional boss gives her formal authority over decision rights to the unit managers. Importantly although the unit managers have the right to make the Y/N decisions HH assume that the professional boss still has the ability to divert the profits of the units to herself. Delegation is a form of governance that is intermediate between integration and non-integration. As the boss is still legally in charge she retains the right to change her mind and take back the decisions rights. HH call the taking back of decision rights a *reversal*. Any reversal, it is assumed, takes place *ex post* before the unit managers have made their decisions. Any reversal is seen by the unit managers as a "breach of promise" and leads to an increase in the level of aggrivement and thus shading on their part. The shading parameter increases from θ to $\bar{\theta}$, where $1 \geq \bar{\theta} \geq \theta$. HH explain that if $\bar{\theta} > \theta$ and there is uncertainty then delegation can be useful as a partial commitment device.

As with the discussion of integration in Section 3, there are two cases that need to be considered:

Case 1: $\Delta v_A + \Delta v_B \leq 0$. Here preferences are aligned. No one wants coordination. Coordination therefore does not occur and there is no aggrivement and no shading. Social surplus is

$$S = 0.$$

Case 2: $\Delta v_A + \Delta v_B > 0$. The problem here is that the boss wants coordination but the managers do not. At this point ignore reversal. If the managers do not coordinate, the boss will be aggrrieved and will shade. Assume the boss divides her shading 50:50 between the two unit managers. The payoff for each manager will then be given by $-\frac{\theta}{2}(\Delta v_A + \Delta v_B)$. So the managers will choose to coordinate if the payoff from coordination is greater than that from non-coordination, i.e. $\Delta w_i \geq -\frac{\theta}{2}(\Delta v_A + \Delta v_B)$ $i = A, B$ which means that coordination will take

place if

$$\begin{aligned} \Delta w_A + \frac{\theta}{2}(\Delta v_A + \Delta v_B) &\geq 0 \\ \text{and} & \\ \Delta w_B + \frac{\theta}{2}(\Delta v_A + \Delta v_B) &\geq 0 \end{aligned} \tag{4.67}$$

When (4.67) holds the managers will coordinate but only reluctantly. They will be aggrieved and will therefore shade which reduces the social surplus to,

$$S = \Delta z_A + \Delta z_B + \theta(\Delta w_A + \Delta w_B). \tag{4.68}$$

Next consider the situation where (4.67) does not hold. Here coordination will not occur unless the boss reverses her decision and selects coordination herself. Forced coordination leads to aggrievement and shading by the unit managers. The aggrievement levels will be $\Delta w_A + \Delta w_B$ and the shading costs will equal $\bar{\theta}(\Delta w_A + \Delta w_B)$. Remembering that the shading parameter has risen from θ to $\bar{\theta}$. So reversal occurs if and only if

$$\Delta v_A + \Delta v_B + \bar{\theta}(\Delta w_A + \Delta w_B) \geq 0. \tag{4.69}$$

If neither (4.67) nor (4.69) holds then coordination does not occur and we get a social surplus of

$$S = -\theta(\Delta v_A + \Delta v_B) \tag{4.70}$$

If (4.67) does not hold but (4.69) does hold then coordination happens and the social surplus is

$$S = \Delta z_A + \Delta z_B + \bar{\theta}(\Delta w_A + \Delta w_B). \tag{4.71}$$

HH summarise the above discussion in their Proposition 2, renumbered here as Proposition 12:

Proposition 12 *In the delegation model.*

A. *If $\Delta v_A + \Delta v_B \leq 0$, coordination does not occur and social surplus is given by $S = 0$.*

- B.** If $\Delta v_A + \Delta v_B > 0$ and [(4.67)] holds, managers will coordinate reluctantly and $S = \Delta z_A + \Delta z_B + \theta(\Delta w_A + \Delta w_B)$.
- C.** If $\Delta v_A + \Delta v_B > 0$ and [(4.67)] does not hold, but [(4.69)] does, the boss forces coordination and $S = \Delta z_A + \Delta z_B + \bar{\theta}(\Delta w_A + \Delta w_B)$.
- D.** If $\Delta v_A + \Delta v_B > 0$ and neither [(4.67)] nor [(4.69)] holds, then coordination does not occur, but the boss is aggrieved and $S = -\theta(\Delta v_A + \Delta v_B)$.

(Hart and Holmström 2009: 27-8).

Next HH compare the outcomes under delegation and integration. It is clear that (4.67) implies (4.60). Note that $\Delta v_A + \Delta v_B + \theta(\Delta w_A + \Delta w_B) > \Delta w_A + \Delta w_B + \theta(\Delta v_A + \Delta v_B) \Rightarrow (1 - \theta)(\Delta v_A + \Delta v_B) > (1 - \theta)(\Delta w_A + \Delta w_B)$ which is true given that $\theta < 1$ and $(\Delta v_A + \Delta v_B) > 0$ and $(\Delta w_A + \Delta w_B) < 0$. It is also true that (4.69) implies (4.60). To see this note that $\Delta v_A + \Delta v_B + \theta(\Delta w_A + \Delta w_B) > \Delta v_A + \Delta v_B + \bar{\theta}(\Delta w_A + \Delta w_B)$ since $\bar{\theta} > \theta$. These results mean that whenever coordination occurs under delegation, that is, in cases B and C in Proposition (12), it also occurs under integration. Also note that (4.55) implies (4.69), that is, $\Delta v_A + \Delta v_B + \bar{\theta}(\Delta w_A + \Delta w_B) \geq \Delta v_A + \Delta v_B + (\Delta w_A + \Delta w_B)$ which is true since $\bar{\theta} \leq 1$. This means that there is too much coordination under delegation relative to the first-best outcome. That is, coordination occurs, under delegation, whenever it is efficient but it can also occur when it is inefficient.

This gives HH's Proposition 3, which is given here as Proposition 13.

Proposition 13 *Under delegation there is (weakly) less coordination than under integration, but still too much coordination relative to the first-best. (Hart and Holmström 2009: 28).*

The intuition behind this result is that if the unit managers would reluctantly coordinate under delegation, i.e., reversal is not needed, then the professional manager would also coordinate under integration. In addition if the professional manager is willing to incur the costs of reversal to bring about coordination then she would also pick coordination if reversal was not needed. Finally, given that $\bar{\theta} \leq 1$, if it is efficient to pick coordination, then the boss will be prepared to incur the costs of reversal to achieve it.

When discussing the trade-off between integration and delegation HH note that both result in coordination occurring too often, but delegation yields it less of the time and thus is closer to the first-best than integration. However, given that the boss may have to reverse delegation to achieve coordination, the deadweight losses due to shading are larger under delegation than those which occur under integration.

The next proposition HH put forward shows that under certainty, delegation is never strictly optimal. Proposition 14 below is Proposition 4 from HH.

Proposition 14 *Under perfect certainty, “non-integration without cooperation” or integration can be strictly optimal, but delegation is never strictly optimal. (Hart and Holmström 2009: 29).*

Proof: Consider first that the equilibrium outcome under delegation is (N, N) . Then the equilibrium outcome under “non-integration without cooperation” cannot be any worse than this. This is because the equilibrium is either (N, N) with less shading, or it is (Y, Y) which is Pareto superior.

Next consider the case where the equilibrium under delegation is (Y, Y) . As shown above if (4.67) holds so does (4.60) and thus coordination occurs under integration with the same shading costs. On the other hand, if (4.67) does not hold then (4.69) must hold, for if it did not then we would have the outcome (N, N) . But note that if (4.69) holds then so does (4.60) and thus coordination occurs under integration with lower costs from shading.

Lastly, we can find parameters such that (N, N) is socially optimal, and “non-integration without cooperation” yields (N, N) , while integration and delegation yield (Y, Y) ; and parameters such that (Y, Y) is socially optimal, and integration yields (Y, Y) , while “non-integration without cooperation”, and delegation yield (N, N) . What we can take from this is that non-integration and integration can each be uniquely optimal. ■

In a world with uncertainty, on the other hand, it is possible that delegation can be better than either non-integration or integration. HH make the point that for delegation to be superior it is necessary for $\bar{\theta} > \theta$. This is clear from the fact that if $\theta = \bar{\theta}$ then (4.67) implies (4.69) and (4.69) and (4.60) are equivalent.²⁰ From this it becomes clear that cases *B* and *C* from Proposition 12 are both situations where (4.60) will hold. Next a comparison of cases *B-D* and (4.61) shows

²⁰(4.67) implies (4.69) follows from $\Delta v_A + \Delta v_B + \theta(\Delta w_A + \Delta w_B) \geq \Delta w_A + \Delta w_B + \theta(\Delta v_A + \Delta v_B) \geq 0$ when $\bar{\theta} = \theta$ and $(\Delta v_A + \Delta v_B) > 0$, $(\Delta w_A + \Delta w_B) < 0$. (4.69) and (4.60) being equivalent follows from $\Delta v_A + \Delta v_B + \bar{\theta}(\Delta w_A + \Delta w_B) = \Delta v_A + \Delta v_B + \theta(\Delta w_A + \Delta w_B)$ when $\bar{\theta} = \theta$.

that the outcome under integration with delegation is the same as that under integration, and thus from now on HH assume that $\bar{\theta} > \theta$.

To introduce uncertainty (more correctly, risk) HH assume that the payoffs are drawn from a commonly known probability distribution and that both parties observe the payoffs *ex post*.²¹ To see that delegation can, in some situations, be strictly optimal HH concentrate on a special case in which $\Delta w_A = \Delta w_B = \Delta w$. Also HH write $\Delta v = \frac{1}{2}(\Delta v_A + \Delta v_B)$. From this we can see that the condition for first-best coordination, (4.55), can be rewritten as $\Delta v \geq |\Delta w|$.²² If $\Delta v \leq 0$ then all preferences are aligned and all the organisational forms, non-integration, integration and delegation, yield the same outcome: non-coordination. No one, not the boss or the unit managers, wants coordination so it doesn't happen. HH therefore assume $\Delta v > 0$. Given this it is clear that the condition for coordination without reversal (reluctant coordination), (4.67), becomes $\theta\Delta v \geq |\Delta w|$. The condition for coordination with reversal under delegation (forced coordination), (4.69), becomes $\Delta v > \bar{\theta}|\Delta w|$ and the condition for coordination under integration, (4.60), can be rewritten as $\Delta v > \theta|\Delta w|$.

The situation is illustrated in Figure 220.1 below. Here Δv varies but Δw is held constant.

It is clear from Figure 220.1 that for values of Δv in the range $\Delta v \leq \theta|\Delta w|$ there is no coordination under either delegation or integration. For Δv greater than $\theta|\Delta w|$ there is coordination under integration. Under delegation the value of Δv has to reach $\bar{\theta}|\Delta w|$ before coordination occurs. For the range $\theta|\Delta w| \leq \Delta v \leq \bar{\theta}|\Delta w|$ delegation results in a more efficient outcome than integration. But for the range $\bar{\theta}|\Delta w| \leq \Delta v \leq \frac{|\Delta w|}{\theta}$ delegation achieves the efficient coordination outcome albeit with higher shading cost due to reversal being required.

Delegation dominates integration in two regions. If the probability distribution of Δv is such that Δv falls in either the range $\theta|\Delta w| \leq \Delta v \leq \bar{\theta}|\Delta w|$ or the range $\Delta v > \frac{|\Delta w|}{\theta}$ then delegation achieves non-coordination when it is efficient and coordination when it is efficient. Moreover, the shading costs are low when coordination is achieved since reversal is not needed. Under integration, on the other hand, coordination can occur also when it is inefficient, that is, in the range $\theta|\Delta w| \leq \Delta v \leq \bar{\theta}|\Delta w|$.

HH note that the intuition behind this is straightforward. Delegation can be used as a

²¹There is symmetric information.

²²(4.55) is $\Delta z_A + \Delta z_B = (\Delta v_A + \Delta v_B) + (\Delta w_A + \Delta w_B) = 2\Delta v + 2\Delta w \geq 0$. This implies $\Delta v \geq -\Delta w$ which in turn implies $\Delta v \geq |\Delta w|$ since $\Delta w < 0$. $|\cdot|$ denotes the absolute value.

way for the boss to commit to a policy of non-intervention, when intervention is inefficient, because the costs of intervention, that is, reversal, are high. Also note that over the range for which integration with delegation is superior to integration without delegation, integration with delegation will also be superior to non-integration if there are large gains from coordination but these gains are unevenly divided.

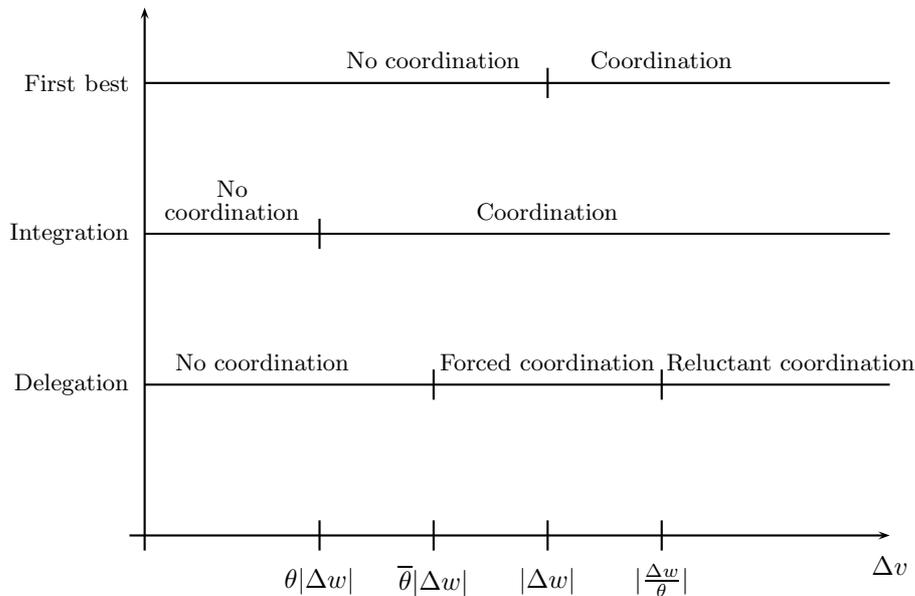


Figure 220.1.

(Hart and Holmström 2009: Figure II)

Section 5 of the HH paper deals with the example of the Cisco takeover of StrataCom. HH argue that the approach developed above is particularly relevant to understanding the struggle for platform leadership in the network industry. They illustrate this with the example of Cisco's acquisition of StrataCom.

Conclusions make up Section 6 of the paper. HH explain that their model is one that is in a number of ways like the traditional view of the firm in that it is a technologically defined entity that makes decisions about inputs, outputs and prices. An important difference is that the HH firm may not maximise profits because the boss could care directly about the non-transferable private benefits or because they may be forced to internalise them given that employees can shade.

HH highlight two advantages that flow from the Hart and Moore (2008) approach. First,

aggravement makes clear why there is a need for an initial choice of ownership. If we set $\theta = 0$, that is, have no aggravement costs, we could choose the optimal ownership structure *ex post*. Second, without aggravement in a dynamic model with uncertainty we would expect to see continuous reallocations of decision rights. Aggravement brings a source of inertia into dynamic models. This inertia also makes delegation differ from ownership. How decision rights are allocated within the firm does matter.

The HH approach also suggests that who takes over who in a takeover matters. If the boss of firm *A* becomes the boss of the integrated firm, the decisions of the integrated firm will reflect manager *A*'s preferences, private benefits and world view. Such decisions will cause aggravement for employees with different preferences and thus the cultural compatibility and fit of an acquisition partner may be of great importance.

While there are no workers in the HH model one interpretation of the manager's private benefits is as a reflection of an alignment of preferences with workers. However a boss of a firm with broad scope will put less weight on private benefits than a boss of a firm which has a narrower scope. Firms with a broader range of activities will have a more heterogeneous workforce resulting in the boss having less empathy with any given group.

Giving private benefits a major role in the analysis moves attention away from assets towards activities as a way of determining the boundaries of the firm. HH argue that their model is one in which asset ownership is the means by which control rights can be acquired. These rights are needed to be able to bring activities together under the authority of one boss.

4.5.1 a digression on profit maximisation

It was noted in section above, see page 220, that HH argue that the firm in their model may not maximise profits because the boss could care about the non-transferable private benefits or because they may be forced to internalise them given that employees can shade. If we think of the private benefits as on-the-job consumption then the HH model can be contrasted with the Demsetz model of Section 1.2.1. In the Demsetz model the firm produces only for those outside the firm and not for internal (on-the-job) consumption and both profit maximisation and utility maximisation are achieved, with the former being implied by the latter. The HH model, on the other hand, allows for on-the-job consumption, but neither profit maximisation nor utility

maximisation can be guaranteed.

But it should be noted that if money profits are less due to the boss caring directly about the non-transferable private benefits of employees and the boss is also the owner then it is not clear that this is not profit maximising behaviour.²³ What this means is that part of the profits realised by the firm are being taken by the owner in the form of the transfer to employees via their private benefits. Assuming the owner is acting rationally, it must be that the value to the owner of the transfer is greater than the money profits sacrificed. That is, the sum of the value of the transfer plus the lower money profits is larger than the value of the sum of no transfer and a greater money profits. One way to view this is as the owner maximising the money profits of the firm and then spending some of this profit, which is now part of his personal wealth, to pay for the transfer to his employees. Viewed in this way, the transfer is just on-the-job consumption by the owner and this doesn't diminish the usefulness of assuming that owners seek to maximise profits. In effect on-the-job consumption is being secured by using earned (maximised) profits in-house. If the boss is not the owner then the boss caring directly about the private benefits of employees raises questions about agency problems between the owner and the boss.

4.6 shading

Obviously what all the papers reviewed in this chapter have in common is the application of the reference point approach to the theory of contracts to issues to do with the theory of the firm. All the papers assume that a contract acts as a reference point for the contracting parties feelings of entitlement and that should these feelings not be meant then shading will occur. Importantly not all actions by the parties can be contracted upon, even *ex post*. It is this assumption that only some actions are contract that gives rise to the ability for agents to act in a perfunctory rather than consummate manner.

An assumption made with regard to shading is that the reason for aggrievement does not affect the amount of shading that takes place, clearly it could. As noted in the discussion of Hart (2009) if an agent thinks another agent behaviour is opportunistic they may react differently than if they feel the another agent's action are the result of external factors. The first case could result

²³Obviously no assumption that production is completely specialised for sale is being made.

in more shading than the second. But such concerns over the reasons for aggrievement may have wider application. For example, the choice of price by B in the Hart and Moore (2007) model may be seen by S as self-interested behaviour, but not truly opportunistic, whereas the deliberate decision to attempt “hold-up” in Hart (2009) model could be more readily seen as opportunistic behaviour and thus punished by a greater amount of shading. A reversal of delegation by the boss in the Hart and Holmström (2010) model is seen by subordinates as, in the words of Hart and Holmström, a “breach of promise”, i.e. truly opportunistic behaviour. Such a view could result in greater shading from the subordinates than would be induced by aggrievement for other reasons in their model.

4.7 reference points, property rights and transaction costs

Hart (2008: 406) argues that shading costs are akin to “haggling costs”. The modelling of haggling costs can be seen as a move towards the modelling (however imperfectly) of transaction costs. Hart and Moore (2008: 4-5) argue that “[...] the costs of flexibility that we focus on—shading costs—can be viewed as a shorthand for other kinds of transaction costs, such as rent-seeking, influence, and haggling costs.” Exactly how similar the reference point and transaction-cost explanations are is, however, open to debate. There is also the question of the relationship between these two approaches to the firm and the property rights approach.

In a discussion of the differences between the Grossman-Hart-Moore (GHM) theory of the firm and the transaction-cost approach, Williamson (2000: 605-6) argues that the most important difference between them is that GHM introduce inefficiencies at the ex ante investment stage while the transaction-cost approach emphasises that ex post haggling and maladaptation drive inefficiencies.²⁴ There are no ex post inefficiencies in GHM due to their assumption of common knowledge and ex post costless bargaining. Gibbons (2010: 283) explains it this way:

“[t]he model in question is Grossman and Hart’s (1986), which explores an alternative to Williamson’s (2000, p. 605) emphasis that “maladaptation in the contract execution interval is the principal source of inefficiency”. Instead, in the Grossman-Hart

²⁴Holmström and Roberts (1998: 75-9) also highlights the distinctions between the transaction cost and property rights theories. Whinston (2003) looks at the empirical differences between the two theories.

model, there is zero maladaptation in the contract execution interval, and the sole inefficiency is in endogenous specific investments.

It is striking how different the logic of inefficient investment can be from the logic of inefficient haggling. In their pure forms envisioned here, the two can be seen as complements. For example, the lock-in necessary for Williamson's focus on inefficient haggling could result from contractible specific investments chosen at efficient levels. But by assuming efficient bargaining and hence zero maladaptation in the contract execution interval, Grossman and Hart focused attention on non-contractible specific investments and hence discovered an important new determinant of the make-or-buy decision: in the Grossman-Hart model, an important benefit of non-integration is that both parties have incentives to invest; in Williamson's argument, an important cost of non-integration is inefficient haggling. In short, the two theories are simply different."

This emphasis on ex post haggling and maladaptation can be interpreted as reflecting a view that internal organisation is better at reconciling the conflicting interest of the parties to a transaction and facilitating adaptation to changing supply and demand conditions when such cost are high.

The reference point approach can be seen as a movement away from the ex ante GHM approach and back towards transaction cost thinking in so much as contracting is not perfectly contractible ex post. This fact, as Hart (2008: 294) points out "[...] is a significant departure from the standard contracting literature. The literature usually assumes that trade is perfectly enforceable ex post (e.g. by a court of law). Here we are assuming that only perfunctory performance can be enforced: consummate performance is always discretionary", and thus inefficiencies can arise ex post.²⁵ The development of a tractable model of contracts and organisational form that exhibits ex post inefficiency is one of motivations for advancing the reference point approach in the first place. (Hart and Moore 2008: 4). Hart's interpretation of the reference point theory is "[i]n a sense, this work can be viewed as a "merger" of the transaction cost and property rights literatures." (Hart 2011b: 106).

²⁵This focus on ex post inefficiency has meant that the reference point literature has downplayed the role of noncontractible investments which are important in the property rights models. But Hart (2011a) shows that the reference point approach to contracts can be extended to incorporate noncontractible relationship-specific investments.

The reference point approach also highlights the importance of Williamson's notion of the "fundamental transformation".²⁶ Hart and Moore argue that the move from an ex ante competitive market to an ex post bilateral setting—what Williamson (1985: 61-3) terms the fundamental transformation—provides a rationale for the idea that contracts are reference points. "A competitive ex ante market adds objectivity to the terms of the contract because the market defines what each party brings to the relationship. HM assume that the parties perceive a competitive outcome as justified and accept it as a salient reference point." (Fehr, Hart and Zehnder 2009: 562).

But we must also be aware that important features of the transaction-cost theory may still have been left out. How fully shading costs capture the costs of ex post maladaptation and haggling is an open question. When discussing some opportunities for the future of transaction-cost economics, Robert Gibbons (2010: 283) notes that "[...] it may be that Hart and Moore's (2008) "reference points" approach is a productive path. Time will tell [...]" Hart (2011b: 106) concludes "[w]hether this merger [resulting in the reference point theory] will be successful remains to be seen."

4.8 conclusion

The papers discussed here have, on the positive side, developed a new framework within which to study the theory of the firm, based on the new 'reference point' approach to the study of (incomplete) contracts. They have demonstrated that the trade-off between contractual rigidity and flexibility has important implications for the organisation of firms. What the papers share is the application of the idea that contracts act as a reference point for feelings of aggrievement and thus acts of shading. The Hart and Moore theory and its extensions provide an explanation for the existence of long-term contracts in the absence of relationship specific investments, which are assumed in most of the incomplete contracts approaches to the firm. Also the reference point

²⁶Given the importance of fundamental transformation to the analysis of economic organisation Williamson (1985: 63) asks why this notion was ignored for so long. In footnote 23 he gives three reasons: "One explanation is that such transformations do not occur in the context of comprehensive, once-for-all contract—which is a convenient and sometimes productive contracting fiction but imposes inordinate demands on limited rationality. A second reason is that the transformation will not arise in the absence of opportunism—which is a condition that economists have been loath to concede. Third, even if bounded rationality and opportunism are conceded, the fundamental transformation appears only in conjunction with an asset specificity condition, which is a contracting feature that has only recently been explicated."

theory can shed new light on the roles of the employment relationship and authority. In work extending the theory, Hart (2009) reintroduces assets into the model and shows that previously hard to explain observations in the empirical literature on contracting and integration can be explained by the reference point approach. Hart and Holmström (2010) offers a theory of firm scope. They provide an analysis that moves the focus of the theory away from the role of non-human assets in determining a firm's boundaries towards a theory where the activities undertaken by the firm determine the firm's scope.

On the negative side the Hart and Moore theory, and thus the papers surveyed here, rests on strong (ad-hoc) behavioural assumptions which have only limited experimental support and, thus far, no direct empirical backing. There are concepts in the behavioural literature, such as reference dependent preferences, the self-serving bias or reciprocity, which are broadly consistent with the Hart-Moore model but, as already noted, the experimental/empirical support for the model is, at best, limited. An important topic for future work in the reference point literature on contract theory is to show that the ad-hoc nature of the behavioural assumptions used within it are consistent with utility-maximising behaviour.

Hart and Moore (2007) argue that one failing of the property rights theory is its reliance on noncontractible, relationship-specific investments which are hard to measure empirically. But it is not clear that aggrievement and shading present any less in the way of measurement issues for empirical work.

Also the theory has an inherent human capital bias. The reliance on aggrievement and shading could be seen as limiting the applicability of the theory to areas relatively dependent on human capital. In firms in which production is mainly dependent on non-human capital, which cannot be aggrieved and cannot shade, the theory may be of less value. Also for areas where it is possible to write contracts that cover most of, if not all of, the relevant actions - thereby reducing the likelihood of aggrievement and the ability to shade if aggrievement does occur - the theory would be of more limited usefulness. In other words the theory is less applicable to situations where the set of actions which defines consummate, as opposed to perfunctory, performance is small. Thus the theory seems to have greater potential when applied to firms who have a greater dependence on human capital and where monitoring is ineffective.

This human capital bias is important, for example, when Hart and Holmström (2010: 511)

state that “giving private benefits a pivotal role in the analysis moves the focus of attention away from assets toward activities in the determination of firm boundaries.” More properly they have moved the focus of attention away from asset ownership to human capital utilisation. They tie the ‘unit’ to the manager in such a way that an expansion of activities requires the addition of extra managers (human capital). What happens if, for example, the activities the firm undertakes can be expanded by simply expanding the range of physical capital the firm employs? There is no basis for an increase in the level of aggreivement and shading and therefore Hart and Holmström’s reference point model would say the boundaries of the firm would not have changed but the firms activities have increased. What Hart and Holmström exploit is an implied positive correlation between the range of human capital a firm employs and the range of its activities. While theories such as the property rights approach to the firm may go too far in defining firms solely in terms of asset ownership, the reference point theories may go too far in the opposite direction by over emphasising human capital.

Avenues for future work on the reference point approach to the firm would include the re-introduction of non-contractible investments into models of the firm. Hart (2011a) analyses noncontractible investments in a model with shading. The paper studies a model where a long-term contract is utilised to encourage a seller to make quality-enhancing investments in addition to trying to achieve ex post efficiency and avoid shading. It is shown that if contracts act as reference points, the first-best can not be achieved even if renegotiation is excluded. It is also shown that asset ownership can increase efficiency. An obvious extension to this idea is an application directly to the theory of the firm. Such an extension would move the reference point approach back towards the property rights framework. Like the property rights approach to the firm, firms in the reference point framework are or divisions of firms are fundamentally individuals, can the reference point approach be applied to more sophisticated organisational firms? Questions also have to be asked about where does a reference point come from and how can we pin it down? Do reference points have to be the same at the contractual performance stage as they where at the contractual negotiation stage? If they can change, when, how and why? Answering such questions will provide the basis for a fruitful and exciting future for the reference point approach to the theory of the firm.

Chapter 5

Human capital in the reference point theory

“But the sensibility of pirates’ democratic managerial organization in the particular context in which they operated doesn’t mean democratic management makes sense for all firms in all circumstances. Different firms that operate in different economic contexts will find different managerial forms most conducive to making profits.”

Leeson (2009: 182).

5.1 introduction

Peter Leeson’s point about different economic contexts resulting in different organisational forms for firms can be illustrated for the more usual case of a non-human capital intensive firm with the (unusual) example of pirates versus privateers.¹ An important difference between privateers and pirates is that although they both practised maritime plunder, privateers were state-sanctioned. That is, governments would commission privateers to attack and seize enemy nations’ merchant shipping during times of war. The most obvious piece of non-human (physical in this case) capital for both the pirates and the privateers was their ship. The role of investors in providing this capital was important to the organisational form that pirates and privateers developed. Pirates had no investors; they simply stole the capital they needed. Privateers, on the other hand, as legal enterprises could not just go out and steal the capital they required; they needed external financiers to supply their capital requirements. This difference in capital supply resulted in very different organisational forms with privateers utilising a more autocratic management system than pirates. Pirate crews were equal contributors and part owners of the “firm” they worked for.² Having no need for investors, pirates did not need to develop mechanisms to protect the interests of the firm’s financiers as the privateers needed to. This meant that incentive problems

¹See Leeson (2009) for more details on the economics of pirate organisation.

²Bylund (2010) argues that Leeson is wrong to see pirate ships as firms. Bylund argues that the modern theories of the firm are not fully compatible with the nature of piratical organisation. Leeson replies in Leeson (2010).

could be dealt with by developing a “worker-owned firm” with the crew (usually) sharing equally in “profit” and electing its leaders and having power dispersed among multiple members of the crew such as the captain and the quartermaster. In contrast the privateer had investors and a management system designed to protect their investments. The investors appointed privateer captains and developed an organisational scheme that in some important respects mirrored the managerial organisation of (also investor backed) merchant ships.

If, as the above argument would suggest, non-human capital is an important determinant of a firm’s organisational form, What happens when non-human capital plays only a minor role in the firm, as it effectively did for pirate firms? In other words, What determines the organisational form of the human capital based firm? Are human capital based firms going to resemble pirates, as least as far as they will be worker-owned firms as some commentators have suggested.³ In the following sections we utilise simple versions of models developed from the reference point theory of Hart and Moore (2008) to look at these questions.

5.2 modelling firm scope

Obviously the more a firm does in house, the greater the scope of the firm. Thus a firm which utilises employment contracts to keep production activities within its boundaries has a greater scope than a firm which hires independent contractors to carry out the same set of activities. In this section a simple model of firm scope, based on that of Hart and Holmström (2010), is considered. This section examines a model in which the owner of non-human capital wishes to produce a widget that requires the input of two forms of human capital.⁴ We will denote the non-human capital owner by C and the two knowledge workers (human capital) by A and B . We consider two basic organisational forms, an independent contractor contract and an employment contract. An independent contractor relationship is said to exist if C hires the two knowledge workers to act as consultants on the widget production process. In terms of a “make-or-buy” decision this can be thought of as a market contract - a “buy” decision. An employment contract

³See, for example, Rajan and Zingales (2003: 90).

⁴Hart (1995: 56-9) argues that some non-human capital is an essential part of a theory of the firm. But such capital could be either ‘hard’ assets such as machines, inventories, and buildings, or ‘softer’ assets such as patents, client lists, files, existing contracts, or the firm’s name or reputation. Assets in this ‘softer’ category are likely to become more important as human capital becomes of greater significance in production.

is said to exist where the owner of the non-human capital makes the two knowledge workers employees of her firm. This can be seen as a “make” decision.

In this model the distinction between the independent contractor and the employee is based on who has the right to make a coordination decision. Consider a situation where the “knowledge workers”, A and B , are an engineer and a computer scientist, working on different aspects of the widget’s production, who could integrate their computer systems to make the transfer of information easier or to use the Hart and Holmström (2010) example, A and B could be deciding on whether or not to adopt a common standard or platform for their technology or product. Under an employment contract the employer, C , has the right to determine whether or not coordination of the activities of A and B takes place while if A and B are independent contractors they have the right to make the decision for their firm.

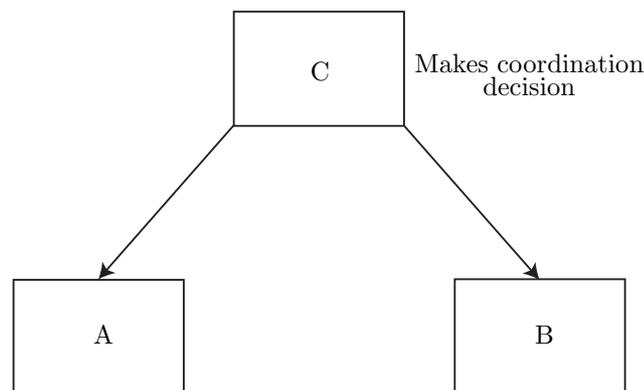


Figure 231.1. Employment relationship, i.e. one firm

Figure 231.1 represents the employment relationship while Figure 232.1 shows the independent contractor relationship.

Following Hart and Holmström (2010), the coordination decision - e.g. integrate the computer systems or not - is a “Yes” (Y) or “No” (N) decision made by whoever has the rights to the decision. If the decision rights are allocated to A and B then coordination occurs if and only if both select Y. If C has the decision rights, then she can force A and B to carry out whatever decision she chooses.

Each of A , B and C has an owner and a manager-employee, and these roles will coincide for each firm if A and B are independent contractors. If an employment contract chosen, A and B ’s

firm will become divisions of C 's firm and thus C will be the integrated firm's owner and A and B will be manager-employees of their respective sections.

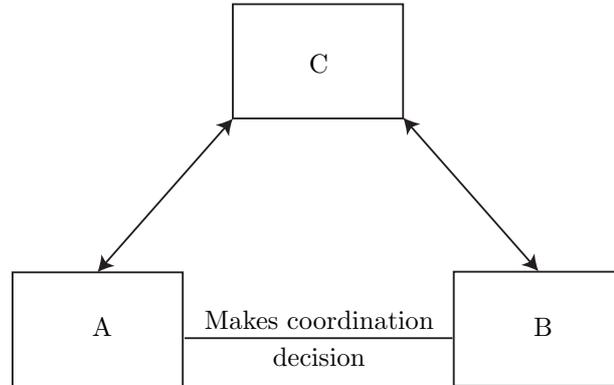


Figure 232.1. Independent contractor relationship, i.e. three firms.

Two forms of payoff are generated by A and B : a contribution towards the monetary profit, v , generated by the production of the widget and a private (nontransferable) benefit in the form of a level of job satisfaction for the manager of the firm.⁵ It will be assumed that the owner of the widget can divert all the profits from its production to herself. The private benefits, on the other hand, always stay with the managers. Importantly the manager's private benefits function can differ depending on whether or not the manager is an independent contractor or an employee. For the case where the manager is an independent contractor we denote the private payoffs as ψ while if he is an employee the private payoffs are referred to as γ . The idea is that we allow for the possibility that A and B may evaluate the private benefits from being self-employed versus being an employee differently based on their personality types and/or personal abilities.⁶

Table 233.1 represents the payoffs from the situation where A and B are hired as independent contractors while Table 233.2 shows the payoffs if A and B are employees. In both tables Δv_i , $i = A, B$ represents the change in the contribution to profits of the two firms/divisions from a change in outcome from one involving at least one N decision to the Y, Y outcome and $\Delta \psi_i$ $i = A, B$ and $\Delta \gamma_i$ $i = A, B$ represents the change in the private benefits of the two managers, under each

⁵Private benefits are measured in money.

⁶See, for example, McClelland (1961) and Beugelsdijk and Noorderhaven (2005) for discussions of the link between personality type and employment preferences. Hartog, van Praag and van der Sluis (2010) compares the effects of cognitive and non-cognitive abilities on the performance (measured by income) of entrepreneurs and employees. Their results show markedly different returns for entrepreneurs and employees. Bandiera, Prat, Guiso, and Sadun (2011) show that managers' risk aversion and talent are correlated with the incentives they are offered and, through these, with the characteristics of the firms that hire them. So managers with different characteristics are matched with firms with different characteristics.

of the contract types. As with Hart and Holmström (2010) it is assumed that these payoffs are nonverifiable and are perfectly certain. The payoffs have been scaled so that both the monetary profits and private benefits under non-coordination are zero for both firms.

		Firm B				Firm B	
		Y	N			Y	N
Firm A	Y	A: $\Delta v_A, \Delta \psi_A$	A: 0,0	Firm A	Y	A: $\Delta v_A, \Delta \gamma_A$	A: 0,0
		B: $\Delta v_B, \Delta \psi_B$	B: 0,0			B: $\Delta v_B, \Delta \gamma_B$	B: 0,0
	N	A: 0,0	A: 0,0		N	A: 0,0	A: 0,0
		B: 0,0	B: 0,0			B: 0,0	B: 0,0
Independent contractor payoffs				Employee payoffs			

Table 233.1.

Table 233.2

(Hart and Holmström 2010: Table I)

The time line is given in Figure 233.3. This time line shows that the parties meet and an organisational form (contract) is selected after which the coordination decision is made and later still payoffs are realised.

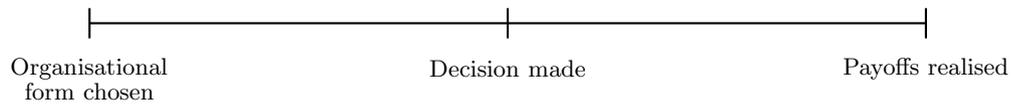


Figure 233.3. Time line.

(Hart and Holmström 2010: Figure I)

At the time of the choice of the organisational form, if an integrated firm is selected, then the two managers will work under a fixed-wage employment contract and they will each receive the sum of the wage and the private benefits of their section. If the use of independent contractors is the chosen organisational form then the two contractors will each receive a fixed consulting fee in addition to the private benefits generated by their firm. Under both organisational forms the profits from the production of the widget, $v_A + v_B$, goes to C since she is the owner of the widget under both contracts.

It will also be assumed that as far as the change in profits is concerned

$$\Delta v_A + \Delta v_B > 0 \tag{5.1}$$

holds. In terms of signs on the changes in private benefits five cases will be considered:

$$\begin{bmatrix} \Delta\psi_A \geq 0, \Delta\gamma_A \geq 0 \\ \Delta\psi_B \geq 0, \Delta\gamma_B \geq 0 \end{bmatrix} \quad \text{Case 1}$$

$$\begin{bmatrix} \Delta\psi_A \leq 0, \Delta\gamma_A \leq 0 \\ \Delta\psi_B \leq 0, \Delta\gamma_B \leq 0 \end{bmatrix} \quad \text{Case 2}$$

$$\begin{bmatrix} \Delta\psi_A \geq 0, \Delta\gamma_A \leq 0 \\ \Delta\psi_B \geq 0, \Delta\gamma_B \leq 0 \end{bmatrix} \quad \text{Case 3}$$

$$\begin{bmatrix} \Delta\psi_A \leq 0, \Delta\gamma_A \geq 0 \\ \Delta\psi_B \leq 0, \Delta\gamma_B \geq 0 \end{bmatrix} \quad \text{Case 4}$$

$$\begin{bmatrix} \Delta\psi_A \leq 0, \Delta\gamma_A \leq 0 \\ \Delta\psi_B \geq 0, \Delta\gamma_B \geq 0 \end{bmatrix} \quad \text{Case 5}$$

First assume that inequality (5.1) holds, which implies that C wants coordination: that is, C wants, for example, the computer systems of the computer scientist and the engineer integrated. If Case 1 applies then the preferences of A , B and C are aligned. That is, they all want coordination under either the employment contract or the independent contractor contract. Thus no one is aggrieved and there is no shading.⁷ Therefore we get the first-best, meaning no aggrievement and no shading and therefore no deadweight loss, outcomes under both the employment contract and the independent contractor contract. This means that social surplus is given by.

$$S_E = \Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B \quad (5.2)$$

$$S_{IC} = \Delta v_A + \Delta v_B + \Delta\psi_A + \Delta\psi_B \quad (5.3)$$

where S_E is the social surplus under the employment contract and S_{IC} refers to the social surplus under the independent contractor organisation. Which organisational form is chosen depends on

⁷When shading does occur the shading parameter is θ where $0 < \theta < 1$. Remember that a party will happily provide consummate performance when he feels he has received what he is entitled to, but when he feels shortchanged he is aggrieved and thus shades by performing in a perfunctory rather than consummate manner. Consummate performance does not cost significantly more than perfunctory performance: either it costs slightly more or it costs slightly less, that is, a party may actually enjoy providing consummate performance. Hart and Moore (2008) assume, to simplify matters, that a party is completely indifferent between providing the two levels of performance. Shading is costless to the party undertaking it but lowers the payoff of the “victim”. The costless nature of shading implies shading is credible because a costless threat will be carried out.

whether equation (5.2) or (5.3) is larger which in turn depends on the relative sizes of $\Delta\gamma_A + \Delta\gamma_B$ and $\Delta\psi_A + \Delta\psi_B$.

Next assume that inequality (5.1) holds and Case 2 applies. Again C wants coordination, but both A and B do not, no matter which organisational form is chosen. Under an employment contract C can choose coordination and A and B must comply. That is, once C has made the Y/N decision the courts can and will enforce it. However, given Case 2 applies, both A and B will be aggrieved, and thus both will shade. Total shading will be $\theta(\Delta\gamma_A + \Delta\gamma_B)$. C will therefore change her choice to no coordination if $-\theta(\Delta\gamma_A + \Delta\gamma_B) > \Delta v_A + \Delta v_B$. In this case C reluctantly agrees to no coordination and is aggrieved and thus shades by an amount $\theta(\Delta v_A + \Delta v_B)$. This gives the social surplus as

$$S_E = \Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B + \theta(\Delta\gamma_A + \Delta\gamma_B) \text{ if coordination occurs} \quad (5.4)$$

$$-\theta(\Delta v_A + \Delta v_B) \text{ if coordination doesn't occur} \quad (5.5)$$

Note that the condition for coordination taking place is $\Delta v_A + \Delta v_B + \theta(\Delta\gamma_A + \Delta\gamma_B) \geq 0$. Comparing this to the condition for first best coordination, $\Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B \geq 0$, we see there is too much coordination. That is, we can have coordination taking place when the payoffs from coordination do not justify it.⁸

Under an independent contractor contract both A and B will prevent coordination by choosing N . This will aggrieve C and she will therefore shade in total by an amount $\theta(\Delta v_A + \Delta v_B)$. If we assume that C shades against A and B equally then A would change his decision to Y if $\frac{1}{2}\theta(\Delta v_A + \Delta v_B) > -\Delta\psi_A$ and B will change his decision if $\frac{1}{2}\theta(\Delta v_A + \Delta v_B) > -\Delta\psi_B$. If both these inequalities hold then A and B will choose coordination, but only reluctantly which means they will be aggrieved and thus will shade.⁹ A shades by an amount $\theta\Delta\psi_A$ and B by $\theta\Delta\psi_B$. This gives the social surplus as

$$S_{IC} = \Delta v_A + \Delta v_B + \Delta\psi_A + \Delta\psi_B + \theta(\Delta\psi_A + \Delta\psi_B) \text{ if coordination occurs} \quad (5.6)$$

⁸ $\Delta v_A + \Delta v_B + \theta(\Delta\gamma_A + \Delta\gamma_B) > \Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B \geq 0$, since $0 < \theta < 1$ and $\gamma_i \leq 0$ $i = A, B$, which implies that it is possible to find values such that $\Delta v_A + \Delta v_B + \theta(\Delta\gamma_A + \Delta\gamma_B) > 0 \geq \Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B$ which says that first best ordination will not take place but coordination will take place under the assumed conditions.

⁹If only one of these inequalities hold then this is enough to ensure that coordination does not occur.

$$-\theta(\Delta v_A + \Delta v_B) \text{ if coordination doesn't occur} \quad (5.7)$$

Under Case 2 neither the employment first-best, equation (5.2), nor independent contractor first-best, equation (5.3), can be achieved. The relevant comparison here is between equations (5.4)/(5.5) and equations (5.6)/(5.7). Here the conditions necessary for coordination to occur imply that $\theta(\Delta v_A + \Delta v_B) + \Delta\psi_A + \Delta\psi_B > 0$. Comparing this condition to the condition for first best coordination, $\Delta v_A + \Delta v_B + \Delta\psi_A + \Delta\psi_B > 0$, we see there is too little coordination. That is, coordination may not take place even though the payoffs from coordination justify it occurring.¹⁰

Thus if coordination does not occur, then $S_E = S_{IC}$. While if coordination does occur, then which organisational form provides the greater surplus depends, again, on the relative sizes of $\Delta\gamma_A + \Delta\gamma_B$ and $\Delta\psi_A + \Delta\psi_B$. Note also that the employment contract errs on the side of too much coordination while the independent contractor contract errs on the side of too little coordination.

Now assume that inequality (5.1) holds and Case 3 applies. In this case C wants coordination. To start with the employment contract, C can choose coordination and A and B must comply. However given that Case 3 applies, both A and B will be aggrieved, and thus they will both shade resulting in total shading of $\theta(\Delta\gamma_A + \Delta\gamma_B)$. C will change her decision to N if $-\theta(\Delta\gamma_A + \Delta\gamma_B) > \Delta v_A + \Delta v_B$. If this condition holds C will reluctantly agree to the no coordination outcome but is aggrieved and thus shades by an amount $\theta(\Delta v_A + \Delta v_B)$. This gives the social surplus as

$$S_E = \Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B + \theta(\Delta\gamma_A + \Delta\gamma_B) \text{ if coordination occurs} \quad (5.8)$$

$$-\theta(\Delta v_A + \Delta v_B) \text{ if coordination doesn't occur} \quad (5.9)$$

Note that the condition for coordination taking place is $\Delta v_A + \Delta v_B + \theta(\Delta\gamma_A + \Delta\gamma_B) \geq 0$. Comparing this to the condition for first best coordination, $\Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B \geq 0$, we see there is too much coordination, as in Case 2.

In the independent contractor case the preferences of all of A , B and C are aligned, they all want coordination. There is no aggrievement and thus no shading. This means that social

¹⁰Given that $0 < \theta < 1$ and $\Delta v_A + \Delta v_B > 0$, it must be that $\Delta v_A + \Delta v_B + \Delta\psi_A + \Delta\psi_B > \theta(\Delta v_A + \Delta v_B) + \Delta\psi_A + \Delta\psi_B > 0$. This shows that it is possible for $\Delta v_A + \Delta v_B + \Delta\psi_A + \Delta\psi_B > 0 > \theta(\Delta v_A + \Delta v_B) + \Delta\psi_A + \Delta\psi_B$ which implies that first best coordination would take place even if coordination under the assumed condition does not.

surplus is given by

$$S_{IC} = \Delta v_A + \Delta v_B + \Delta \psi_A + \Delta \psi_B, \quad (5.10)$$

the independent contractor's first best outcome. In this case the independent contractor organisational form achieves optimal coordination in addition to the first best outcome. Under Case 3 the employment first best, equation (5.2) cannot be achieved, the best an employment contract can accomplish is (5.8)/(5.9).

When Case 4 applies and inequality (5.1) holds the employment contract archives the first best, as in Case 1: all preferences are aligned, they all want coordination. Social surplus is given by

$$S_E = \Delta v_A + \Delta v_B + \Delta \gamma_A + \Delta \gamma_B \quad (5.11)$$

Under an independent contractor contract both A and B will prevent coordination, which C wants, as is the situation in Case 2. Case 2 also shows that the social surplus as

$$S_{IC} = \Delta v_A + \Delta v_B + \Delta \psi_A + \Delta \psi_B + \theta(\Delta \psi_A + \Delta \psi_B) \text{ if coordination occurs} \quad (5.12)$$

$$-\theta(\Delta v_A + \Delta v_B) \text{ if coordination doesn't occur} \quad (5.13)$$

We also see that under these conditions there is too little coordination, again as explained in Case 2. In this case the employment contract achieves the optimal level of coordination and results in the first best outcome.

For the last scenario it will be assumed that inequality (5.1) holds and Case 5 applies. Again C will favour coordination while A and B have differing views of the desirability of coordination: B wants coordination while A does not.¹¹ In the case of the employment contract C will choose Y . This is in line with B 's preferences and so he is not aggrieved and does not therefore shade. A , on the other hand, is aggrieved and shades by an amount $\theta(\Delta \gamma_A)$. This suggests that C will change her decision to N if $-\theta(\Delta \gamma_A) > \Delta v_A + \Delta v_B$. But it must be remembered that

¹¹Sidepayments from B to A to induce A to accept coordination cannot be made due to the non-verifiability of the private benefits.

the choice of N will aggrieve B thereby leading to shading of $\theta(\Delta\gamma_B)$. So the condition for C to change her choice to N must take B 's (potential) shading into account.¹² The condition is therefore $-\theta(\Delta\gamma_A) > \Delta v_A + \Delta v_B + \theta(\Delta\gamma_B)$. If this condition holds C is aggrieved and shades $\theta(\Delta v_A + \Delta v_B)$ and B is also aggrieved and shades by an amount $\theta(\Delta\gamma_B)$. This results in the social surplus being given as

$$S_E = \Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B + \theta(\Delta\gamma_A) \text{ if coordination occurs} \quad (5.14)$$

$$-(\theta(\Delta v_A + \Delta v_B) + \theta(\Delta\gamma_B)) \text{ if coordination doesn't occur} \quad (5.15)$$

Under the employment contract the condition for coordination can be written

$$\Delta v_A + \Delta v_B + \theta(\Delta\gamma_A + \Delta\gamma_B) > 0 \quad (5.16)$$

To determine whether there is too much or too little coordination this inequality must be compared to

$$\Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B > 0. \quad (5.17)$$

The relationship between inequalities (5.16) and (5.17) is determined by the sign on the $\Delta\gamma_A + \Delta\gamma_B$ term. That is, given that $0 < \theta < 1$

$$\begin{aligned} \Delta v_A + \Delta v_B + \theta(\Delta\gamma_A + \Delta\gamma_B) &> \Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B \\ \text{if and only if } \Delta\gamma_A + \Delta\gamma_B &> 0 \end{aligned}$$

which means, depending on the sign of $\Delta\gamma_A + \Delta\gamma_B$ we can get either too much or too little coordination.

Under the use by C of independent contractors, A and B will make the coordination decision. B will want coordination while A will not and as it requires both A and B to select Y for coordination to occur, it will not occur. This results in both B and C being aggrieved, and thus induces shading, against A , by both of them. C shades by an amount $\theta(\Delta v_A + \Delta v_B)$ and B by an amount $\theta(\Delta\psi_B)$. The condition for A to choose coordination is therefore, $\theta(\Delta v_A + \Delta v_B) +$

¹²An assumption here is that if B shades he shades (fully) against C and not against A .

$\theta(\Delta\psi_B) > -\Delta\psi_A$. This gives social surplus of

$$S_{IC} = \Delta v_A + \Delta v_B + \Delta\psi_A + \Delta\psi_B + \theta(\Delta\psi_A) \text{ if coordination occurs} \quad (5.18)$$

$$-(\theta(\Delta v_A + \Delta v_B) + \theta(\Delta\psi_B)) \text{ if coordination doesn't occur} \quad (5.19)$$

Under the independent contractor's contract the condition for coordination can be written

$$\Delta\psi_A + \theta(\Delta v_A + \Delta v_B) + \theta(\Delta\psi_B) > 0 \quad (5.20)$$

To determine whether there is too much or too little coordination this inequality must be compared to

$$\Delta v_A + \Delta v_B + \Delta\psi_A + \Delta\psi_B > 0. \quad (5.21)$$

The relationship between the values of inequalities (5.20) and (5.21) reduces to

$$(5.21) \gtrless (5.20) \text{ if and only if } (1 - \theta)(\Delta v_A + \Delta v_B + \Delta\psi_B) \gtrless 0 \quad (5.22)$$

which depends on the relative sizes of $\Delta v_A + \Delta v_B$ and $\Delta\psi_A$, given that $\Delta v_A + \Delta v_B > 0$ and $\Delta\psi_A < 0$. Thus both too much and too little coordination are possible.

As to which organisational form results in the greater social surplus, for $S_E > S_{IC}$, assuming coordination occurs, equation (5.14) needs to be greater than equation (5.18), that is

$$\begin{aligned} \Delta v_A + \Delta v_B + \Delta\gamma_A + \Delta\gamma_B + \theta(\Delta\gamma_A) &> \Delta v_A + \Delta v_B + \Delta\psi_A + \Delta\psi_B + \theta(\Delta\psi_A) \\ \Rightarrow \Delta\gamma_A + \Delta\gamma_B + \theta(\Delta\gamma_A) &> \Delta\psi_A + \Delta\psi_B + \theta(\Delta\psi_A) \end{aligned}$$

which may or may not hold depending on the relative size of $\Delta\gamma_A (< 0)$ and $\Delta\gamma_B (> 0)$ and $\Delta\psi_A (< 0)$ and $\Delta\psi_B (> 0)$. If coordination does not occur then $S_E \gtrless S_{IC}$ requires,

$$\begin{aligned} -(\theta(\Delta v_A + \Delta v_B) + \theta(\Delta\gamma_B)) &\gtrless -(\theta(\Delta v_A + \Delta v_B) + \theta(\Delta\psi_B)) \\ \Rightarrow \theta(\Delta v_A + \Delta v_B) + \theta(\Delta\gamma_B) &\gtrless \theta(\Delta v_A + \Delta v_B) + \theta(\Delta\psi_B) \\ \Rightarrow \theta(\Delta\gamma_B) &\gtrless \theta(\Delta\psi_B), \end{aligned}$$

the truth of which depends on the relative sizes of $\Delta\gamma_B$ and $\Delta\psi_B$.

Thus either organisational form could be optimal depending on the preferences of A and B .

What we see from the results above is that the analysis of Hart and Holmström (2010) can be extended to the case of a human-capital based enterprise. Unlike Hart and Holmström we look at a vertical, rather than horizontal, relationship and allow for a choice between an employment contract with C as the employer or the use of an independent contractor contract where C hires A and B as consultants on the production process. Importantly A and B 's private payoffs can depend on whether they are employees or independent contractors. We see that the “preferences” or “types” of the human capital matters in determining the organisational structure of the firm.

5.2.1 summary

One conclusion that follows from the results of these five cases is that heterogeneity of preferences, in the sense of the signs on $\Delta\psi_i$, $\Delta\gamma_i$ and $\Delta v_A + \Delta v_B$ being different, matters in determining the outcome. In the cases where preferences are homogeneous, as in Case 1; the independent contractor contract in Case 3; and the employment contract in Case 4, the first best can be achieved. The outcomes in these cases also achieve the optimal level of coordination. Here the scope of the firm is clear. The productive activities of C 's firm are all undertaken in house given the optimal utilisation of employment contracts under Case 4 while under Case 3 C utilises independent contractors thereby reducing the range of activities undertaken in house. That is, the scope of C 's firm is greater under Case 4 than it is under Case 3. In the remaining cases, heterogeneity of preferences results in the outcomes, which now include deadweight losses, being determined by both the sign and the size of the change in the private benefits. Both under and over levels of coordination can be seen in these outcomes. The scope of the firm is just as inconclusive in these cases. The range of activities taking place within the firm is equally dependent on the size and sign of the change in the private benefits.

This suggests that the organisation of a human capital based firm depends, at least in part, on the “types” of human capital involved in the firm. Having a homogeneous group of human capital involved in a firm may well lead to a different organisational form than that found in a firm which involves a heterogeneous group of human capital. This is an issue examined in more depth in the following sections.

5.3 a toy example

To illustrate some of the basic features of the model developed in the following section we follow Hart (2008) and start with a simple toy model. Our example will start with the parameters as outlined in Table 241.1. This case involves the production of a widget via a production process utilising a combination of non-human capital, NH_C , and the input of a “knowledge worker”, KW . We will assume that the non-human capital and knowledge worker are significantly less productive if producing alone and thus joint production is value enhancing. The effort of the knowledge worker, e_{KW} , in conjunction with the non-human asset and a minor input of effort from the owner of the non-human asset, e_{NH} , are required for the successful production of the widget.

	Widget 1	Widget 2
Price	24	16
e_{NH}	4	1
e_{KW}	10	8
Surplus	10	7

Table 241.1. Payoffs/Costs to widget production

The time line for the relationship is given in Figure 241.2.

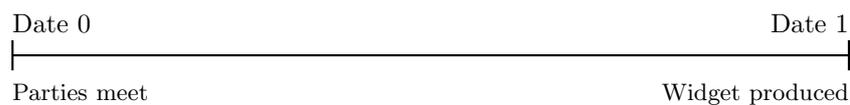


Figure 241.2. Time line.

This time line tells us that NH_C and KW will write a contract some months before the widget is produced, at date 0, rather than at the last minute, date 1. One reason for this is that each party has more options earlier on. In fact it is assumed that there is a competitive market for knowledge workers, at date 0. Two generic forms of organisation will be considered, an independent contractor contract and an employment contract. The wage or consultant’s fee is fixed in the date 0 contract to avoid aggrivement, due to arguments over these payments, and thus shading. The type of widget can not be specified in the date 0 contract, since the details of

the widget are too complicated to be verifiable by the courts. At date 1, however, the choice of the widget becomes clear.

Now we have to compare three organisational forms: two employment contracts and an independent contractor contract. First assume that NH_C and KW are separate firms. Let NH_C and KW agree that KW will act as a consultant to NH_C in the production of the widget for a fixed fee of 10 and that KW will get to choose the type of widget to be produced. They also agree that NH_C owns the widget and can thus receive the proceeds from selling it. This is, in other words, a market exchange involving an independent contractor.

What does KW do? From Table 241.1 we see that KW has lower effort costs, e_{KW} , for the production of widget 2 and thus given the fixed payment of 10 she chooses widget 2. This results in a return for NH_C of the price of the sold widget, 16, minus the effort cost she has to put in, $e_{NH} = 1$, minus the consultant fee of 10. The total surplus for NH_C is therefore $16 - 1 - 10 = 5$. The payment for KW is the consultant fee, 10, minus the effort costs $e_{KW} = 8$, giving 2. Widget 1 is the preferred choice of NH_C since the return to this widget is $24 - 4 - 10 = 10$ which is greater than the return to widget 2, $16 - 1 - 10 = 5$. So NH_C is aggrieved by $10 - 5 = 5$ and thus shades by 5θ . This reduces KW 's return to $2 - 5\theta$. Total social surplus is thus $5 + (2 - 5\theta) = 7 - 5\theta$.

Next let us consider the first of the two employment contracts. Let KW buy the non-human asset and offer NH_C an employment contract. Here the payment of 4 is a (fixed) wage payment. It is being assumed that 4 would be the competitive wage for NH_C at date 0. As KW is the employer she gets to pick the widget to be produced and receives the sale price of it. So for widget 1 KW 's payoff is $24 - 10 - 4 = 10$ which is greater than $16 - 6 - 4 = 6$ which is the payoff for widget 2. For KW $10 - 3\theta$ is the payoff with shading. The 3θ is the cost of shading by NH_C . The payoff for NH_C is $4 - 4 = 0$ giving a social surplus of $10 - 3\theta + 0 = 10 - 3\theta$.

The second employment contract is where NH_C keeps ownership of the non-human asset and offers to employ the knowledge worker. Again the payment of 10 is a wage payment. As NH_C is now the boss she gets to choose the widget to be produced and to keep the revenue from its sale. She decides to produce widget 1 since the returns to 1 are $24 - 4 - 10 = 10$, which is greater than the return to widget 2 which are $16 - 1 - 10 = 5$. The choice of 1 causes KW to shade by 2θ giving NH_C a net return of $10 - 2\theta$. KW 's return is $10 - 10 = 0$. The social return is thus $10 - 2\theta$. Thus the efficient choice of organisational form is an integrated firm owned by NH_C .

Now consider the situation given in Table 243.1.

	Widget 1	Widget 2
Price	24	16
e_{NH}	4	1
e_{KW}	10	6
Surplus	10	9

Table 243.1. Payoffs/Costs to widget production

For the case of an independent contractor the knowledge worker picks widget 2 for a payoff of 5 for NH_C and a payoff of $4 - 5\theta$ for KW . Total surplus is $9 - 5\theta$. When KW is the employer and NH_C the employee, widget 1 is chosen ($24 - 10 - 4 = 10 > 16 - 6 - 4 = 6$) resulting in the payoff for KW being $4 - 3\theta$ and for NH_C the payoff being 0. Thus total surplus is $10 - 3\theta$. Widget 1 is chosen when NH_C is the employer meaning NH_C 's payoff is $10 - 4\theta$, KW 's payoff is 0 and the total surplus is $10 - 4\theta$. Here then the efficient choice of organisational form is an integrated firm owned by KW . This is due to two factors, one being that with KW as the employer the surplus maximising widget 1 is chosen and shading is minimised; the nonhuman capital owner shades by 3 whereas the knowledge worker would shade by 4 .

	Widget 1	Widget 2
Price	24	19
e_{NH}	4	1
e_{KW}	10	6
Surplus	10	12

Table 243.2. Payoffs/Costs to widget production

A third example is given in the Table 243.2. Here the price at which widget 2 can be sold has increased to 19 while all other entries in the table are the same as in the previous example. In the independent contractor case, KW picks widget 2 resulting in a payoff of $4 - 2\theta$ while NH_C receives a payoff of 8. The total surplus is therefore $12 - 2\theta$. When KW is the employer and NH_C the employee the payoff for KW is $10 - 3\theta$ and for NH_C the payoff is 0. Widget 1 is chosen. Thus total surplus is $10 - 3\theta$. For the case of NH_C being the employer, NH_C 's payoff is $10 - 4\theta$, KW 's payoff is 0 meaning a total surplus of $10 - 4\theta$. Again widget 1 has been chosen.

Here then the efficient choice of organisational form is KW being an independent contractor. This is because the surplus maximising widget is selected by KW and the shading costs, due to NH_C , are the lowest of the three alternatives.

Clearly the examples above are toy ones, but they contain the basic ingredients of a theory of the human capital based firm in that they consider the choice between carrying out a transaction in the market, using an independent contractor, and ‘inside the firm’, via an employment contract and they suggest that the firm can under certain circumstances be owned by either the human capital or the non-human.

The reason that ownership of the firm by NH_C is possible is due to the presence of e_{NH} . Without this there would be no shading under KW ownership and thus KW ownership would be efficient and therefore the optimal choice of organisational form. This can be interpreted as suggesting that if human capital based firms are small and made up of a homogeneous group of knowledge workers then some form of worker ownership is optimal. But if the firm gets bigger and introduces more heterogeneity into its workforce, in the examples above the inclusion of effort by the capital owner in the production process, then NH_C ownership becomes possible. This is consistent with firms like partnerships normally consisting of a single group of knowledge worker, e.g. lawyers, doctors but not both, and being small.¹³

5.3.1 summary

The Hart (2008) paper illustrates how the reference point approach to the theory of contracts introduced in Hart and Moore (2008) can be applied to the theory of the firm. What the analysis of the above model suggests is that the same approach can be usefully extended to the case of the human capital based knowledge firm. The model here is a little more complicated than that of Hart (2008) inasmuch as we analyse the production of a homogeneous widget (as opposed to Hart’s musical evening) involving two agents, one of whom, a capital owner, supplies an amount of non-human capital along with a small amount of complementary human capital while the other, a knowledge worker, supplies the majority of the necessary human capital inputs. Hart assumes that one of his agents values the musical evening while the other faces an effort cost of providing the music. In the current model the widget generates revenue via its sale and

¹³There is the question as to what degree legal regulations rather than economic logic drive this observation.

both agents face effort costs. The similarity between the Hart model and the model above is the application of the reference point theory to the analysis of both situations. Hart compares an employment contract with the use of an independent contractor while the current models compares two different employment contracts, the capital owner as employer and the knowledge worker as employer, and the use of an independent contractor. The analysis above illustrates that depending on the values of the price of the widget and the two effort costs each of the three contracts could be optimal. The following section formalizes and expands on the current argument.

5.4 a simple model of a human-capital based firm

The model considered here is a formalised version of the examples discussed in the previous section, so its basic structure is the same. Again we deal with a long-term relationship between an owner of non-human capital and a “knowledge worker”. The time line for the relationship is given in Figure 245.1. The parties meet at date 0 and can transact, in the future, at date 1. We assume that there is, at date 0, a perfectly competitive market for non-human capital and knowledge workers but this competition is much reduced at date 1. At date 1 it is supposed, for the most part, that the owner of the non-human capital and the knowledge worker are bilateral monopolists. We have what Williamson (1985: 61-3) calls a “fundamental transformation” occurring between dates 0 and 1. Here we do not model why this transformation occurs.

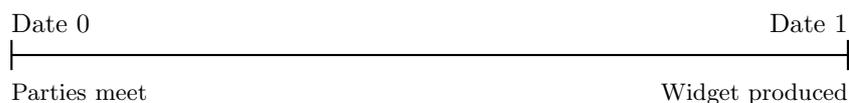


Figure 245.1

In this section three different organisational forms will be compared to determine when each is an optimal way of organising the production of a widget. A simple “make-or-buy” type decision will be studied in so far as a choice between the use of an independent contractor or an employment contract will be made. There are two forms that the employment contract can take. Either the knowledge worker can employ the (ex)non-human capital owner or the non-human capital owner can employ the knowledge worker.

Thus we can think of there being three types of contracts as illustrated in Figure 246.1.

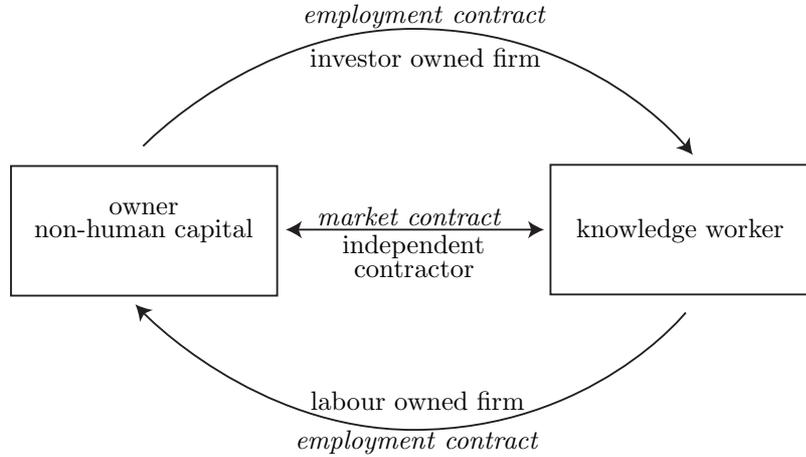


Figure 246.1

The first involves the use of an independent contractor under which the owner of the non-human capital hires the knowledge worker as a consultant on the production process. This can be thought of as a market contract - a “buy” decision. The second is where the owner of the non-human capital employs the human capital (the knowledge worker) which can be thought of as very simple model of an investor or capital owned firm.¹⁴ The third is where the human capital employs the (ex)owner of the non-human capital which can be thought of as a very simple version of a labour owned firm.^{15,16} These employment contracts can be seen as “make” decisions.

More precisely, we consider the situation in which the production of a standard good - a widget, for which there are two possible versions - at sometime in the future, date 1, requires a combination of some non-human capital, NH_C , and a small amount of “effort” by its owner, along with a much more substantive expenditure of “effort” by a knowledge worker, KW . The twist is that at date 0 there is uncertainty about the price, p , the widget can be sold for at date

¹⁴With regard to the difference between capital and labour owned firms Dow (2003: 5) writes “[a] capital-managed firm (KMF) is defined as an enterprise in which ultimate control is allocated by virtue of, and in proportion to, capital supply, while a labor-managed firm (LMF) assigns control by virtue of, and in proportion to, labor supply.”

¹⁵Labour owned firms often employ non-owning workers. A firm of lawyers (a partnership), for example, may employ a secretary or receptionist and/or have “employee lawyers”, none of whom have ownership rights.

¹⁶The modern theory of labour owned firms is normally dated from Ward (1958). For a neoclassical theory of the firm approach to the labour owned firm see Ireland and Law (1982). For a discussion of labour ownership utilising more recent approaches to the theory of the firm see Hansmann (1988: section 5, 1996: chapters 5 and 6) and Dow (2003). Jensen and Meckling (1979) discuss some of the problems with labour owned firms. For a discussion of the (in)famous Yugoslavian experience with labour managed firms see George (1993: chapter 4). George (1993: 62) concludes that the unfortunate Yugoslavian experience cannot be used to illustrate the economic failure of labour managed firms.

1 and the effort costs of the owner of the non-human capital, e_{NH} , and the knowledge worker, e_{KW} . This uncertainty is resolved at date 1. It is assumed that there is symmetric information throughout so that p, e_{NH}, e_{KW} are observable to both the non-human capital owner and the knowledge worker. But they are not observable to third parties and thus are not verifiable and so state-contingent contracts cannot be written.

An independent contractor contract will be said to exist if the non-human capital uses the knowledge worker as a consultant when producing the widget. The consulting contract will specify that the knowledge worker will have the right to decide on which widget is to be made, but the non-human capital will retain ownership of the widget and thus the revenues from selling it. The owner of the non-human capital has the residual control rights in this case. The knowledge worker will be paid a fixed consultant's fee, w . An integrated firm will be said to exist under two conditions. The first of these is when the non-human capital employs the knowledge worker to produce the widget. In this case the non-human capital will decide on the widget to be produced and keep the widget and its revenue while the knowledge worker will be paid a fixed wage, w . Again the non-human capital owner has the residual control rights. The second form of an integrated firm is one where the knowledge worker employs the (ex)non-human capital owner and owns or rents the non-human capital. Here the knowledge worker will decide on the widget to be produced and keep the widget and its revenue while the non-human capital will be paid a fixed wage, w . Here the knowledge worker has the residual control rights.

Table 248.1 outlines the price of the two widgets along with the effort costs for the knowledge worker and the non-human capital and the total surpluses generated in the two cases. The dual role that the NH_C plays here, both as the owner of non-human capital and supplier of effort is similar to that played by the informed party in models 2 and 3 of Rabin (1993). Rabin extends the property rights framework by assuming that an agent has information about how to make production more productive which they are willing to sell. The problem is if the information is not revealed before the agent is paid, a (potential) buyer may have little reason to believe the agent is truly well-informed, but if the agent reveals the information up front, the buyer could simply use the information without payment. In Rabin's two models the informed party has a dual role in that she can supply useful information and after that is revealed she can still contribute to productivity in some other way. Here we can think of NH_C 's human capital as

being complementary to the non-human capital; for example he may be the only person who knows how to operate some necessary piece of machinery; or at least the knowledge worker can not operate it.

	Widget 1	Widget 2
Price	$p + \gamma$	p
Effort cost NH	$e_{NH} + \Delta$	e_{NH}
Effort cost KW	$e_H + \psi$	e_H
Surplus	$p - e_{NH} - e_H + \gamma - \Delta - \psi$	$p - e_{NH} - e_H$

Table 248.1. Price/Costs of widget production

The organisational form that the firm will take will depend on a “make-or-buy” constraint and the relative size of changes in the effort costs of the owner of the non-human capital and the knowledge worker. Results 1 - 8 show the determination of the form of the firm for the case where $\psi > 0$ and $\Delta > 0$.

Result 1 *If $\Delta > 0, \psi > 0, \gamma > \psi, \gamma > \Delta$ with $\Delta > \psi$ and $\gamma > \psi + \Delta$ then ownership of the firm by the owner of the non-human capital is the optimal organisational form.*

These conditions can be interpreted as saying that switching from widget 2 to widget 1 will raise the effort costs for both the human and non-human capital as well as increasing the price of the widget. Also the increase in the effort cost for the non-human asset owner is greater than the increase for the knowledge worker. This means that should an employment contract be selected it is optimal to give ownership of the firm to NH_C since her aggrievement level is greater than that of KW and therefore NH_C cares more about the widget choice than KW . Here the efficient choice of widget is widget 1. $\gamma > \psi + \Delta$ is the ‘make-or-buy’ condition for this case. This condition determines whether an independent contractor or an employment contract will be used. Having a greater surplus for widget 1 means that ownership by NH_C , who selects (the efficient) widget 1, dominates the independent contractor organisational form, under which widget 2 is selected.

Proof: See Appendix

Result 2 *If $\Delta > 0, \psi > 0, \gamma > \psi, \gamma > \Delta$ with either $\psi > \Delta$ and $\gamma < \frac{\psi + \theta \Delta}{1 + \theta} + \Delta$ or $\psi < \Delta$ and $\gamma < \psi + \Delta$ then an independent contractor contract is the optimal organisational form.*

Result 2 gives conditions under which integration does not take place. If this result holds then having two separate firms is optimal. The first set of conditions state that if a employment contract was to be used making KW the employer would be optimal since $\psi > \Delta$. But from the proof of Result 2 we know that $\gamma < \frac{\psi+\theta\Delta}{1+\theta} + \Delta$ is the condition that when shading is taken into account means an independent contractor is preferred to ownership by KW . Note that as $\gamma < \frac{\psi+\theta\Delta}{1+\theta} + \Delta < \psi + \Delta$ ¹⁷, $\gamma < \frac{\psi+\theta\Delta}{1+\theta} + \Delta$ is sufficient for widget 2 being efficient and $\gamma > \psi$ implies a ‘labour-owned firm’ will select widget 1 while the lower effort cost of widget 2 for the independent contractor means he will select the efficient widget 2. Hence the independent contractor is preferred to a ‘labour-owned firm’.

A similar argument applies to the second set of conditions except here the conditions are sufficient for the independent contractor to be preferred over a ‘capital-owned firm’.

Proof: See Appendix

Result 3 *If $\Delta > 0, \psi > 0, \gamma > \psi, \gamma > \Delta$ with $\psi > \Delta$ and $\gamma > \frac{\psi+\theta\Delta}{1+\theta} + \Delta$ then ownership of the firm by the owner of the human capital is the optimal organisational form.*

The condition $\psi > \Delta$ tells us that if an employment contract is used having the human capital as employer is optimal since the knowledge worker has higher levels of aggrivement and shading and thus generates greater deadweight losses. To avoid these losses ownership should be given to the knowledge worker since he cares most about the selection of the widget. The $\gamma > \frac{\psi+\theta\Delta}{1+\theta} + \Delta$ condition is the “make-or-buy” constraint which says that an employment contract is preferred to the use of an independent contractor.

Proof: See Appendix

Result 4 *If $\Delta > 0, \psi > 0, \gamma < \psi, \gamma > \Delta$ then ownership of the firm by the non-human capital is never optimal.*

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$$\begin{aligned}
 \frac{\psi + \theta\Delta}{1 + \theta} + \Delta &< \psi + \Delta \\
 \psi + \theta\Delta &< (1 + \theta)\psi \\
 \theta\Delta &< \theta\psi \\
 \Delta &< \psi \quad \text{which is true by assumption}
 \end{aligned}$$

We have that $\Delta < \gamma < \psi$, which says that if an employment contract is optimal then the knowledge worker should be the employer. The alternative to an employment contract is an independent contractor. Either way ownership by the non-human capital is not optimal.

Proof: See Appendix

Result 5 *If $\Delta > 0, \psi > 0, \gamma < \psi, \gamma > \Delta$ then use of an independent contractor is never optimal.*

$\gamma < \psi < \psi + \Delta$ which implies the use of an independent contractor is optimal but only if the alternative employment contract has the non-human capital as the employer. But with $\psi > \Delta$ having the human capital as owner would be optimal.

Proof: See Appendix

Result 6 *If $\Delta > 0, \psi > 0, \gamma < \psi, \gamma > \Delta$ then human capital ownership is optimal.*

This is implied by Results 4 and 5.

Proof: See Appendix

Results 3 - 6 reinforce the idea that ownership by the knowledge worker makes sense when the relative important of the human capital is high. The fact that $\psi > \Delta$ indicates that in a switch from widget 2 to widget 1 the effort costs of the knowledge worker increases by more than those of the non-human capital and thus the aggrievement of the knowledge worker is greater than the non-human capital and thus the shading potential of the knowledge worker is also greater than that of the non-human capital. Ownership is therefore placed in the hands of the group that has the greatest interest in the choice of the widget. This suggests that if the firm has a homogeneous group of knowledge workers whose interests are highly correlated, and thus their reasons for aggrievement and levels of aggrievement, ψ in the model, are similar, then labour ownership is likely to be a stable organisation form. Dow (2003: 251) makes the point that the congregation of labour-owned firms in areas in which there is limited division of labour and the skill sets of workers are similar is due, in part, to having to overcome problems related to heterogeneity of preferences:

“[t]he heterogeneity of worker preferences can account for the tendency of LMFs [labour-managed firms] to congregate in industries where workers have similar skills and firms have a limited division of labor. This is a feature of most traditional workers’

cooperatives and many professional partnerships. [...] Asymmetries in the internal composition of control groups can thus explain various observations about the design, incidence, and life cycles of LMFs that would be difficult to rationalize in terms of financial constraints alone.”

The restriction to workers with similar skills with little utilisation of the division of labour reduces the heterogeneity of worker preferences, e.g. the workers are all of “type ψ ”, and this reduces asymmetries in the composition of the controlling group thereby reducing aggrivement and shading.¹⁸

Hansmann (1996: 91) asks the question, with regard to employee-owned firms, “Which Firms Succeed?” In part his answer is,

“[t]he most striking evidence of the high costs of collective decision making [for employee-owned firms] is the scarcity of employee-owned firms in which there are substantial differences among employees who participate in ownership. Most typically, employee-owned firms all do extremely similar work and are of essentially equivalent status within the firm. Rarely do they have substantially different types or levels of skills, and rarely is there much hierarchical authority among them.”

When considering what constitutes homogeneity of interest for employee ownership Hansmann writes,

“[t]he preceding evidence implies that employee ownership works best where the employee-owners are so homogeneous that any decision made by the firm will affect them roughly equally, or where, though the employees differ in ways that cause the burdens and benefits of some decisions to be shared unequally, there is an objective and widely accepted basis for making those decisions. That is, employee ownership is most viable where either no important conflicts of interest exist among the employee-owners, or some simple and uncontroversial means is available to resolve the conflicts that are present.” (Hansmann 1996: 97).

Such observations are consistent with the basic results of this section. What we gain from the results above is an understanding, in terms of reducing aggrivement and shading, of why

¹⁸Having team members of a similar “types” also makes mutual monitoring less costly as each worker knows what the others should be doing and thus reduces opportunism.

homogeneity is important.

If we increase the heterogeneity of the firm's workforce by increasing the relative importance of the non-human capital owner in the model, then the optimal organisational form will move away from a 'labour-owned firm'. See Results 1 and 7.

Result 7 *If $\Delta > 0, \psi > 0, \gamma > \psi, \gamma < \Delta$ then independent contractor and non-human ownership result in the same efficient outcome and both dominate human capital ownership.*

Proof: See Appendix

Result 8 *If $\Delta > 0, \psi > 0, \gamma < \psi, \gamma < \Delta$ then independent contractor, non-human ownership and human ownership all result in the same efficient outcome.*

Result 8 gives us the conditions under which all three organisational forms select the efficient widget, widget 2, and there is no shading in any case and thus all three result in the same total surplus. With no deadweight loss generated, ownership ceases to matter.

Proof: See Appendix

As in section 5.3 we see that the reason that ownership of the firm by the non-human capital is possible is due to the presence and size of the effort costs of the owner of the non-human capital. Without this there would be no shading under human capital ownership and thus control of the firm by the knowledge worker would be efficient and therefore the optimal choice of organisational form. This can be interpreted as suggesting that if human capital based firms are made up of a homogeneous group of knowledge workers then some form of worker ownership is optimal. But if the firm introduces more heterogeneity into its workforce - in the simple model used here, the inclusion of effort by the capital owner in the production process - then ownership by the non-human capital becomes possible. As already noted this is consistent with firms like partnerships normally consisting of a single group of knowledge worker, e.g. lawyers, doctors but not both.

5.4.1 does size matter?

Brynjolfsson (1994) argues that small firms have advantages in the provision of incentives for the exploitation of information. In Brynjolfsson's view small firms therefore have an advantage over larger ones in situations in which it is important to provide incentives for the application

of information in ways that cannot be easily foreseen and incorporated into a contract. Brynjolfsson (1994: footnote 12) goes further by noting that the stronger, output-based incentives for the non-contractible actions in smaller firms will not only induce higher effort overall, but in multidimensional models, will also induce less effort on actions that do not enhance output.

In the model of the current section the role of size is to help determine the ownership structure of the firm. Insofar as smaller firms are more homogeneous, some form of labour ownership is more likely. Partnerships, for example, tend to be small. If as a firm grows so does the heterogeneity of that firm then the possibility of aggrivement and thus shading resulting in deadweight losses also grows. If this is interpreted as an increase in Δ for the current model, then the likelihood of non-labour ownership increases. This also implies that investor-owned human-capital based firms will tend to be larger than similar firms that are labour-owned.

5.4.2 does scope matter?

Kling (2010: 47) makes the argument that as knowledge becomes more specialised the scope of firms will tend to decrease, that is, the range of activities carried out by an individual (knowledge-based) firm will decrease. Being highly competent in one specialised area means that it likely that you will have to make decisions outside your area of expertise if the firm has broad scope. If, as seems reasonable, a decrease in activities is associated with a reduction in the heterogeneity of the types of knowledge workers employed in the firm then some form of labour ownership is more likely. Again partnerships such as lawyers or accountants are an example where labour ownership and limited scope coincide.

5.4.3 why are there conversions to investor ownership?

In raising this question Hansmann (1996: 83) writes

“[i]f [...] there is no perverse mechanism that causes successful employee firms to convert to investor ownership simply as a consequence of their very success, then why do conversions from employee ownership to investor ownership occur so frequently?”

The answer suggested here would be that conversion can in fact be a result of the success of the firm, at least for human-capital based employee owned firms.¹⁹ If success means growth of the firm and thus increased heterogeneity of the firm then conversion makes sense. In the model an increase in heterogeneity can be interpreted as the introduction of or increase in Δ which changes the relative sizes of Δ and ψ and thus could result in a change in ownership.

5.4.4 summary

In the simple model developed in this section the optimal organisational form is determined by two conditions. First there is a “make-or-buy” constraint which picks an independent contractor contract or an employment contract depending on which contractual type results in the optimal widget, 1 or 2, being chosen. Second, if an employment contract is chosen then the owner of the integrated firm is whoever has the highest grievement level, and thus will shade the most. This person will care most about the choice of widget and thus it makes sense to allocate ownership to them. Some of the conclusions noted above give conditions under which more than one of the possible organisational forms result in the efficient outcome.

5.5 conclusion

The models of the human-capital based firm developed in this chapter suggest that the ownership structure that such a firm will develop depends on more than just the fact that the knowledge worker is the firm’s primary source of value added. A frequently observed organisational form that human-capital based firms take is some form of labour-owned firm, a partnership being the most common example. As human capital has increased in importance, as the “knowledge economy” has expanded, some commentators have argued that knowledge based firms are developing organisational structures along the lines of partnerships. As noted in Chapter 2, Rajan and Zingales (2003: 90) argue that,

“[h]uman capital is replacing inanimate assets as the most important source of corporate capabilities and value. In both their organizational structure and their promotion

¹⁹Hansmann’s answer is that “[t]he most likely explanation is simply that employee ownership is not an efficient mode of organization for the firms involved.” (Hansmann 1996: 83). Dow (2003: 225) offers two other reasons: employees may no longer need the insurance features of a LMF and for collective choice reasons investors may be able to design a takeover offer 51% of a LMF’s members will accept.

and compensation policies, large firms are becoming more like professional partnerships.”

One conclusion from the work of this chapter is that while there is truth to the Rajan and Zingales claim, it is not likely that their argument is universally applicable. While some firms may move towards a more partnership like structure, others will maintain a more traditional organisational framework.

The models of this chapter show that differences in preferences or in the “types” of human capital matter for the choice of organisational form. From the first model we see that when preferences are homogeneous the first best can be achieved with the optimal level of coordination occurring and the scope of the firm being clearly defined. Heterogeneity of preferences results in both the level of coordination and the scope of the firms being dependent on the parameter values. Also we find that deadweight losses can occur.

In the second model it is shown that the more heterogeneous the human capital used by the firm the more likely is an investor owned firm to be formed. The labour-owned firm is more likely to be formed when the human capital is relatively homogeneous in its characteristics and faces a common set of incentives. The pirate example at the beginning of the chapter is an unusual example of this. Another (more usual) example of a human-capital based “firm”, but one where labour-owned firms are seldom, if ever, found, due to the heterogeneity of the human-capital involved, is that of the professional sports team. Here we have a situation where human capital, talent at playing a particular sport, is the basis for the “firm” but ownership by the human capital, the players, is extremely rare since a worker-owned team would be at a disadvantage relative to a player-as-employee based team.

Heterogeneity among playing talent and thus earning potential²⁰ acts as a disincentive to the formation of a worker cooperative, which involves (rough) equality in payment²¹, since those players with the greatest earning potential, the largest outside options, will transfer away from

²⁰As Goddard and Sloane (2005: 353) explain “[r]eal stars are few in number and possess skills that cannot be easily replicated by training the average player more intensively. Rosen (1981) referred to this as the superstar phenomenon, and illustrated how human capital interacted with production technology to magnify small differences in talent, resulting in large differences in earnings. [...] Characteristically, wages are highly convex with respect to star quality, resulting in a highly skewed distribution of earning with a long upper-tail to the distribution.”

²¹Some worker cooperatives do require all staff to be paid the same wages while others have a limit on the range of pay offered. Such limit is normally expressed as a ratio of the highest paid worker to the lowest paid, e.g. 3:1 or 4.5:1. Also an owner’s allocation of the “profits” of the firm will be proportionate to that owner’s labour input, so for similar labour inputs, owners receive a similar allocation of “profits”. Thus overall compensation is commonly roughly equal.

the cooperative to maximise their income stream.²² Differential payment schemes can occur, especially within partnerships, but they require that the individual employee productivities are sufficiently easy to measure so that a relatively objective method of productivity related pay is possible. Given the team production nature of team sports productivities are difficult, if not impossible, to estimate and thus payment by productivity is not feasible, which argues in favour of equality in payments. Thus a worker-owned team would have few, if any, star players, a handicap in the winner-takes-all world of professional sports.^{23,24}

Another issue for a cooperative sports team is that while the star players may leave the team too soon, the “average players” may stay too long. The average players will have smaller outside options and thus less incentive to leave but as they are also owners of the team it would be more difficult to get rid of those who are not performing. It would be easier for an employee-based team to remove under performing players as they are not owners of the firm.

Also to the degree that exit barriers are entry barriers a worker-owned organisation is at a disadvantage. Such an organisation could hinder rapid transfers between clubs. Problems with transfers could arise, for example, if the terms of the exit have to be negotiated with the remaining player-owners at the time of exit. Or the remaining owners may be unable or unwilling to buy out the exiting player – under a “right of first refusal” or “right of first offer” scheme – or any of them could veto an incoming replacement player-owner. Also there is the question of the value of a player’s interest in the team as well as the question of the time period over which an agreed upon value would be paid. These costs make exit more difficult than it would be under

²²Ricketts (1999: 20) explains the problem as “[f]urther, to minimise antagonism a rough equality in the division of the residual will be necessary and this may conflict with outside opportunities. Those with high transfer earnings reflecting high productivity elsewhere will desert the co-operative. It is for these reasons that control of the firm by its labour force is usually found in circumstances which permit a high degree of common interest.” Jossa (2009: 709-10) explains the basic issue in terms of the management of capitalistic versus co-operative firms: “[g]iven the tendency of cooperatives to distribute their income equitably among all the members, it is difficult to deny that few cooperatives are in a position to pay the high salaries that able managers can expect to earn in capitalistic firms. Whenever a group of people resolve to work as a team-we may add-the member who outperforms the others in initiative and organizational skills will inevitably take the lead. The crux of the matter is that such a person has no incentive to establish a cooperative and share power and earnings with others. He or she will prefer to found a capitalistic firm, where he or she will hold all authority and, if sole owner, appropriate the whole of the surplus [references deleted]

²³Scully (2008) notes that there is a relationship between a team’s finances and a team’s success since better financed teams can buy the best players: “[h]ow good a professional sports team is depends, of course, on the quality of its players. Because teams compete for better players by offering higher salaries, the quality of a team depends largely on how strong it is financially. The financially stronger teams will, on average, be the better teams.”

²⁴One way around the problem is to pay all players the amount necessary to retain the best player. But this implies paying most players more than their productivities and has obvious implications for the team’s budget constraint. This would also aggravate the problem of non-performing average players-owners not wanting to leave the team.

an employment contract and thus tend to lock-in the player/owner to the team. Such lock-in is a disincentive to forming, or joining, a labour-owned firm, especially for the best players.²⁵ Many of these problems can, to a degree, be contracted around but this imposes additional negotiation costs at the time of entry into the team, which again is a disincentive to forming a worker-owned team. Utilising a worker-owned organisation results in additional haggling costs, either *ex ante* or *ex post*, relative to a player-as-employee team.

Put simply, an employee can leave an organisation more quickly and easily than an owner and in the case of professional sports, transfers between teams, or at least a credible threat to transfer, are particularly valuable to the best players. Therefore a player-owned team would be at a competitive disadvantage compared to teams comprised of employee players.

An alternative interpretation of the models developed above is that it shows that organisational form depends, in part, on the relative mix of the inputs used in production. For a largely human capital based firm some form of labour-ownership is feasible while for a firm with a greater (relative) use of non-human capital, a capital owned organisation is more likely.

To see this, note that within this framework an increase in Δ , relative to ψ , increases the relative importance of the non-human capital compared to the human capital. So as the amount of non-human capital the knowledge worker needs to be productive increases, the ability of the non-human capital owner to shade, and thus his ability to impose welfare losses, also increases. Thus what we see is that when the firm is homogeneous in its inputs, in the sense that they consist largely of the efforts of the knowledge worker – meaning Δ is relatively small – some form of worker-owned organisation is feasible. But as the relative importance of the non-human capital increases, that is, the heterogeneity of inputs increases with Δ becoming relatively large, the firm begins to look more ‘traditional’ in its input mix and thus begins to look more traditional in its organisation form in that a capital-owned firm becomes increasingly likely. If you are a computer scientist using a PC to design small business accounting software then the firm being a partnership is feasible whereas if you are writing software for a super-computer you are more

²⁵There are also problems such as those which could arise between the manager or coach and the player/owners in their roles as players and as owners. In addition to this there is the problem that if the players provide any financial capital the team needs themselves they risk being badly underdiversified. If the team goes bankrupt they lose not only their job but also (at least part of) their savings. Given the short time span that a player is likely to be a member of the team there is the issue of the return on any capital the player has invested in the team. To ensure a suitable post playing standard of living players are likely to place an emphasis on high returns on their investments.

likely to be an employee of whoever owns/rents the computer.

A somewhat more unorthodox interpretation of the model would arise if we were to think about the model as one without non-human capital, that is, a model with just two “types” of human capital and thus both Δ and ψ would represent effort by knowledge workers. First, consider what happens if Δ and ψ are approximately the same. Here it is not clear who the owner should be as each “type” can shade to, roughly, the same degree, albeit for different reasons. This could make the ownership of the firm indeterminate and the firm seemingly unstable. What is to stop one or other of the knowledge workers from just announcing one morning that they have become a new firm? Such a result would be consistent with Hart’s (1995: 56-7) argument that even a human-capital based firm needs some non-human capital to act as “glue” to keep the firm together.²⁶

Next assume that one of either Δ or ψ is larger than the other. Here the results of Section 5.4 could then be interpreted as showing why human-capital only firms tend to be owned by a single “type” of human capital. Ownership would be allocated to whichever of the “types” of human capital is most likely to be aggrieved and thus most able to shade. This makes sense as it minimises any possible deadweight losses. The problem is the same as the previous case, the concept of the firm is not well defined. Again it is not clear why the firm would stay together, What is the “glue” in this case? What stops the owner from forming a new firm without the non-owner or the non-owner forming his own firm?

What these last two paragraphs highlight is the importance of the non-human capital in the model. Without this it seems a firm is little more than a single knowledge worker, a phantom without any real organisation or structure.

Thus we observe the most common form of worker ownership, partnerships, in situations where the firms are small and the human input is of a single “type”, e.g. partnerships consisting of just lawyers or just doctors but not both. Also the partners in the firm tend to stay with the firm for a long period which minimises the exiting problem.

What this suggests is that a human-capital only firm with heterogeneous human capital is likely to be unstable and thus a long lasting human-capital only firm will consist of homogeneous

²⁶Hart (1995: 56) notes that the non-human capital could be as simple as “[...] patents, client lists, files, existing contracts or the firm’s name or reputation.” Or it could be a good location for carrying out the firm’s business or a contract preventing the non-owner from working for competitors, etc.

human capital. A firm which involves heterogeneous human capital will require some “glue”, in the form of non-human capital of some kind, to remain viable. Given the importance of this glue to the firm ownership of the firm by the owner of the non-human capital is likely.

In the models of this chapter, size helps to determine ownership structure in that smaller firms are more likely to be homogeneous in their labour inputs and thus some form of labour ownership is more likely. If as firms grow so does the heterogeneity of their knowledge workforce then the possibility of aggrievement and thus shading resulting in deadweight losses also grows. The results of this chapter would suggest therefore that the likelihood of non-labour ownership increases. The scope of the firm has similar results for its organisational form. Being highly competent in one specialised area means that it is likely that you will have to make decisions outside your area of expertise if the firm has broad scope. If, as seems reasonable, a decrease in activities is associated with a reduction in the heterogeneity of the types of knowledge workers employed in the firm then some form of labour ownership is more likely.

Thus it is not only the fact in the knowledge economy human capital is becoming more important to firms that determines a firm’s organisational structure but it is also the heterogeneity of that human capital which is important in this regard.²⁷

²⁷This does raise the question of what “homogeneity” of interest is. Hansmann (1996: 97-8) considers this question and notes that there is no unique answer. “It follows that homogeneity of interest is, in important degree, a social construct. Consequently, what passes for homogeneity in one setting may not in another.” (Hansmann 1996: 98).

appendix: proofs of results

Proof of Result 1: First compare the performance of the non-human capital owned firm, (NH_C), with that of the independent contractor. In the independent contractor case the knowledge worker, (KW), acts as a consultant to NH_C on the production of the widget. KW receives a fixed fee, w . Given this fixed fee it is optimal for him to pick widget 2 given the lower effort cost associated with widget 2: $e_{KW} < e_{KW} + \psi$ as $\psi > 0$. The payoff for KW will therefore be $w - e_{KW}$. The payoff of NH_C is $p - e_{NH} - w$. NH_C will shade because his payoff is less than that he would have received had widget 1 been chosen: $p - e_{NH} - w + \gamma - \Delta > p - e_{NH} - w$ given $\gamma > \Delta$. NH_C shades by an amount $\theta(\gamma - \Delta)$. The total surplus will therefore be $p - e_{NH} - w + w - e_{KW} - \theta(\gamma - \Delta) = p - e_{NH} - e_{KW} - \theta(\gamma - \Delta)$.

In a non-human capital owned firm, NH_C employs the knowledge worker to produce the widget. If NH_C owns the firm then he will pick widget 1 as the payoff is higher: $p + \gamma - e_{NH} - \Delta - w > p - e_{NH} - w$ since $\gamma > \Delta$. The payoff for KW is $w - e_{KW} - \psi$. KW will shade by amount $\theta\psi$ since his effort costs are $e_{KW} + \psi$ for widget 1 against e_{KW} for widget 2. The total surplus will therefore be $p + \gamma - e_{NH} - \Delta - w + w - e_{KW} - \psi - \theta\psi = p + \gamma - e_{NH} - \Delta - e_{KW} - \psi - \theta\psi$.

Thus the condition for the total surplus of a non-human capital owned firm to be greater than the total surplus of an independent contractor is

$$\begin{aligned}
 p + \gamma - e_{NH} - \Delta - e_{KW} - \psi - \theta\psi &> p - e_{NH} - e_{KW} - \theta(\gamma - \Delta) \\
 \gamma - \Delta - \psi - \theta\psi &> -\theta(\gamma - \Delta) \\
 (\gamma - \Delta) + \theta(\gamma - \Delta) &> \psi + \theta\psi \\
 (\gamma - \Delta)(1 + \theta) &> \psi + \theta\psi \\
 \gamma - \Delta &> \frac{\psi(1 + \theta)}{(1 + \theta)} \\
 \gamma &> \psi + \Delta.
 \end{aligned}$$

In a human capital owned firm, KW employs the NH_C to produce the widget. If KW owns the firm then he will pick widget 1 as the payoff is higher: $p + \gamma - e_H - \psi - w > p - e_H - w$ since $\gamma > \psi$. The payoff for NH_C is $w - e_{NH} - \Delta$. NH_C will shade by amount $\theta\Delta$ since his effort costs are $e_{NH} + \Delta$ for widget 1 against e_{NH} for widget 2. The total surplus will therefore be

$$p + \gamma - e_H - \psi - w + w - e_{NH} - \Delta - \theta\Delta = p + \gamma - e_H - \psi - e_{NH} - \Delta - \theta\Delta.$$

Thus the condition for the total surplus of a non-human capital owned firm to be greater than the total surplus of a human-capital-owned firm is

$$\begin{aligned} p + \gamma - e_{NH} - \Delta - e_{KW} - \psi - \theta\psi &> p + \gamma - e_H - \psi - e_{NH} - \Delta - \theta\Delta \\ -\theta\psi &> -\theta\Delta \\ \theta\psi &< \theta\Delta \\ \psi &< \Delta. \end{aligned}$$

Thus for the given parameter values the surplus for the non-human capital owned firm is greater than the alternatives. ■

Proof of Result 2: We know the equations for the surpluses of the three organisational forms from the proof of result 1. Thus we just need to show the conditions under which an independent contractor contract dominates the alternatives. For the independent contractor to dominate the non-human capital ownership we need:

$$\begin{aligned} p - e_{NH} - e_{KW} - \theta(\gamma - \Delta) &> p + \gamma - e_{NH} - \Delta - e_{KW} - \psi - \theta\psi \\ -\theta(\gamma - \Delta) &> \gamma - \Delta - \psi - \theta\psi \\ \psi + \theta\psi &> (\gamma - \Delta) + \theta(\gamma - \Delta) \\ (1 + \theta)(\gamma - \Delta) &< (1 + \theta)\psi \\ \gamma &< \psi + \Delta. \end{aligned} \tag{5.23}$$

Comparing the independent contractor with the human capital owned firm we get:

$$\begin{aligned} p - e_{NH} - e_{KW} - \theta(\gamma - \Delta) &> p + \gamma - e_{KW} - \psi - e_{NH} - \Delta - \theta\Delta \\ -\theta(\gamma - \Delta) &> \gamma - \Delta - \psi - \theta\Delta \\ \psi + \theta\Delta &> (\gamma - \Delta) + \theta(\gamma - \Delta) \\ (1 + \theta)(\gamma - \Delta) &< \psi + \theta\Delta \\ \gamma &< \frac{\psi + \theta\Delta}{(1 + \theta)} + \Delta \end{aligned} \tag{5.24}$$

Depending on the relative values of Δ and ψ we can rank the righthand sides of equations (5.23) and (5.24).

$$\begin{aligned} \frac{\psi + \theta\Delta}{(1 + \theta)} + \Delta &\gtrless \psi + \Delta \\ \frac{\psi + \theta\Delta}{(1 + \theta)} &\gtrless \psi \\ \psi + \theta\Delta &\gtrless \psi(1 + \theta) \\ \theta\Delta &\gtrless \psi\theta \\ \Delta &\gtrless \psi \end{aligned}$$

Thus if $\Delta > \psi$ then $\gamma < \psi + \Delta < \frac{\psi + \theta\Delta}{(1 + \theta)} + \Delta$ and if $\Delta < \psi$ then $\gamma < \frac{\psi + \theta\Delta}{(1 + \theta)} + \Delta < \psi + \Delta$. This means that either $\psi > \Delta$ and $\gamma < \frac{\psi + \theta\Delta}{1 + \theta} + \Delta$ or $\psi < \Delta$ and $\gamma < \psi + \Delta$ will satisfy both (5.23) and (5.24). ■

Proof of Result 3: We know the equations for the surpluses of the three organisational forms from the proof of result 1. Thus we just need to show the conditions under which human ownership dominates the alternatives. First consider human ownership against the independent contractor.

$$\begin{aligned} p + \gamma - e_H - \psi - e_{NH} - \Delta - \theta\Delta &> p - e_{NH} - e_{KW} - \theta(\gamma - \Delta) \\ \gamma - \psi - \Delta - \theta\Delta &> -\theta(\gamma - \Delta) \\ (\gamma - \Delta) + \theta(\gamma - \Delta) &> \psi + \theta\Delta \\ (1 + \theta)(\gamma - \Delta) &> \psi + \theta\Delta \\ \gamma &> \frac{\psi + \theta\Delta}{1 + \theta} + \Delta. \end{aligned}$$

Next consider the case of the human capital owned firm against the non-human capital owned firm.

$$\begin{aligned} p + \gamma - e_H - \psi - e_{NH} - \Delta - \theta\Delta &> p + \gamma - e_{NH} - \Delta - e_{KW} - \psi - \theta\psi \\ -\theta\Delta &> -\theta\psi \\ \Delta &< \psi. \end{aligned}$$

Thus for the given parameter values the surplus for the human capital owned firm is greater than the alternatives. ■

Proof of Result 4: For the case of the independent contractor, KW will pick widget 2 as he receives a fixed fee and costs are lower for him with widget 2: $e_{KW} < e_{KW} + \psi$ given $\psi > 0$. KW 's payoff will therefore be $w - e_{KW}$. NH_C 's payoff will be $p - e_{NH} - w$. NH_C will shade by an amount $\theta(\gamma - \Delta)$ since his payoff would be higher for widget 1: $p - e_{NH} - w + \gamma - \Delta > p - e_{NH} - w$ since $\gamma - \Delta > 0$.

Total surplus is therefore $p - e_{NH} - e_{KW} - \theta(\gamma - \Delta)$.

If the non-human capital is the employer then he will choose widget 1 since his payoff would be higher: $p - e_{NH} + \gamma - \Delta - w > p - e_{NH} - w$ given that $\gamma > \Delta$. NH_C 's payoff is $p - e_{NH} + \gamma - \Delta - w$. KW 's payoff will be $w - e_{KW} - \psi$. KW will shade by an amount $\theta\psi$ given his costs are ψ higher for widget 1.

Total welfare will be $p - e_{NH} + \gamma - \Delta - e_{KW} - \psi - \theta\psi$.

NH_C ownership will dominate IC if

$$\begin{aligned} p - e_{NH} + \gamma - \Delta - e_{KW} - \psi - \theta\psi &> p - e_{NH} - e_{KW} - \theta(\gamma - \Delta) \\ \gamma - \Delta - \psi - \theta\psi &> -\theta(\gamma - \Delta) \\ (1 + \theta)(\gamma - \Delta) &> (1 + \theta)\psi \\ \gamma - \Delta &> \psi \\ \gamma &> \psi + \Delta \end{aligned}$$

But $\gamma \not> \psi + \Delta$ given that by assumption it is less than ψ .

Under KW ownership widget 2 will be chosen since $p - e_{KW} - w > p - e_{KW} - w + \gamma - \psi$ which implies $\gamma - \psi < 0$ which is true as $\psi > \gamma$. KW 's payoff will be $p - e_{KW} - w$ while NH_C 's payoff will be $w - e_{NH}$. NH_C will not shade as his costs are less under widget 2

Total surplus will be $p - e_{KW} - w + w - e_{NH} = p - e_{KW} - e_{NH}$.

Thus HN_C ownership will dominate KC ownership if

$$\begin{aligned} p - e_{NH} + \gamma - \Delta - e_{KW} - \psi - \theta\psi &> p - e_{KW} - e_{NH} \\ \gamma - \Delta - \psi - \theta\psi &> 0 \\ \gamma &> \Delta + \psi + \theta\psi. \end{aligned}$$

But this cannot be true since $\gamma < \psi$ by assumption.

Thus NH_C ownership dominates neither of the other organisational forms. ■

Proof of Result 5: For IC to dominate NH_C it must be that

$$\begin{aligned} p - e_{NH} - e_{KW} - \theta(\gamma - \Delta) &> p - e_{NH} + \gamma - \Delta - e_{KW} - \psi - \theta\psi \\ -\theta(\gamma - \Delta) &> \gamma - \Delta - \psi - \theta\psi \\ \theta(\gamma - \Delta) &< -\gamma + \Delta + \psi + \theta\psi \\ (1 + \theta)(\gamma - \Delta) &< \psi(1 + \theta) \\ \gamma &< \psi + \Delta. \end{aligned}$$

But this cannot be true because $\gamma > \Delta$ by assumption. For IC to dominate KW it must be

$$\begin{aligned} p - e_{NH} - e_{KW} - \theta(\gamma - \Delta) &> p - e_{KW} - e_{NH} \\ -\theta(\gamma - \Delta) &> 0 \end{aligned}$$

which cannot be true since $\gamma > \Delta$. ■

Proof of Result 6: For human capital ownership to be optimal it must be that it dominates both non-human ownership and the independent contractor. To show the first part:

$$\begin{aligned} p - e_{KW} - e_{NH} &> p - e_{NH} + \gamma - \Delta - e_{KW} - \psi - \theta\psi \\ 0 &> \gamma - \Delta - \psi - \theta\psi \\ \gamma &< \psi + \Delta + \theta\psi \end{aligned}$$

which is true because $\psi > \gamma$ alone.

For the second part:

$$\begin{aligned} p - e_{KW} - e_{NH} &> p - e_{NH} - e_{KW} - \theta(\gamma - \Delta) \\ 0 &> -\theta(\gamma - \Delta) \end{aligned}$$

which is true since $\gamma > \Delta$. ■

Proof of Result 7: Given that $\psi > 0$ for the case of the independent contractor, KW will pick widget 2 since he faces a fixed fee and widget 2 has lower effort costs. KW 's payoff will be $w - e_{KW}$. NH_C 's payoff will be $p - e_{NH} - w$. There will be no shading by NH_C since $p - e_{NH} - w > p - e_{NH} - w + \gamma - \Delta$ because $\Delta > \gamma$. Total surplus will be $p - e_{NH} - e_{KW}$.

For the case where NH_C is the employer he will pick widget 2 since $p - e_{NH} - w > p - e_{NH} - w + \gamma - \Delta$ given that $\Delta > \gamma$. KW will not shade since widget 2 is his least-effort cost state. Thus the total surplus will be $p - e_{NH} - e_{KW}$. This shows that in this case the independent contractor case and the NH_C employer case give the same efficient outcome.

In the third case where KW is the employer, KW will pick widget 1 since $p + \gamma - e_{KW} - \psi - w > p - e_{KW} - w$ because $\gamma > \psi$. KW 's payoff is $p + \gamma - e_{KW} - \psi - w$ while NH_C 's payoff is $w - e_{NH} - \Delta$ which is less than his payoff for widget 2 which is $w - e_{NH}$ because $\Delta > 0$. This means NH_C will shade by an amount $\theta\Delta$. Total surplus will therefore be $p - e_{NH} - e_{KW} + \gamma - \psi - \Delta - \theta\Delta$. Given that $\gamma < \psi + \Delta + \theta\Delta$, since $\gamma < \Delta$ by assumption, human capital ownership is dominated by both other alternatives. ■

Proof of Result 8: Given the fixed consultants fee, KW will choose the least cost widget which is widget 2. γ being less than Δ means NH_C maximises his surplus with widget 2 and thus will not shade. As γ is less than both ψ and Δ there is no incentive for either employer to pick widget 1 and as widget 2 is least cost for both KW and NH_C , neither will shade. As all three organisational types pick the efficient outcome and there is not shading in any situation, all three organisational forms must result in the same level of total surplus. ■

Chapter 6

Conclusion

“I see the knowledge/power discrepancy as a generic problem not limited to financial services. Knowledge is becoming more specialized and more dispersed, while government power is becoming more concentrated. This discrepancy creates the potential for government to become increasingly erratic and unaccountable and, as a result, less satisfying to individuals.”

Kling (2010: 39).

The knowledge/power discrepancy Kling refers to in the quote above is an unintended consequence of growing importance of knowledge in the economy and society more generally. In his discussion of the reasons underlying the recent financial crisis in the U.S. Kling argues that this discrepancy operated at the level of the firm. Here the discrepancy is between the “suits” and the “geeks”. The top-level decision makers – “suits” – at financial firms (and at the agencies regulating the financial sector) did not fully understand the environment they were operating in. Much of the critical knowledge was located further down their organisations, it was held by the financial engineers, or “geeks”. The “suits” had the power to make decisions but the “geeks” had the knowledge relevant for those decisions.¹

Significantly Kling sees this knowledge/power discrepancy as being a much broader issue, “as a generic problem”.² As the knowledge economy grows we each know more about less, knowledge is becoming increasingly specialised and more dispersed but, if we accept Kling’s view, political power is becoming more concentrated.³ An important consequence of this discrepancy is that those making decisions, in both firms and government, are not those with the requisite knowledge

¹A similar argument was made 30 years before Kling in Sowell (1980). Anticipating the basic thrust of Kling’s argument Sowell (1980: 13-4) wrote, “[i]n those cases where the subordinate unit has better information, then in terms of the whole decision-making process the knowledge is one place and the power is another; the quality of decisions suffers as a result.”

²Kling (2010: 40) defines power to be the ability to make decisions or design incentives that influence the actions of others. He measures political power in terms of spending per legislator.

³The growth in knowledge and specialisation creates problems for government as well. In the extreme case of central planning, knowledge growth makes the planners task increasingly difficult. As the philosopher H. B. Acton wrote back in 1971, “[b]ut the range of scientific discovery and technological invention is enormous, and as specialisation increases, it becomes more difficult for any man or even committee to know what is afoot everywhere. Even if planning a whole economy were a valid concept (in fact it is a confused one), and even if it were a feasible economic exercise (and this may well be doubted), the planners would still be faced with the paradox that the more successfully science and technology are pursued the more uncontrollable they become and the more social surprises they will give rise to. Scientists and technologists make the central planner’s task impossible.” (Acton 1993: 144).

needed to do so.⁴ As Kling (2010: 34) comments about the financial crisis of 2008,⁵

“[o]verall, what strikes me both about the crisis and the response was that information was dispersed in such a way that decision-makers were not making good choices. The knowledge/power discrepancy was a factor throughout”.

If Kling is right then the knowledge/power discrepancy is of more than just academic interest; it highlights the need for a better understanding of how the increasing reliance on knowledge and information is affecting the economy, especially if we are to avoid, or at least mitigate the effects of, another crisis such as the recent financial meltdown. This is just one example which drives home the importance of the growth in the knowledge economy. As the knowledge economy takes centre stage, the “geeks” increasingly become the driving force behind economic, and it seems indirectly political, change. The increasing specialisation and dispersion of knowledge has effects throughout the economy, in both the private and public sectors. It affects private firms and all levels of government.

The purpose of this thesis was to investigate one small part of this multi-dimensional problem. It was to make a contribution to our understanding of the affects of knowledge at the level of the

⁴A similar point was made in the context of firms in Section 2.8 where we noted the Cowen and Parker (1997) argument that companies are decentralising their management systems, in part, to ensure that those with the required knowledge and right incentives are the ones making the decisions and taking responsibility for the outcomes. Thus the use of market-based management can be seen as an attempt to deal with the knowledge/power discrepancy at the firm level.

⁵On the knowledge/power discrepancy and the financial crisis Kling writes “[w]hen it comes to hindsight about why the financial crisis was not prevented, I would argue that the regulators suffered from a lack of knowledge. Had policymakers determined that the housing bubble posed risk, they could have warned banks and the GSEs to limit their risk exposure starting in, say, 2005. Had policymakers understood the way that bank capital requirements were distorting the mortgage market away from direct lending and towards securitization, they could have adjusted those capital requirements. Had regulators understood the extent to which the GSEs were trading off safety and soundness in order to meet affordable housing goals, they could have required the GSEs to change behavior, either by buying fewer risky loans or by raising more capital. Had regulators understood the way that rating agencies were mislabeling mortgage securities, they could have issued rules to banks requiring them to treat mortgage securities as riskier than their ratings signified.

The failure to regulate in time was not due to the lack of tools. Nor was it due to lack of will, as suggested by the narrative that a free-market ideology prevailed. The failure to prevent the crisis was due to the lack of knowledge among key policymakers. [...]

I believe similarly that the failures in the private sector were also due largely to a discrepancy between power and knowledge. The leaders of financial firms did not set out to incur large risks for short-term gains, although that certainly is what resulted in many instances. Rather, CEOs at banks and other firms believed that they were following sound, long-term strategies. From their perspective, they were using highly-rated securities in ways that met the approval of regulators who in turn had crated a framework for safety and soundness. At lower levels, there were staff who were concerned that the risk/reward trade-offs were not being made correctly. Journalists and Congressional committees have uncovered warnings at the GSEs and at the rating agencies about problems. However, those were delivered in a context in which CEOs ere receiving other signals, particularly from their counterparts in other firms, which convinced them that risk has been contained.

Finally, the response to the crisis continued to demonstrate a knowledge/power discrepancy. Henry Paulson seized the power to buy “toxic” assets. However, as soon as Congress give him the money and authority, it became apparent that his agency did not have the knowledge to undertake such a program.” (Kling 2010: 36-7).

firm. In particular how the greater importance of human capital as a factor of production effects the theory of the firm.

The increasing importance of human capital for the firm flows from the increasing importance of knowledge and information for the economy in general.⁶ As was noted in Chapter 1 it is commonly argued that because of a combination of factors such as the application of information technologies, increased global competition, deregulation and financial innovation we are increasingly living in a knowledge economy and society. What is not clear, however, is what this idea of the knowledge economy really means. As Appendix 1.A shows there are many different terms, and definitions of those terms, applied to changes we have seen occurring in the economy. We have knowledge economies, information economies, weightless economies, knowledge-based economies, knowledge-driven economies, Goldilocks economies, digital economies, new economies and internet economies, among other terms.

This multitude of terms and definitions inhibits, rather than clarifies, the analysis of the underlying phenomenon that the notion of the knowledge economy tries to capture. It is also one reason why measurement of the knowledge economy is proving so difficult. Section 1.1 discussed a number of issues to do with the measurement of the knowledge economy, arguing that the standard System of National Accounts is inadequate for this purpose. It was also argued that without an adequate theory of the knowledge economy little progress is likely to be made on the measurement issues. More data is not, by itself, going to deal with the problems besetting measurement of the knowledge economy.

Given the unsuccessful nature of the attempts to measure the knowledge economy an interesting question is, Can we know we are in such an economy? Section 1.1 noted that if we accept growth in productivity as an indicator of the onset of the new economy then, for the U.S. at least, the answer is yes. The U.S. productivity data do suggest that something changed in the mid-1990s as U.S. productivity jumped for the period 1996 to the third quarter of 2002 to 2.6 percent. Over the period 1974-1995 the rate was 1.4 per cent. However while this macro level

⁶The importance of knowledge to economic analysis has long been recognised, if largely ignored. F. A. Hayek articulated its importance in 1945 when he noted that the economic problem that society faces is one which depends on dispersed knowledge: “[t]he economic problem of society is thus not merely a problem of how to allocate “given” resources—if “given” is taken to mean given to a single mind which deliberately solves the problem set by these “data”. It is rather a problem of how to secure the best use of resources known to any of the members of society, for ends whose relative importance only these individuals know. Or, to put it briefly, it is a problem of the utilization of knowledge which is not given to anyone in its totality.” (Hayek 1945: 519-20).

productivity data can tell us that something has changed, it can not tell us what changed and why. The productivity data is the aggregated result of changes at the micro level, in this case at the level of the firm. Such changes require a microeconomic explanation. Without an understanding of the firm level effects of changes in the importance of knowledge/information to the production process, we will be unable to fully characterise the knowledge economy and thus will be unable to measure it correctly.

In trying to understand the effects of the knowledge economy on the firm one common, if not universal, theme that runs through the literature relates to the growing importance of human capital and thus knowledge workers – the “geeks” in Kling’s terminology – in the creation of value for the firm. Human capital is increasingly seen as the driver of value creation for knowledge firms. And yet there is no satisfactory theory of the knowledge firm or the role of human capital in these firms. What do the standard mainstream theories of the firm tell us about the “knowledge firm”? How does human capital determine the organisational form that knowledge firms develop? Are partnership, or other types of labour-owned enterprises, the form that the typical knowledge firm would take? Is there a better way to model the human-capital based firm?

Our examination of the human-capital based firm started in Chapter 2 (and Walker (2010)) by offering what is seemingly the first comprehensive treatment of why none of the mainstream theories of the firm offer a satisfactory theory of the knowledge firm. The argument was made that none of the orthodox approaches to the firm fully capture the implications of knowledge for economic organisation. It was argued that the neo-classical production function approach is not a true theory of the firm but rather the firm is portrayed as an uninvestigated perfectly efficient ‘black box’ which simply turns inputs into outputs without organisation structure. Output is produced by the actions of multiple input owners interacting solely via the market. Relationship-specific investment induced hold-up arguments for vertical integration are at their weakest when dealing with human capital. Human capital can not be owned in the same way as physical capital and so the investor in human capital can act opportunistically whether an employee or not. The incentive-system theory assumes the use of a physical asset rather than a human capital asset in the production process. Neither the ownership nor the value of a human asset can be transferred and so such an asset cannot determine where the boundaries of the firm lie within the model. The extensions of the GHM framework offered by Brynjolfsson (1994) and Rabin (1993) inherit the

implicit owner-manager restriction of the original GHM framework and thus are of limited value when modelling the knowledge firm. When we turn to the location of production the models suggest that we should, in general terms, see a movement back towards home production but we are not given a specific relationship between knowledge and plant size or production location. Overall we are left with an unsatisfactory model of the knowledge firm.

Chapter 5 made a first step toward rectifying this deficiency by offering two models of the human-capital based firm based on the reference point approach to the theory of the firm. These models offer a new formal approach to the modelling of the human-capital based firm. The models developed in this chapter suggest that the form that such a firm will take depends on more than just the fact that the knowledge worker is the firm's primary source of value added. Just as important is the heterogeneity of the human capital.⁷ The sole role for non-human capital in these models is the determination of ownership of an integrated firm should an employment contract turn out to be optimal.

A common organisational form that human-capital based firms take is some form of labour-owned firm, a partnership being a frequently observed example. As human capital has increased in importance, as the knowledge economy has expanded, some commentators have argued that knowledge based firms have developed organisational structures along the lines of partnerships. The models developed in Chapter 5 argue that while there is truth to this claim, it is not likely that the argument will be found to be universally true. One interpretation of the results of this chapter is that differences in the "types" of human capital matter for the choice of organisational form rather than organisational form depending solely on the fact that human capital is the primary productive input. The more heterogeneous the human capital used by the firm the more likely is an investor owned firm to be formed. The labour owned firm is more likely to be formed when the knowledge workers are more homogeneous in their characteristics and face a common

⁷An increase in the heterogeneity of labour will have effects beyond the firm. There will be effects for labour markets as a whole and government interventions in these markets. As an example consider the make work programs often used by governments during times of economic downturn. These were common in many countries during the 1930s depression and did put a significant number of people into work. One reason for the success of these programs was the more homogeneous nature of labour at this time. Work was more physical then than now and more adults were likely to have had experience in such employment. Today with a more heterogeneous labour force such make work programs are less likely to be as effective. The demand for physical labour is much less and the work experience of adults today is much more varied as the economy is markedly more complex than it was in the 1930s. This would make it much more difficult for the government to design make work schemes that match the human capital structure of the labour which is unemployed. To a lesser degree this kind of matching problem will be an issue even under more normal economic conditions as the knowledge economy grows and the heterogeneity of labour increases with it.

set of incentives. The pirate example at the beginning of the chapter 5 is an extreme example of this. We observe partnerships in situations where the firms are small and the knowledge input is of a single “type”, e.g. partnerships consisting of just lawyers or just doctors but not both.

In the models of Chapter 5 size helps to determine ownership structure in that smaller firms are more likely to be homogeneous in their labour inputs and thus some form of labour ownership is more likely. As firms grow so can the heterogeneity of their knowledge workforce. Thus the possibility of aggrievement and thus shading resulting in deadweight losses can also grow. The results of this chapter would suggest therefore that the likelihood of non-labour ownership increases. The scope of the firm has similar results for its organisational form. Being highly competent in one specialised area means that it is likely that you will have to make decisions outside your area of expertise if the firm has broad scope. If, as seems reasonable, a decrease in activities is associated with a reduction in the heterogeneity of the types of knowledge workers employed in the firm then some form of labour ownership is more likely.

What the models of Chapter 5 provide is a new theoretical explanation as to why homogeneity in human capital is important for the organisational form taken by a human-capital based firm.⁸ The reasoning is based on the reference point theory of contracting first introduced in Hart and Moore (2008) which utilises the notions of aggrievement and shading. Any of the organisational forms – independent contractors, labour-owned or investor-owned firms – are optimal business types depending on the relative levels of aggrievement and shading. Assuming that multiple firms are not optimal, that is, utilising independent contractors is not optimal, a labour-owned firm makes sense when Δ is small. This implies that the human capital is relatively homogeneous, i.e. everyone is of “type ψ ”, allocation of ownership to the knowledge worker means giving ownership to the party whose levels of aggrievement and shading is the greatest. In this case the knowledge worker cares most about the choice of business form. As Δ is increased, and thus labour inputs become more heterogeneous, the allocation of ownership to the capital owner becomes more feasible as the capital owners aggrievement and shading has increased. Independent contractors

⁸Hansmann (1988 and 1996) also suggests that homogeneity of interest among the patrons of a firm who are considered the owners of that firm is a important factor in determining which group of patrons are the owners. Unlike the argument presented above Hansmann’s reasoning is driven by transaction cost concerns. But see Section 4.7, page 223: the similarities in interpretation may be due to the use of ex post inefficiencies in the reference point theory which, as suggested in Section 4.7, can be seen as a step towards a formalization of the transaction cost approach. Note that Gibbons (2005) offers two attempts at formalisation of the transaction cost approach to the firm: a “rent-seeking” theory and an “adaptation” theory.

are optimal in either of two situations, when the make-or-buy constraint is such that separate firms are preferable to the best alternative which can be either ownership by the human capital or the non-human capital.

What the results of Chapter 5 suggest is that a human-capital only firm with heterogeneous human capital is likely to be unstable and thus a long lasting human-capital only firm will consist of homogeneous human capital. A firm which involves heterogeneous human capital will require some “glue”, in the form of non-human capital of some kind, to remain viable. Given the importance of this glue to the firm ownership of the firm by the owner of the non-human capital is likely.

Interestingly what we gain from the models of Chapter 5 is an understanding as to why the organisational landscape of the knowledge economy may not look too different from that of today’s economy, that what we will see is evolution of organisations rather than revolution in organisational form. There is no reason to think that any one organisational form will come to completely dominate the knowledge economy any more than any one form totally dominates today’s economy. As Hansmann (1996: 287) notes with regard to the current economy, “[a]s a general matter, one cannot say that one form of ownership is superior to another. Ownership by any group of a firm’s patrons—whether investors, consumers, workers, or other supplies – can be efficient in the appropriate context, and the same is true of nonprofit firms. Each type of ownership has its appropriate niche in the economy.”⁹ Each ownership form will also have its appropriate niche in the “knowledge economy”. As now, particular forms of organisation will be chosen in particular circumstances. What the results developed above do tell us is that the reasons why a particular business form is chosen will change with a movement away from physical, or other non-human, assets being the determining factor towards human capital, and especially its heterogeneity, being the driving force behind the choice of organisational structure. An important implication of this is that while the empirical distribution of firms may not look like it is changing in face of the continued development of the knowledge economy and thus the knowledge economy may look like it is not affecting business form, this misses the important point that the reasons for the choice of firm organisation are changing. This is something (aggregated)

⁹Even before Hansmann, Thomas Sowell made the same basic point. In 1980 Sowell wrote “[t]he corporation may be the predominant institutional way of doing certain things during a particular era, but it will never be the only market mechanism even during that given era, and certainly not for all eras. Partnerships, cooperatives, episodic individual transactions, and long-run contractual agreements all exist as alternatives.” (Sowell 1980: 41).

data has difficulty in speaking to.

Overall the multi-faceted landscape we see today in terms of the types of forms that businesses take will remain even as the knowledge economy expands. We will have more of the same, just for different reasons.

The models presented in this thesis have been very simple, but they do suggest that the reference point approach to contracts can be usefully applied to the human capital based firm. An obvious development of the work contained in this thesis is to incorporate investment into the model. Hart (2011a) shows that the reference point approach can be extended to include noncontractible investments and such a development could allow for the inclusion of ex ante, as well as ex post, inefficiencies. This could allow for a more sophisticated modelling of the role of non-human capital in firm in so much as it would no longer be necessary to assume that the non-human capital owner also provided a small amount of human effort. The advantage here is that this could allow the ownership of non-human capital to be separated from human capital inputs. Another extension of the model could involve the introduction of employees in addition to owners and managers. This could allow for a better discussion of a firm's structure. Having owners, managers and workers separately in the model would give us a better framework for looking at the internal organisation of firms.

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