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A Replication of "Are Competitive Banking Systems More Stable?" (Journal of Money, Credit, and Banking, 2009)

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Abstract: This study replicates Schaeck, Čihák, and Wolfe (2009), henceforth SCW, and performs a variety of robustness checks. Using a cross-country, time series sample of 45 countries from 1980-2005, SCW investigate the relationship between competition and concentration in the banking system, and the occurrence of country-level systemic crises. Their primary measure of competition in the banking industry is Panzar and Rosse's H-statistic. Concentration is measured using a concentration ratio of the three largest banks. They conclude that (i) competition and concentration measure two separate dimensions of the banking sector, and (ii) greater competition is associated with fewer systemic crises. Using data and code provided by the authors, we are able to exactly reproduce the original results of SCW. However, we find that their results are not generally robust. While we confirm their results on concentration, when we extend the data to the current period and use updated variable values, we find that competition, as measured by the *H-statistic*, is consistently insignificant across both duration and logit models.

Keywords: Systemic risk, Bank competition, concentration, H-statistic, Replication

JEL Classifications: C41, G21, G28, L11

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1. INTRODUCTION

This paper investigates key findings reported by Schaeck, Čihák and Wolfe (2009), henceforth SCW, in their influential *Journal of Money, Credit, and Banking* article, "Are Competitive Banking Systems More Stable?" Over the last twenty years there has been increasing interest in the relationship between conditions in the financial sector and country-level economic performance. Of particular interest is whether competition in the financial sector contributes, or inhibits, the likelihood that a country will be vulnerable to banking sector distress.

A key element in this literature is how one should measure "competition" in the banking sector. One measure that has been frequently used is the "concentration ratio", measured by the proportion of assets held by a given number (usually three) of financial institutions. However, some studies have argued that this is an inadequate measure of competition (Claessens and Laeven, 2004). A prominent alternative is the H-statistic, which uses bank level data to measure the ability of banks to pass on increases in input prices (Panzar and Rosse, 1987). The greater the elasticity of banking revenues to input prices (i.e., the more negative), the less competitive the banking sector.

SCW analyse 38 "systemic crises" from a sample of 45 countries over the period 1980-2005. They report evidence to support two conclusions. First, they find that the more competitive the banking sector, as measured by the H-statistic, the less likely it is to experience a "systemic crisis" (to be defined below). Second, they find that when the concentration ratio is included in an equation with the H-statistic variable, both are statistically significant. Increases in the concentration ratio are also associated with a lower probability of a systemic crisis. SCW consequently conclude that concentration ratio does not measure competition, but proxies for bank size. They speculate that larger banks may be better able to diversify risk, or more likely to receive government support, and thus better able to survive negative shocks.

SCW is widely cited. At the time of this writing (November 2016), it had received 458 Google Scholar cites, and 82 Web of Science citations. One reason for its wide influence is because the authors demonstrated that their results were robust to a wide variety of estimation and specification approaches. SCW use two different estimation procedures. They check for compositional robustness in the sample by altering the countries and time periods used in the analysis. They modify variable specifications to control for macroeconomic dynamics and banking sector development. They control for cross-country differences in regulatory environments. Throughout this battery of robustness checks, SCW consistently find that competition and concentration are both significantly and negatively associated with systemic crises.

Our replication of SCW proceeds as follows. In Section 2, we demonstrate that we can exactly reproduce the key findings in SCW. In Section 3, we use the same data as SCW but substitute two alternative measures of competition, the Lerner index (Fernandez de Guevara, 2007; Maudos and Solis, 2011) and the Boone indicator (Boone, 2008). We find that the positive relationship between stability and competitive banking systems largely disappears when one uses these alternative measures.

In Section 4, we investigate the effect of updating variables. We observe that there are substantial differences in the values of many of SCW's variables when we compare the original data with currently available data from the same sources. We also observe substantial differences across data sources. Section 5 investigates the effect on SCW's key results when the equations are re-estimated using updated data. A complication arises because the updated sample only imperfectly overlaps the original data. When we pare down the observations to include the intersection of the two samples, we find that the competition and concentration variables generally remain same-signed and statistically significant in both the original and updated subsamples. The only exceptions to statistical significance come when the sample sizes

are reduced less than a third of their original size. While the estimated effect sizes are same-signed and of similar size, the associated standard errors are larger. This causes some of the estimates to become insignificant.

Section 5 continues by exploring the following thought experiment: Suppose SCW had undertaken their analysis in 2016. Would they have reached the same conclusion using the data that was available then? We conclude that SCW would not have reached the same conclusion regarding competition, though they would have found similar results with regard to concentration. In particular, they would have found that greater concentration was negatively associated with systemic crises, but competition was consistently statistically insignificant. Section 8 summarizes our findings and applies the implications of our replication analysis to SCW's conclusions.

2. REPRODUCTION OF SCW'S KEY RESULTS

The dependent variable in SCW's analysis is "systemic crisis." This is a dummy variable that takes the value 1 for a given country in a given year if any of the following four criteria hold (SCW, page 717):

1. "emergency measures such as deposit freezes or bank holidays are implemented,"
2. "large-scale bank nationalizations take place,"
3. "nonperforming assets reach at least 10% of total assets," or
4. "fiscal cost of the rescue operations reach 2% of gross domestic product (GDP)".

The key explanatory variables are *H-statistic* and *Concentration*, described above, which measure competition and concentration in a country's banking sector. The H-statistic takes the value 1 when the banking sector is characterized by competition. It takes values between 0 and 1 when the sector is monopolistically competitive, and is negative in the case of monopoly. Thus, increases in the H-statistic are associated with greater competition in the banking industry.

Two estimation procedures are used. SCW use duration analysis to measure the determinants of "time to failure"; that is, the number of years from the start of the sample until a systemic crisis occurs. If no systemic crisis occurs for a given country, the spell is treated as being right-censored. A variable that is positively associated with stability will have a positive coefficient in this analysis, as it will take longer for a systemic crisis to occur. SCW also estimate a logit model. A variable that positively contributes to stability will have a negative coefficient in this analysis, as an increase in this variable will be associated with a lower probability of a crisis occurring.

SCW include a large number of control variables. To address macroeconomic determinants of financial stability, they include lagged GDP growth, inflation, the real interest rate, exchange rate depreciation, terms of trade, real credit growth, and a variable to measure "moral hazard" associated with generous deposit insurance. They include a set of dummy variables to control for legal origin of the country, as previous research has linked this to the contractual environment underlying the banking sector. Finally, a set of regional dummy variables are included as general controls for economic development.

SCW's main results are reported in Table 3 of their paper. The first four columns of Table 3 report various specifications of the duration model. Column (1) reports the results of estimating the model with control variables but no competition or concentration variables. Column (2) adds the competition variable (*H-statistic*). Column (3) adds the concentration variable to the specification in Column (2). Column (4) adds an interaction term for the competition and concentration variables to Column (3). Columns (5) through (8) do the same for the logit model. As SCW's main conclusions focus on the coefficients of *H-statistic* and *Concentration*, we will focus our attention on Columns (2), (3), (6), and (7) in SCW's Table 3.

The first step in our replication study consists of reproducing SCW's key results. As SCW graciously provided their data and Stata do files, this proved to be straightforward.

TABLE 1 reports the results of estimating the duration model using the variable specifications of Column (2) and (3) in SCW's Table 3 with the data and do files they provided us. TABLE 2 does the same for the logit models of Columns (6) and (7) in SCW's Table 3. As both tables demonstrate, we are able to exactly reproduce their main findings.

As SCW provide a discussion of the estimated coefficients of the respective control variables, we do not do that here. Instead, we focus on the competition and concentration variables. When the competition variable (*H-statistic*) stands alone, the duration model produces an estimate of 1.6977, which is significant at the 10 percent level. The positive coefficient indicates that greater competition in a country's banking sector is associated with a longer time before a systemic crisis occurs. When both competition and concentration variables are included in the model, both coefficients are positive and statistically significant. The concentration variable is significant at the 1 percent level, while the competition variable increases to 2.3482 and is now significant at the 5 percent level. The fact that both *H-statistic* and *Concentration* are statistically significant lead SCW to conclude that these two variables "describe different characteristics of banking systems" (page 725), with the *H-statistic* capturing the effect of competition, and *Concentration* capturing advantages of being large-sized.

TABLE 2 repeats the replication exercise for the two logit models. When the competition variable stands alone, the associated coefficient is negative and statistically significant at the 5 percent level. When the concentration variable is added to the specification, both competition and concentration variables achieve statistical significance at the 5 percent level. As a negative coefficient here implies a lower probability of a crisis, these estimates are consistent with the corresponding duration model estimates from TABLE 1.

3. ROBUSTNESS CHECK #1: Alternative Measures of Competition

While Panzar and Rosse's (1987) H-statistic is a frequently used measured of competition, it is not the only one. Also widely used is the Lerner index. While the H-statistic measures the ability of firms to pass on input price increases to their customers, the Lerner index measures competition by estimating the ratio of the price of total assets over their marginal cost (Beck, De Jonghe, and Schepens, 2013; Fernandez de Guevara, Maudos, and Perez, 2007; Maudos and Solis, 2011). Increases in the Lerner index are associated with diminished competition. The Boone indicator measures the degree of competition based on profit-efficiency and is calculated as the elasticity of profits to marginal costs (Boone, 2008; Duygun, Shaban, and Weyman-Jones, 2015; and Schaeck and Čihák, 2014). Like the Lerner index, larger (less negative) values of Boone indicate a less competitive industry.

A list of papers that use the respective measures to measure competition in the banking sector is given below:

- H-statistic: Molyneux, Lloyd-Williams and Thornton (1994); Bikker and Haaf (2002); Claessens and Laeven (2004); Casu and Girardone (2006); Matthews, Murinde and Zhao (2007); Yeyati and Micco (2007); Schaeck, Čihák and Wolfe (2009); Maudos and Solıs (2011); Schaeck and Čihák (2012); Weill (2013); Bolt and Humphrey (2015); Leon (2015).

- Lerner index: Shaffer (1983); Fernandez de Guevara, Maudos, and Perez (2007); Lopez and Saurina (2007); Schaeck and Čihák (2008); Berger, Klapper and Turk-Ariss (2009); Beck, De Jonghe and Schepens (2013); Weill (2013); Fu, Lin and Molyneux (2014); Love and Peria (2014); Mirzaei and Moore (2014); Bolt and Humphrey (2015); Diallo (2015); Jiménez, Kasman and Kasman (2015); Leon (2015).

- Boone indicator: Schaeck and Čihák (2008); Schaeck and Čihák (2012); Love and Peria (2014); Mirzaei and Moore (2014); Schaeck and Čihák (2014); Diallo (2015); Duygun, Shaban and Weyman-Jones (2015); Kasman and Kasman (2015); Leon (2015).

To check for robustness across these alternative competition measures, we obtained Lerner index and Boone indicator values from the Global Financial Development Database (Čihák et al., 2012). We then substituted these variables for the H-statistic in the Column (2), (3), (6) and (7) specifications of TABLES 1 and 2. Everything else was held constant. We used

exactly the same observations, variables, and variable values for everything else in the respective models.

TABLE 3 summarizes the results of this robustness check, bringing together the results from the duration and logit models. We focus on the estimates of the competition and concentration coefficients, and do not report the estimated coefficients for the respective control variables. The top panel reproduces the estimates of the coefficients for *H-statistic* and *Concentration* from TABLES 1 and 2. The next two panels report the results of substituting the Lerner and Boone measures of competition. If the alternative measures for competition are to be consistent with the *H-statistic* estimates, the respective coefficients would need to be opposite signed, as increases in the *Lerner* and *Boone* variable are associated with decreased competition. In contrast, increases in the *H-statistic* are associated with greater competition.

TABLE 3 makes clear that SCW's competition results are not robust across alternative measures of competition. Of the four *Lerner* estimates in the middle panel, only the coefficient in Column (3) is statistically significant. However, it is wrong-signed. The positive *Lerner* coefficient indicates that decreases in competition are associated with longer durations before a systemic crisis – the exact opposite to the conclusion from using *H-statistic* as a measure of competition.

In contrast, the estimates using the *Boone* measure of competition are consistent in sign with the *H-statistic* results. However, all of the four estimates in the bottom panel of TABLE 3 are statistically insignificant. Taken together, these results indicate the SCW's conclusions rest entirely on *H-statistic* being the appropriate measure of competition in the banking sector. Had they used a different measure of competition, they would not have drawn the same conclusion.

4. UPDATING THE CONTROL VARIABLES

The next step in our robustness check consists of updating the values of the control variables to see if substituting updated values continues to give the same results. The Data Appendix in SCW identifies the sources they used for all the variables in their analysis. For example, SCW used the World Development Indicators to obtain values for GDP growth, inflation, and terms of trade. They used International Financial Statistics for depreciation.

In this process, we found numerous, substantial differences between the original data series provided by SCW and the respective, updated data sources. FIGURE 1 gives some examples. The figure produces four screen shots of data that allow one to compare the original data with the updated data from the same source, as well as some additional data sources.

For example, Panel A reports values for *GDP growth (lag)* for Indonesia for the years 1980-2005. The source of these data is the World Development Indicator dataset (WDI), so that the first two columns ("Original" and "WDI") allow a side-by-side comparison of the data used by SCW and the updated data from the same source. The last column presents values for lagged GDP growth as reported in the International Financial Statistics dataset (IFS), which allows a comparison from an alternative data source.

One immediately notes a large number of "missing values" in SCW's dataset. However, these "missing values" should not be misinterpreted. In some cases they are missing from SCW's dataset because SCW deleted observations during "crisis years." In their words (page 717): "As most crises run over multiple years, we follow the approach in the literature (Demirgüç-Kunt and Detragiache 2002) and remove observations classified as crisis after the initial year of the crisis." Our analysis follows the same practice.

The main takeaway from Panel A is that the original and updated data can differ greatly. For example, lagged GDP growth for Indonesia in 1980 is 1.63% in SCW's original dataset, but 7.09% when we access currently reported values from the same source (WDI). When we

go to an alternative source, the IFS, we find a value (6.26%) that is different from both the original dataset and WDI, but is closer to the latter. Similarly, for 1981, SCW's data has lagged GDP growth of -0.58%, with the updated WDI reporting a value of 8.72%, and IFS reporting 9.88%.

Another example is given in Panel B, which reports inflation rates for Brazil from 1980-2005. The first two columns of inflation data report values from SCW's dataset and the updated values from the WDI, which is the source that SCW originally used for their data. The last two columns report values from alternative data sources -- IFS and DataMarket -- where in this case the latter values are identical to the WDI data. The original data are surely wrong, as Brazil was experiencing well-known hyperinflation in the 1980 and early 1990s. Panels C and D repeat the exercise for depreciation and terms of trade for Austria and Columbia, respectively. They provide further examples of substantial differences in values between the original and updated datasets.

An interesting data scenario can be found in Panel C during the years 1999-2005. This is an example where SCW's original dataset contains values for variables for which corresponding values are unavailable at either the updated, same data source (in this case, IFS), or the alternative data sources (WDI and DataMarket). Interestingly, a noticeable shift in the original data series occurs after 1998 for Austria. Another thing to note from Panels C and D is that sometimes updated values are available from one data source but not another. For example, DataMarket does not have depreciation values for Austria for the years 1980-1991 (cf. Panel C), while IFS and WDI do; and WDI does not have a value for terms of trade for Columbia in 1980, while DataMarket does.

While FIGURE 1 is illuminating, its few examples do not allow a larger picture of the differences between the original and updated data. To do that, TABLE 4 reports descriptive statistics for the respective data sources using a common set of observations. We focus on

common observations because this ensures that any differences we observe are due to changes in variable values, and not because we are comparing observations from different countries and/or time periods. In this case, to be included in the table, the observation must have been used in the estimation of the Column (3) model, and are also available in the updated data.

The top panel of TABLE 4 reports descriptive statistics for lagged GDP growth from three data sources: SCW's original dataset, WDI, and IFS. An asterisk is placed next to WDI to indicate that this is the source cited by SCW for their data. The original data have a mean lagged growth rate of -0.197% over the 699 observations for which we have observations from all three data sources. For the exact same observations, the WDI and IFS data have a mean lagged growth rate of 3.556% and 3.679%, respectively.

As the table demonstrates, similar differences are found for other variables. Where there are alternative data sources, these generally accord closely with each other, so that the original data is an outlier. This does not mean that SCW did anything wrong, as the data in their dataset may have been correct at the time it was collected. However, it does mean that using the updated data should give a more accurate measure of the true values of the control variables. The next section investigates whether these data differences impact SCW's key findings about competition and concentration.

5. ROBUSTNESS CHECK #2: Reestimation of Models with Updated Data

TABLE 5 reports the effects of estimating the Column (2), (3), (6) and (7) models using updated variable values. It carries on in spirit the same exercise of TABLE 4. Whereas TABLE 4 calculated descriptive statistics for individual variables over a common set of observations, TABLE 5 requires observations for which the entire model can be estimated. Thus the original and updated datasets need to have a common set of observations not just for one variable, but for the full set of control variables. To be included in a "common set of observations," an observation must both (i) have been used in the estimation of the original model in SCW (e.g.,

Column 2 model, Column 3 model, etc.), and (ii) have available an updated value for each of the control variables. We continue to use SCW's values for the competition and concentration variables.

Our analysis constructs two sets of common observations. The first set ("Common Observations 1") restricts itself to updated observations from the same data source as SCW. So, if SCW used WDI for lagged GDP growth, the updated dataset only takes lagged GDP growth values from WDI. The second set of common observations ("Common Observations 2") uses updated values from whatever data source will provide the most observations. So, for example, if, as in Panel D of FIGURE 1, SCW used WDI for terms of trade, but DataMarket has more total observations for terms of trade than WDI, then we take our updated values from DataMarket.

The top panel of TABLE 5 (Panel A) investigates the effect of re-estimating the four key models from SCW using updated data from same sources. The top half of Panel A re-reports the results of estimating the four models using the original data provided by SCW. The bottom half of that panel repeats the analysis, substituting updated values for the control variables. Whereas the original results reported by SCW used 701 observations for the duration models, and 707 observations for the logit models; when we restrict ourselves to observations that appeared in the original estimates and for which updated values from the same sources are available, the number of observations drops to 222 and 218, respectively. The fact that both halves of Panel A use the same observations ensures that any differences are due solely to updating the variables, and not due to differences in observations.

The first takeaway from TABLE 5 is that SCW's report of robustness across subsamples is largely confirmed. Turning first to the "Common Observations 2: Original Data" subsample in Panel B, both the *H-Statistic* and *Concentration* variables are statistically significant and have the same signs as they did in the full samples of 701 and 707 observations

(cf. top panel of TABLE 3). Thus, using SCW's original data but restricting the analysis to observations for which updated values of the variables are available from multiple sources, we confirm SCW's conclusion that competition and concentration are both negatively associated with systemic crises.

When SCW's original data is restricted yet further to observations for which updated values of the variables are drawn from the same sources (cf. "Common Observations 1: Original Data" in Panel A), the results are somewhat weakened. Of the six coefficients, only three remain statistically significant. However, the respective coefficients all have the "right" sign and are of similar absolute size to previous estimates. Statistical insignificance stems from the larger standard errors, which may reflect the much smaller sample sizes. Columns (2)/(3) and (6)/(7) in Panel A have sample sizes of 222 and 218 respectively, compared to 474/479 in Panel B.

A similar finding is obtained when we replace SCW's original data with updated values. Focusing on the bottom part of Panel B ("Common Observations 2: Updated Data – Multiple Sources"), we see that, again, *H-statistic* and *Concentration* have the same signs and approximate sizes as originally reported by SCW, despite using a restricted sample and updated values for the control variables – updated values that often are quite different from the original values (cf. TABLE 3). Of the six coefficients in that panel, four are statistically significant, with *H-statistic* being insignificant whenever it is paired with *Concentration.* When the number of observations is restricted to the 222 and 218 observations of the "Common Observations 1: Original Data" subsample, statistical significance evaporates across the board. So while the estimated coefficients remain "correctly signed," and of similar size to previous estimates, the standard errors are sufficiently larger so as to render all estimated coefficients statistically insignificant.

Our interpretation of the preceding analysis is that the use of updated values for the control variables, with concomitant decrease in the number of observations, generally confirms SCW's original findings, except that their case is somewhat weakened because several of the variables do not achieve statistical significance. This latter result may be primarily driven by the fact that the smaller samples are inducing larger standard errors.

TABLE 6 reports the last set of robustness checks. Conceptually, TABLE 6 addresses the question, suppose SCW had undertaken their analysis in 2016, using values and data sources that were currently available at that time. Would their analysis have led to the same conclusion as the original SCW study?

TABLE 6 proceeds in steps. The first panel (Panel A) reports the results of using all possible observations when drawing data from the same sources as SCW over the same set of years (1980-2005). This analysis uses 327 observations for the duration models, and 331 for the logit models. The next panel (Panel B) expands the set of possible observations by drawing data from multiple data sources, choosing whichever data source (WDI, IFS, DataMarket, etc.) maximizes the sample size, while continuing to restrict itself to the years 1980-2005. The associated samples sizes are 679 ad 682 for the duration and logit models, respectively.

The next three panels extend the years of analysis to the most recent available, so that the period of analysis covers the years 1980-2014. Panel C draws data from the same sources as SCW. Panel D uses multiple data sources. And Panel E updates not only the control variables, but also the *H-statistic* and *Concentration* variables. In this sense, Panel E comes closest to addressing the question, would SCW's conclusions been different had they undertaken their analysis in 2016, rather than in 2008 when their paper was accepted at the *Journal of Money, Credit, and Banking.*[1]

[1] SCW's paper was first submitted to the *JMCB* in January 2006; and accepted in August 2008.

On the basis of Panel E, we conclude that SCW would not have reached the same conclusion they reported in their original manuscript. While the variable *Concentration* is negatively associated with systemic crises, as in the original study, the competition measure *H-statistic* is both smaller in size and statistically insignificant in both the duration and logit models.

In fact, this is a consistent finding across all five panels in TABLE 6. In each and every case, the estimated coefficient for *H-statistic* is statistically insignificant. Furthermore, unlike TABLE 5, statistical insignificance cannot be blamed on small sample sizes, as the sample sizes in Panels D and E exceed those of the SCW's original analysis by approximately 20 percent.

6. CONCLUSION

Schaeck, Čihák and Wolfe (2009), henceforth SCW, ask whether "competitive banking systems are more stable" in their influential *Journal of Money, Credit, and Banking* study. They summarize their findings as follows (SCW, page 711):

> Using the Panzar and Rosse H-statistic as a measure of competition in 45 countries, we find that more competitive banking systems are less prone to experience a systemic crisis and exhibit increased time to crisis. This result holds even when we control for banking system concentration, which is associated with higher probability of a crisis and shorter time to crisis. Our results indicate that competition and concentration capture different characteristics of banking systems, meaning that concentration is an inappropriate proxy for competition. The findings suggest that policies promoting competition among banks, if well executed, have the potential to improve systemic stability.

Our replication examines a number of features of their study to determine whether their results are sufficiently robust to support the policy conclusion that greater competition promotes stability in the banking sector. We interpret our results as indicating that they are not.

We base our interpretation on two results. First, replacing the competition measure *H-statistic* with either of two alternative measures of competition – the Lerner index and Boone

indicator -- causes SCW's competition estimates to generally become statistically insignificant. It may be that the Lerner index and Boone indicators are inferior measures of competition in the banking sector, so that this lack of robustness need not definitively weigh against SCW's conclusion. But it is worth noting that their results crucially hang on the superiority of the *H-statistic.*

Second, and more importantly, SCW would not have reached the same conclusion as their original study if they had undertaken their analysis in 2016, rather than 2008. The combination of updated variable values and additional crisis episodes would have caused them to reach a substantively different conclusion. While concentration appears to be negatively associated with systemic crises, competition, as measured by the *H-statistic*, is consistently insignificant across both duration and logit models. As a result, they would not have been able to conclude that competition was positively associated with banking stability, at least not as measured by the Panzar and Rosse H-statistic.

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TABLE 1
Replication of Key Duration Models with Authors' Data

Variable	*Column (2)*		*Column (3)*	
	Original	*Replication*	*Original*	*Replication*
GDP growth (lag)	-0.0594 (0.0365)	-0.0594 (0.0365)	-0.0592 (0.0377)	-0.0592 (0.0377)
Inflation	-0.1693 (0.3200)	-0.1693 (0.3200)	-0.1907 (0.3457)	-0.1907 (0.3457)
Real interest rate	-0.0251** (0.0121)	-0.0251** (0.0121)	-0.0224* (0.0114)	-0.0224** (0.0114)
Depreciation	0.0533* (0.0275)	0.0533* (0.0275)	0.0524* (0.0289)	0.0524* (0.0289)
Terms of trade	-0.3126*** (0.0697)	-0.3126*** (0.0697)	-0.3043*** (0.0746)	-0.3043*** (0.0746)
Credit growth	-0.0008** (0.0004)	-0.0008** (0.0004)	-0.0008*** (0.0003)	-0.0008*** (0.0003)
Moral hazard index	-0.4363** (0.1785)	-0.4363** (0.1785)	-0.4215* (0.2279)	-0.4215* (0.2279)
German legal origin	-0.5967 (1.0905)	-0.5967 (1.0905)	-0.8851 (1.0288)	-0.8851 (1.0288)
French legal origin	-1.0421** (0.4511)	-1.0421** (0.4511)	-1.3532*** (0.3887)	-1.3532*** (0.3887)
Scandinavian legal origin	0.6542 (1.0942)	0.6542 (1.0942)	-0.0875 (1.1386)	-0.0875 (1.1386)
Africa dummy	-1.5102** (0.6586)	-1.5102** (0.6586)	-1.8586*** (0.6682)	-1.8586*** (0.6682)
Other dummy	-1.1901* (0.6368)	-1.1901* (0.6368)	-1.5535** (0.6481)	-1.5535** (0.6481)
Latin America dummy	-0.5069 (0.7557)	-0.5069 (0.7557)	-0.4322 (0.6853)	-0.4322 (0.6853)
H-statistic	1.6977* (0.8804)	1.6977* (0.8804)	2.3482** (0.9700)	2.3482** (0.9700)
Concentration	----	----	3.0834*** (0.9595)	3.0834*** (0.9595)
Observations	701	701	701	701

NOTE: This table reports the replication of Columns (2) and (3) of Table 3 in SCW (page 722). The data for the replication were provided by SCW, as were the Stata do files used to produce the replications. Estimates are derived from a duration model that assumes that survival times are exponentially distributed. Survival times are measured in years as time to a systemic crisis. The numbers in parentheses below estimated coefficients are cluster robust standard errors, clustered on country. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

TABLE 2
Replication of Key Logit Models with Authors' Data

Variable	*Column (6)*		*Column (7)*	
	Original	*Replication*	*Original*	*Replication*
GDP growth (lag)	-0.2554*** (0.0773)	-0.2554*** (0.0773)	-0.2640*** (0.0842)	-0.2640*** (0.0842)
Inflation	0.5328* (0.2985)	0.5328* (0.2985)	0.5125 (0.3154)	0.5125 (0.3154)
Real interest rate	0.0306 (0.0193)	0.0306 (0.0193)	0.0290 (0.0222)	0.0290 (0.0222)
Depreciation	0.0273 (0.0653)	0.0273 (0.0653)	0.0151 (0.0685)	0.0151 (0.0685)
Terms of trade	0.2680*** (0.0609)	0.2680*** (0.0609)	0.2388*** (0.0655)	0.2388*** (0.0655)
Credit growth	0.0006 (0.0006)	0.0006 (0.0006)	0.0006 (0.0006)	0.0006 (0.0006)
Moral hazard index	0.5596 (0.3550)	0.5596 (0.3550)	0.4734 (0.3803)	0.4734 (0.3803)
German legal origin	0.2724 (1.2038)	0.2724 (1.2038)	0.5139 (1.1809)	0.5139 (1.1809)
French legal origin	0.8124 (0.6748)	0.8124 (0.6748)	1.2292** (0.6031)	1.2292** (0.6031)
Scandinavian legal origin	0.1937 (0.9042)	0.1937 (0.9042)	1.1016 (0.8323)	1.1016 (0.8323)
Africa dummy	0.6712 (0.9422)	0.6712 (0.9422)	1.0718 (0.9226)	1.0718 (0.9226)
Other dummy	0.5525 (0.6716)	0.5525 (0.6716)	0.9495 (0.7398)	0.9495 (0.7398)
Latin America dummy	-0.7543 (0.8183)	-0.7543 (0.8183)	-0.8618 (0.8182)	-0.8618 (0.8182)
H-statistic	-2.3116** (1.0644)	-2.3116** (1.0644)	-2.9703** (1.2328)	-2.9703** (1.2328)
Concentration	----	----	-3.4672** (1.4747)	-3.4672** (1.4747)
Observations	707	707	707	707

NOTE: This table reports the replication of Columns (6) and (7) of Table 3 in SCW (page 722). The data for the replication were provided by SCW, as were the Stata do files used to produce the replications. Estimates come from maximum likelihood estimation of a logit model, where the dependent variable takes the value 1 if there has been a systemic crisis for that country in that year, and 0 otherwise. The numbers in parentheses below estimated coefficients are cluster robust standard errors, clustered on country. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

TABLE 3
Replication of Key Models Using Alternative Competition Variables

Variable	*Duration models*		*Logit models*	
	(2)	*(3)*	*(6)*	*(7)*
Original Data				
H-statistic	1.6977* (0.8804)	2.3482** (0.9700)	-2.3116** (1.0644)	-2.9703** (1.2328)
Concentration	----	3.0834*** (0.9595)	----	-3.4672** (1.4747)
Observations	701	701	707	707
Replacing H-Statistic with Lerner				
Lerner	0.9784 (1.5270)	3.0542** (1.5275)	-1.0808 (2.6320)	-3.2511 (2.5638)
Concentration	----	3.5171*** (0.9505)	----	-3.7882** (1.6727)
Observations	701	701	707	707
Replacing H-Statistic with Boone				
Boone	-1.7596 (1.4641)	-1.3156 (1.4573)	2.6595 (3.4264)	2.3090 (3.8305)
Concentration	----	2.6709** (1.1211)	----	-2.9291* (1.7057)
Observations	701	701	707	707

NOTE: The column headings indicate that the respective estimates refer to estimating the models in Columns (2), (3), (6) and (7) from Table 3 in SCW (page 722). Only the competition and concentration coefficients are reported. The top panel reproduces the estimates from TABLES 1 and 2. The remaining two panels use the identical set of observations, so that the only difference across panels for a given specification is that a different competition variable has been used (*Lerner* or *Boone* instead of *H-statistic*). The numbers in parentheses below estimated coefficients are cluster robust standard errors, clustered on country. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

TABLE 4
Descriptive Statistics for Original and Updated Data (Common Observations)

Variable	*Data Source*	*N*	*Mean*	*Std. Dev.*	*Min*	*Max*
GDP growth (lag)	*Original*	699	-0.197	3.731	-17.333	25.572
	WDI*	699	3.556	3.399	-13.128	21.829
	IFS	699	3.679	3.797	-8.857	52.554
Inflation	*Original*	691	1.854	1.166	-4.257	6.439
	WDI*	691	15.085	45.013	-0.929	625.802
	IFS	691	15.169	44.896	-4.410	620.840
	DataMarket	691	15.085	45.013	-0.929	625.802
Depreciation	*Original*	332	2.835	2.546	-4.760	8.868
	IFS*	332	0.083	0.250	-0.282	3.219
	WDI	332	0.083	0.250	-0.282	3.219
	DataMarket	332	0.083	0.250	-0.282	3.219
Terms of trade	*Original*	404	4.626	0.197	3.931	5.305
	WDI*	404	0.312	10.945	-46.653	67.797
	DataMarket	404	1.409	15.754	-63.605	169.845
Real interest rate†	*Original*	591	2.159	16.931	-312.233	41.110
	WDI	591	7.231	9.505	-35.078	76.428
	DataMarket	591	7.225	9.505	-35.078	76.428
Credit growth†	*Original*	698	108.092	282.845	-811.882	3393.340
	WDI	698	15.887	93.366	-1605.175	541.081
	GDD	698	15.759	93.416	-1605.175	541.081
Moral hazard index†	*Original*	544	1.664	0.259	0.000	1.940
	DID	544	0.289	2.774	-11.862	4.618

NOTE: The values in the table allow comparison of descriptive statistics across data sources for key variables in SCW's analysis. "Original" refers to the data provided by SCW. The other

data sources are World Development Indicators ("WDI"), International Financial Statistics ("IFS"), Global Financial Development Database ("GDD"), Deposit Insurance Database ("DID") and DataMarket. For each variable, we selected the maximum number of observations for which data were available for all data sources listed for that variable. This insured that differences were due solely to different values across data sources, and not because different observations were used to calculate the descriptive statistics. An asterisk indicates that the respective data source was used by SCW.

† We did not use SCW's datasources for these three variables when it came time for updating. The reasons are given below.

Real interest rate. SCW state that they sourced real interest rate data from International Financial Statistics (IFS). They state that real interest rates were calculated as "nominal interest rate minus the rate of inflation". However, IFS reports various interest rates and inflation rates. The available interest rates are Central Bank policy rate, money market rate, Treasury bill rate, deposit rate, lending rate and government bond rates. Inflation rate data are available for both the consumer price index and the GDP deflator. Not knowing the exact series that SCW used to calculate their real interest data, we instead used the variables identified as "real interest rate" in WDI and DataMarket for the purposes of updating.

Credit growth. Credit growth is based on the amount of domestic credit loaned to the private sector. SCW used IFS data in their paper. However, these data are not currently available from IFS. Therefore, we used domestic credit to private sector data from the WDI and GDD databases when updating.

Moral hazard index. SCW obtained data for their moral hazard index from Demirguc-Kunt and Detragiache's (2002) Deposit Insurance Database. These data were updated by Demirguc-Kunt, Kane and Laeven (2014), and we draw from this latter source when calculating updated values for this variable.

TABLE 5
Replication of Key Models Using Updated Data/Common Observations

Variable	*Duration models*		*Logit models*	
	(2)	*(3)*	*(6)*	*(7)*
A. COMMON OBSERVATIONS 1				
Original Data				
H-statistic	2.7960** (1.2908)	1.9825 (1.7485)	-5.9893** (2.7642)	-5.4947* (2.8957)
Concentration	----	5.7003 (3.9084)	----	-4.3380 (4.0548)
Observations	222	222	218	218
Updated Data – Same Sources				
H-statistic	3.9171 (3.1742)	3.3610 (3.3713)	-4.6618 (3.9148)	-4.1897 (4.3716)
Concentration	----	3.9562 (2.6326)	----	-4.3421 (3.1285)
Observations	222	222	218	218
B. COMMON OBSERVATIONS 2				
Original Data				
H-statistic	2.5688** (1.1370)	2.6843** (1.2699)	-3.8997*** (1.3828)	-4.6277*** (1.7297)
Concentration	----	4.8737* (2.6118)	----	-5.3242** (2.5415)
Observations	474	474	479	479
Updated Data – Multiple Sources				
H-statistic	2.9316* (1.5956)	3.5204 (2.2027)	-3.1329* (1.7123)	-3.7062 (2.4572)
Concentration	----	4.4773*** (1.5671)	----	-4.9514*** (1.5722)
Observations	474	474	479	479

NOTE: The column headings indicate that the respective estimates refer to estimating the models in Columns (2), (3), (6) and (7) from Table 3 in SCW (page 722 and 723). Only the competition and concentration coefficients are reported. All datasets used in the table consist of subsamples of the observations used to estimate the original specifications in SCW. The table consists of two panels. The top panel updates variable values using the same data sources as SCW. The bottom panel expands the number of data sources, choosing the one that maximizes the number of observations available for estimation. Each panel (A and B) consists of two parts. Both parts within a panel use the identical set of observations. The only difference is the top part uses SCW's original data, while the bottom part of the panel uses updated values of the control variables. Note that there are variables values that are available in SCW's original dataset, for which updated values are not available; and variables for which current values are available, but for which values are missing in SCW's original dataset. For this reason, the number of observations in each panel is less than the original number of observations used by SCW. The numbers in parentheses below estimated coefficients are cluster robust standard errors, clustered on country. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

TABLE 6
Replication of Key Models Using Updated Data/Maximum Observations

Variable	*Duration models*		*Logit models*	
	(2)	*(3)*	*(6)*	*(7)*
A. SAME SOURCES (1980-2005)				
H-statistic	0.9160 (1.2235)	0.3447 (1.3776)	-0.5822 (1.6485)	-0.0653 (1.7760)
Concentration	-	4.4016** (1.8738)	-	-4.3776** (1.9312)
Observations	327	327	331	331
B. MULTIPLE SOURCES (1980-2005)				
H-statistic	0.2551 (0.9266)	0.3110 (0.9797)	-0.0580 (1.3563)	-0.1678 (1.6199)
Concentration	-	4.6350*** (1.4047)	-	-4.9581*** (1.5413)
Observations	679	679	682	682
C. SAME SOURCES (1980-2014)				
H-statistic	0.5394 (1.2349)	0.3736 (1.3669)	-0.2029 (1.6536)	0.0223 (1.7882)
Concentration	-	3.3357** (1.5215)	-	-3.4130* (1.8728)
Observations	506	506	497	497
D. MULTIPLE SOURCES (1980-2014)				
H-statistic	0.0513 (0.8524)	0.0327 (0.9209)	0.1044 (1.3045)	0.0940 (1.5566)
Concentration	-	4.4240*** (1.2262)	-	-4.6509*** (1.3697)
Observations	851	851	846	846
E. MULTIPLE SOURCES + UPDATED H-STATISTIC AND CONCENTRATION (1980-2014)				
H-statistic	1.2131 (0.9201)	1.4096 (0.8714)	-1.2431 (1.0914)	-1.4448 (1.2715)
Concentration	-	4.0230*** (1.2677)	-	-4.3229** (1.7700)
Observations	851	851	846	846

NOTE: The column headings indicate that the respective estimates refer to estimating the models in Columns (2), (3), (6) and (7) from Table 3 in SCW (page 722). Only the competition and concentration coefficients are reported. Panels A and B are identical to Panels A and B in Table 5, except that all available observations are used, even if the observations were not included in SCW's original analysis. Panels C and D repeat the analysis of Panels A and B except that the sample periods are extended to the most recently available data (2014). Panel E is identical to Panel D, except that the values for the competition and concentration variables are also updated, whereas the previous panels used the values originally used by SCW. The numbers in parentheses below estimated coefficients are cluster robust standard errors, clustered on country. *, **, and ***, indicate significance at the 10-, 5-, and 1-percent significance levels.

Global Financial Development Database provides H-statistic data from year 2010 onwards. Panel E considers 2010 H-statistic value as a constant value throughout the sample period.

FIGURE 1
Comparison of Selected Data Values from Alternative Sources

A. Variable = *GDP growth (lag)*

Country	*Year*	*Original*	*WDI**	*IFS*
INDONESIA	1980	1.63	7.09	6.26
INDONESIA	1981	-0.58	8.72	9.88
INDONESIA	1982	-7.04	8.15	7.93
INDONESIA	1983	7.35	1.10	2.25
INDONESIA	1984	-1.28	8.45	4.19
INDONESIA	1985	-3.69	7.17	6.97
INDONESIA	1986	2.49	3.48	2.46
INDONESIA	1987	-0.66	5.96	5.88
INDONESIA	1988	1.06	5.30	4.93
INDONESIA	1989	2.73	6.36	5.78
INDONESIA	1990	-0.08	9.08	7.46
INDONESIA	1991	-0.07	9.00	7.24
INDONESIA	1992	-1.71	8.93	6.95
INDONESIA	1993			
INDONESIA	1994			
INDONESIA	1995			
INDONESIA	1996	-0.75	8.40	8.22
INDONESIA	1997	-2.94	7.64	7.82
INDONESIA	1998			
INDONESIA	1999			
INDONESIA	2000			
INDONESIA	2001			
INDONESIA	2002			
INDONESIA	2003			
INDONESIA	2004			
INDONESIA	2005			

B. Variable = *Inflation*

Country	*Year*	*Original*	*WDI**	*IFS*	*DataMarket*
BRAZIL	1980	4.5	87.3	91.2	87.3
BRAZIL	1981	4.7	107.2	104.7	107.2
BRAZIL	1982	4.7	104.8	101.9	104.8
BRAZIL	1983	4.9	140.2	136.4	140.2
BRAZIL	1984	5.4	212.8	204.4	212.8
BRAZIL	1985	5.4	231.7	249.5	231.7
BRAZIL	1986	5.0	145.3	147.5	145.3
BRAZIL	1987	5.3	204.1	204.8	204.1
BRAZIL	1988	6.5	651.1	648.7	651.1
BRAZIL	1989				
BRAZIL	1990				
BRAZIL	1991	6.0	414.2	414.2	414.2
BRAZIL	1992	6.9	968.2	974.1	968.2
BRAZIL	1993				
BRAZIL	1994				
BRAZIL	1995				
BRAZIL	1996				
BRAZIL	1997				
BRAZIL	1998				
BRAZIL	1999	1.7	8.0	8.5	8.0
BRAZIL	2000	2.1	5.5	6.2	5.5
BRAZIL	2001	2.0	8.1	9.0	8.1
BRAZIL	2002	2.3	9.9	10.6	9.9
BRAZIL	2003	2.7	14.0	13.7	14.0
BRAZIL	2004	2.1	7.8	8.0	7.8
BRAZIL	2005	2.0	7.5	7.2	7.5

FIGURE 1
Comparison of Selected Data Values from Alternative Sources (continued)

C. Variable = *Depreciation*

Country	*Year*	*Original*	*IFS**	*WDI*	*DataMarket*
AUSTRIA	1980	2.625	-0.032	-0.032	
AUSTRIA	1981	2.765	0.231	0.231	
AUSTRIA	1982	2.815	0.071	0.071	
AUSTRIA	1983	2.962	0.053	0.053	
AUSTRIA	1984	3.093	0.114	0.114	
AUSTRIA	1985	2.850	0.034	0.034	
AUSTRIA	1986	2.618	-0.262	-0.262	
AUSTRIA	1987	2.420	-0.172	-0.172	
AUSTRIA	1988	2.531	-0.023	-0.023	
AUSTRIA	1989	2.469	0.072	0.072	
AUSTRIA	1990	2.368	-0.141	-0.141	
AUSTRIA	1991	2.369	0.027	0.027	
AUSTRIA	1992	2.430	-0.059	-0.059	-0.059
AUSTRIA	1993	2.497	0.058	0.058	0.058
AUSTRIA	1994	2.395	-0.018	-0.018	-0.018
AUSTRIA	1995	2.311	-0.117	-0.117	-0.117
AUSTRIA	1996	2.394	0.050	0.050	0.050
AUSTRIA	1997	2.536	0.153	0.153	0.153
AUSTRIA	1998	2.464	0.014	0.014	0.014
AUSTRIA	1999	-0.005			
AUSTRIA	2000	0.072			
AUSTRIA	2001	0.126			
AUSTRIA	2002	-0.048			
AUSTRIA	2003	-0.233			
AUSTRIA	2004	-0.309			
AUSTRIA	2005	-0.165			

D. Variable = *Terms of trade*

Country	*Year*	*Original*	*WDI**	*DataMarket*
COLOMBIA	1980	4.72		3.85
COLOMBIA	1981	4.59	-11.86	-12.16
COLOMBIA	1982	4.62	2.55	2.88
COLOMBIA	1983			
COLOMBIA	1984			
COLOMBIA	1985			
COLOMBIA	1986	4.87	25.60	22.74
COLOMBIA	1987	4.55	-27.23	-17.64
COLOMBIA	1988	4.50	-5.50	-5.62
COLOMBIA	1989	4.48	-1.78	-0.69
COLOMBIA	1990	4.40	-7.85	-2.34
COLOMBIA	1991	4.45	5.49	2.16
COLOMBIA	1992	4.33	-11.58	-1.93
COLOMBIA	1993	4.36	3.57	2.24
COLOMBIA	1994	4.51	15.70	0.00
COLOMBIA	1995	4.46	-4.43	0.15
COLOMBIA	1996	4.50	3.48	-1.84
COLOMBIA	1997	4.50	0.10	0.96
COLOMBIA	1998	4.41	-8.21	-10.15
COLOMBIA	1999	4.49	7.71	2.06
COLOMBIA	2000			
COLOMBIA	2001	4.51	-5.75	-7.47
COLOMBIA	2002	4.49	-1.86	0.84
COLOMBIA	2003	4.52	2.91	2.69
COLOMBIA	2004	4.53	7.47	6.12
COLOMBIA	2005			

NOTE: The values in the table allow comparison of variable values across data sources for selected variables, countries, and years. “Original” refers to the data provided by SCW. The other data sources are World Development Indicators (“WDI”), and International Financial Statistics (“IFS”). An asterisk indicates that the respective data source was used by SCW.