J Econ Finan (2017) 41:211–234
DOI 10.1007/s12197-015-9341-7

Factors driving systemic risk of banks in Latin America

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Published online: 29 September 2015

Abstract We investigate the drivers of systemic risk and contagion among banks in the Latin American financial sector. First, a systemic risk measure analysing tail co-movements of daily stock returns of all Latin American banks is derived. We then run panel regressions for our systemic risk measure using idiosyncratic bank characteristics and macroeconomic control variables. Our results include various significant drivers of systemic importance of banks in Latin America like bank size, market concentration and high government indebtedness. Interestingly, we empirically prove that during the financial/economic crisis (2006–2011) systemic risk was driven by banks with low earning prospects and relatively sound deposit management whereas poor capital regulation drove systemic risk of banks during the stable periods before (2003–2005) and after the crisis (2012–2014).

Keywords Too big to fail · Systemic risk · Latin America · SIFI · Marginal expected shortfall (MES) · Conditional value at risk (CoVaR)

JEL Classification G01 · G21 · G28

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1 Introduction

Which factors determine the systemic importance of banks in Latin America? In this paper, we investigate the drivers of systemic risk[1] in the Latin American financial sector as well as contagion among banks[2]. Furthermore, we propose a novel measure of systemic risk – the Systemic Risk Index (SRI) – to capture the impact a single financial institution has on the financial sector and vice versa. The topic of our paper is of considerable interest to regulators and economists as well: Our results offer new insights on the drivers of financial instability and provide implications for the prudential regulation of banks.

Financial systems as a whole tend toward instability. This is due to the fragile nature of the players, i.e. financial institutions, especially banks, and their business models. The instabilities of players in the financial sector do not usually remain isolated events but are of a contagious nature, thus tending to spread through the financial system and to cause severe negative macroeconomic shocks (Allen and Gale, 2000; Giesecke and Kim, 2011). Because of their role as a financial intermediary (or delegated monitor), their opaqueness, their interconnectedness, and the typical characteristics of their lenders, banks are particularly prone to infecting other banks with financial distress – or to being infected by them. This in particular holds for those banks that almost certainly and rather quickly would destabilise the system as a whole, so called systemically important financial institutions (SIFIs). Consequently, the identification of drivers of systemic risk of financial intermediaries is of vital importance. Recent papers on systemic risk of financial institutions produced substantial findings. Existing literature in this field, however, is comparably young and leaves questions unanswered: We contribute to the closing of the research gaps by using innovative key indicators for systemic risk, by focusing on a region less researched to date and by distinguishing between crisis and non-crisis periods. This is carried out as follows: second section offers a review of related literature as our background and starting point. The subsequent third section explains our research design. In the fourth section, we derive key determinants of systemic importance of Latin American Banks, while fifth section concludes our findings.

2 Related literature on systemic risk in Latin America

In this section, we briefly discuss the related theoretical and empirical literature on drivers for systemic risk in the Latin American banking sector. During the financial

[1] Systemic risk is the risk "that cumulative losses will accrue from an event that sets in motion a series of successive losses along a chain of institutions or markets comprising a system… That is, systemic risk is the risk of a chain reaction of falling interconnected dominoes" (Kaufman 1995). We basically follow this idea by measuring the contagion from banks to the financial system and vice versa. European Systemic Risk Board and European Commission (2010) defines systemic risk as the risk of disruption in the financial system with the potential to have serious negative consequences for the internal market and the real economy. Similarly to this idea, Acharya et al. (2011) and Adrian and Brunnermeier (2011) quantify systemic risk by measuring a bank's (risk) contribution to the overall financial system. For a list of more possible definitions of systemic risk in the literature, see Prokopczuk (2009).

[2] Banking contagion, concentrating on the transmission of a bank shock to other banks or the financial system, lies at the heart of systemic risk. Early, Bagehot (1873) diagnoses as follows: "In wild periods of alarm, one failure makes many, and the best way to prevent the derivative failures is to arrest the primary failure which causes them".

crisis that started in 2007, this region did not face market turmoil as severe as that in the US or the EU. Therefore, it is not surprising that such research to date has been limited, and that the existence of systemically important banks has only recently been perceived as a problem. Consequently, existing literature on systemic importance in Latin America can be divided into two streams: (a) earlier studies mainly assessing the *individual* (idiosyncratic) risk[3] of Latin American banks (including extensions to – rather fragmentary – measures of systemic risk), and (b) current studies that primarily assess *systemic* importance. The empirical literature on systemic risks of Latin American banks, however, still lacks a comparative study that examines more than one country. In addition to closing this research gap, we combine the measurement of systemic risk (from bank stock returns) with a determination of drivers for the institutions' systemic importance (by using country- and bank-specific data).

As part of the early research, González-Hermosillo et al. (1997) develop a banking sector fragility index using accounting and stock market data. Their results on *Mexico* demonstrate that a high level of *nonperforming/nonsecuritized loans*, *interbank deposit insurance*, *interest rates*, and a depreciation of the *Peso-USD exchange rate* are drivers for systemic risk in the national banking sector. Conversely, Crystal et al. (2001) find that foreign banks operating in *Argentina*, *Chile* and *Colombia* provide important positive influences on the stability and development of the respective banking systems.

Scrutinizing the business model of banks, the study on the *Colombian* financial sector conducted by Arias et al. (2010) demonstrates that financial corporations and financial cooperatives mostly contribute to systemic risk. In accordance, Tabak et al. (2013a, b) show that contagion among entities in the financial system increases significantly during crisis onsets. The latter analyse systemic risks in the *Brazilian* financial system, finding that the impact of the top 5 institutions on instability is approximately 50 % of all institutions' impact. For the Brazilian banking sector between 2006 and 2012, Araújo and Leao (2013) detect that large financial institutions (in terms of total assets) have lower individual risk exposures, but pose higher systemic risks. However, they also note that a few smaller institutions are systemically relevant, too, and that state-owned institutions are less systemically important. In a series of works on the Colombian interbank payment system, León et al. (2011) stress the importance of *connectedness* for systemic risk, followed by size and substitutability. Their results for Colombia illustrate that only a few financial institutions pertain to the very high categories of systemic importance and that non-banking financial firms pose high systemic risk, too. Interestingly, Tabak et al. (2013a, b) come to the conclusion "that systemically important banks are not…causing instability in the LA financial markets". This interpretation, however, has to be taken with caution since the authors do not measure systemic risk, but single institution risks separately. Finally, several of these studies find that *macroeconomic/policy* determinants explain a large portion of systemic risk of individual financial institutions (León and Murcia 2012; Arias et al. 2010; also Weiß et al 2014).

However, there is no study to date that measures (originally) the systemic risk of banks for a group of Latin American countries, nor is there a combination of the measurements of systemic risk with the identification of its determinants. Our paper is

[3] Fiordelisi and Marqués-Ibañez (2013), however, show that individual bank risk tends to be systematic (i.e. non-diversifiable) and has a direct impact on the European banking market. In this respect, it is useful to also consider individual bank risk for measuring systemic bank risk.

the first one to provide that. To achieve this, we compile a unique accounting dataset of all publicly traded banks in Latin America and combine it with stock price data for a 12 year period from 2003 to 2014. Additionally, this study divides the observation window into two time periods: We capture determinants for systemic risk during the financial crisis ("crisis period": 2006–2011) as well as at the onset of the financial crisis and afterwards ("stable period" 2003–2005 and 2012–2014).

3 Research design

3.1 Methodology

As the literature provides different understandings of systemic risk, measurement becomes a challenge. Systemic risk means different things to different people with respect to causation and can be measured ultimately only ex post[4]. However, to measure systemic risk of institutions from the financial sector, there are basically two modes of research (Weistroffer 2011; Guerra et al. 2013; Bongini and Nieri 2014)[5]: The *contribution approach* measures systemic risk as the contribution of a single financial institution to systemic risk. Conversely, the *sensitivity approach* understands systemic risk as the sensitivity of a financial intermediary to a systemic event. Our *systemic risk index* (SRI) captures both. From the point of view of the method of first measuring the systemic risk of a bank, our paper is related to Adrian and Brunnermeier (2011) and Acharya et al. (2011). Second, to analyze determinants on systemic risks, we make use of the approaches elaborated by Brunnermeier et al. (2011), Acharya and Steffen (2014), and Weiß et al. (2014).

3.1.1 Systemic risk contribution (SRC)

When the financial system is in distress, losses and liquidity shortages spread from one financial institution to others, finally affecting the system as a whole (Hauptmann and Zagst 2011). To analyse the role of a single financial institution in closely knit, and thus contagious networks, Adrian and Brunnermeier (2011) propose the *CoVaR*, which is the value at risk (*VaR*) of the financial system conditional on an institution being in distress. The *CoVaR* follows the *contribution approach*: It is meant to capture the bank-specific potential for spreading financial distress from a single institution across the financial system by gauging the tail co-movement of the financial sector with the institution's stock (Adrian and Brunnermeier 2011). The *CoVaR*, however, does not satisfactorily capture the tail co-movement of the financial system and a single institution, since it cuts observed values within

[4] The problems of systemic risk / too big to fail have been characterized by using "one of the most famous phrases in the entire history of Supreme Court opinions", i.e. the Judge-Potter-Stewart-Expression "I can't define it, but I know it when I see it". On the original (about a definition of pornography), see Gewirtz (1996). In the given banking context, see the citation of Dean Baker in Whitelaw (2009) and, more recently, Hansen (2014), p. 16..

[5] The variety of systemic risk measures is growing fast: Bisias et al. (2012) and Billio et al. (2012) provide overviews of systemic risk measures in finance literature.

the tail.[6] Conceptually, we follow the *CoVaR* -approach to some extent, but avoid its shortcoming by proposing the measure *SRC* – the systemic risk contribution – which considers the co-movement of the financial sector returns and individual bank returns within tails. By including every observed value from the tail, the validity of the measure is superior to the VaR-specific tail cut off.[7] Recall that VaR_q^i – the value at risk of an institution's stock with the return r^i – is implicitly defined as the q -quantile: $PR\left(r^i \leq VaR_q^i\right) = q$. It measures the minimum return r^i of an institution's stocks within the $q\%$ -confidence interval within a certain period of time (e.g. 1 year).

We denote by SRC_q^i the return of a financial system relative to an institution i conditional on the institution's return r^i falling below its value at risk $\left(VaR_q^i\right)$:

$$SRC_q^i := E\left[\frac{r^{Sys}}{r^i}\middle| r^i \leq VaR_q^i\right] = E\left[\frac{r^{Sys}}{r^i}\middle| r^i{}_{q=5\%}\right], \tag{1}$$

with r^{Sys} denoting the return of the financial system.

Generally defined, the SRC_q^i measures the reaction of the financial system at the q% worst days of a certain institution's stocks within 1 year. To put it simply: A $SRC_{5\%}^i$ of 0.8 would mean that the average return of the financial system r^{Sys} would be positively correlated to an institution's stock returns r^i, with a coefficient of 0.8 when the respective institution's losses exceeds their *VaR* limit. In other words, when the institution's stocks decline by 6 % on average during the worst 5 % of days within 1 year, we expect the financial system's stocks to decline by 4.8 % on those days.

3.1.2 Systemic risk sensitivity (SRS)

The second measure follows the *sensitivity approach*: It captures the financial systems' return r^{Sys} when a single institution i is in distress. The *SRS* (systemic risk sensitivity measure) that we propose is very closely related to the marginal expected shortfall (MES) employed by Acharya et al. (2011). Instead of measuring absolute values, we put the financial system's losses in relation to the institution's losses. We improve the explanatory power of the *MES* by capturing the tail co-movement of a single institution and the financial system. Analogously, we denote by SRS_q^i the return of an institution i relative to a financial system conditional on the financial system's return r^{Sys} falling below its value at risk $\left(VaR_q^{Sys}\right)$:

$$SRS_q^i : = E\left[\frac{r^i}{r^{Sys}}\middle| r^{Sys} \leq VaR_q^{Sys}\right] = E\left[\frac{r^i}{r^{Sys}}\middle| r^{Sys}{}_{q=5\%}\right]. \tag{2}$$

An $SRS_{5\%}^i$ of 0.8 would mean that the respective institution's mean stock return r^i would be positively correlated to the financial system's return r^{Sys}, with a coefficient of

[6] This criticism – the ignoring of the tails, backward orientation and sensitivity to model specifications – is similar to the general *VaR* criticism. As a response to the criticism and the bad experience with VaR modifications have been suggested. Real alternatives, however, remain being explored by academia or the financial industry.

[7] To deal with the low number of tail observations in a heavy-tailed environment, Van Oord and Zhou (2011) propose an estimator of tail beta by an EVT approach.

0.8 when the financial system's losses exceed their *VaR* limit. In other words, when the financial system's stocks decline by 6 % on average during the worst 5 % of days within 1 year, we would expect the institution's stocks to decline by 4.8 % on those days.

3.1.3 Systemic risk index (SRI)

At the final stage, we average the SRC_q^i and SRS_q^i to obtain a systemic risk measure for financial institutions that considers both directions of risk transmission and contagion:

$$SRI_q^i := \frac{SRC_q^i + SRS_q^i}{2}. \tag{3}$$

For the remainder of the paper, we will use the 5 % quantile and simplify the notation to SRI^i. This measure is a good convention of the practical requirements of regulators and theoretical models on the systemic importance of financial institutions. It demonstrates both how a single institution affects the financial system and how it can be affected by that system. Furthermore, *SRI* is originally based on well-known statistical measures of risk, and the results – expressed in natural units – allow for an interpretation from an economic point of view. Just as with other systemic risk measures, proving that the SRI is itself highly correlated to the underlying phenomenon, i.e. systemic risk is a challenge. Besides the theoretical reasonableness, also empirical observations convincingly suggest that the SRI does capture systemic risk as intended. Fig. 1 shows the results for the systemic risk of the Latin American banking sample (data description see 3.2.1) over the full period from 2003 to 2014. The emergence of systemic risk in 2006 and a clear decline after 2011 is visible.

Since the *SRI* is also relatively stable, regulators could utilize it for market data-based stress tests or the determination of additional capital buffers of systemically important banks. To demonstrate that the value at risk that measures the individual risk of a financial institution is not equal to our systemic risk index, we plot VaR^i (with reverse signs) against the SRI^i for an illustrative sample of Latin American banks (see Figs. 2 and 3).

The correlation between VaR^i and SRI^i in the full sample are 0.4275 (significant on 99 % confidence level). It illustrates that there is only a weak link between the individual (idiosyncratic) risk of the institutions we analyse, measured by VaR^i (abscissa), and the institutions systemic risk, measured by SRI^i (ordinate). Even though the *VaR*s do generally decrease perceivably from the crisis to the stable period (on average from 3.98 to 2.68), our systemic risk measure *SRI* decreases (0.67 to 0.47) when markets calm down. This suggests that the SRI^i is particularly suitable for measuring systemic risks in economically stable periods, i.e. when regulators and bank stakeholders prepare (or at least should do so) for subsequent crises.

3.2 Data

3.2.1 Sample selection and stock market data

We start by selecting two periods for our analysis: First, our *crisis period* (from 2006 to 2011) captures the world financial crisis, which began to exhibit initial negative effects in 2006 when US real estate prices started decreasing for the first time after 14 years

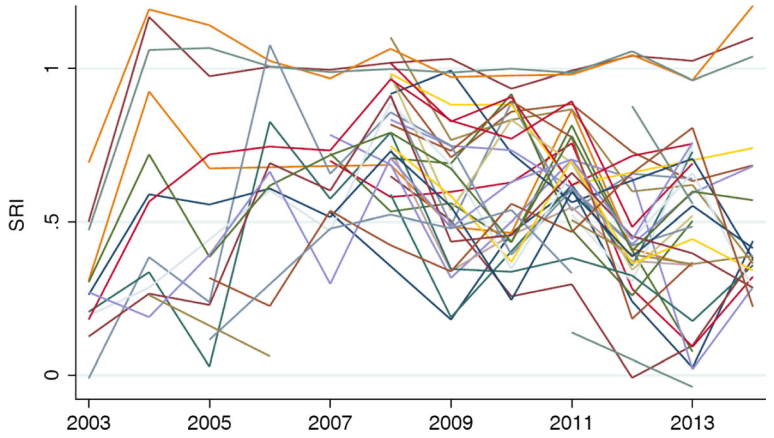

Fig. 1 SRI measure during the full period (2003–2014). The figure presents the panel-data line plots for the systemic risk (SRI) measure of the Latin American bank sample. For the banking sample description see 3.2.1

and which, in particular, includes Lehman Brothers' bankruptcy in September 2008 as the most prominent peak of the ensuing financial crisis (see Brunnermeier 2009). In 2011, the US Financial Crisis Inquiry Commission submitted its final report[8]. The second period, our *stable period* (from 2003–2005 to 2012–2014) captures comparably calm economic periods without noteworthy macroeconomic events in Latin America. Subsequently, we start collecting share price data of all publicly listed banks (~90) from 18 Latin American countries with notable financial markets[9] from *Thompson Reuters Financial Datastream*. However, for a variety of reasons, many Latin American banks are not traded in actuality, their stocks showing constant prices over long periods and trading volumes slightly above zero. After excluding those bank shares with more than 50 % zero daily returns for the analysed periods, 50 banks remained. Additionally, we include banks from the dead-firm list to avoid a survivorship bias. Due to lacking or inconsistent accounting data, we further had to exclude a number of banks,[10] so that we finally produce a full sample of 161 banks for the crisis period and 131 banks for the stable period. The final sample comprises mainly commercial banks (SIC codes 6021, 6022, 6029), savings institutions (SIC 6035), and credit institutions (SIC 6159) from six countries altogether, but which are predominantly located in Brazil (see Table 1)[11]:

[8] For other studies that use the same 2006–2011 period as a reference for the financial crisis see e.g. Gilbert et al. (2013), Trunk and Stubelj (2013), Mukhlas (2012)and Kibritcioglu (2011).

[9] Namely Argentina, Brazil, Bolivia, Chile, Colombia, Costa Rica, Dominican Rep., Ecuador, El Salvador, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, Venezuela.

[10] We manually checked missing accounting values, finding most of them. In five cases, however, we did not find the necessary data, which may bias our results since balance sheet composition may affect the bank opacity, see Flannery et al. (2013). In a recent paper on bank opaqueness, Mendonça et al. (2013) find that a decrease in bank opaqueness fosters an environment favourable to the development of a sound banking system and the avoidance of financial crises.

[11] As such, Brazil's role for our sample is considerable, but in harmony with its general role in Latin America: Here, Brazil is the dominating country with about one third of the Latin American population and GDP. As well, about 70 % of the Latin American market capitalisation is concentrated in this country and in the major Latin America Indices such as the MSCI Emerging Markets Latin America and the S&P Latin America 40, Brazilian stocks make up for more than 50 %. For means of comparison, we have conducted our analysis with an Latin-America-without-Brazil, too. The results can be obtained from the corresponding author upon request.

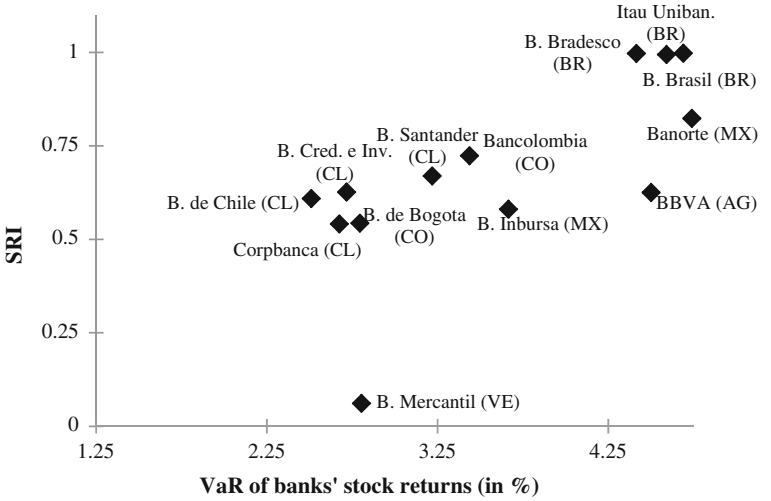

Fig. 2 Average VaR of banks' stock returns (in %) and SRIs during crisis period (2006–2011). The figure presents a comparison of the average value at risk (VaR) and the average systemic risk index (SRI) for Latin American banks from our sample for 2006–2011. The country codes are denoted in brackets

For the estimation of our systemic risk measures in the Latin American financial sector, we use the *Latin America Datastream Financials Index*. This value-weighted index contains share data of around 140 Latin American listed companies from the banking, financial services, insurance, and real estate sector.[12]

3.2.2 Bank characteristics for panel regressions

One purpose of our study is to identify sources for systemic risk of banks in Latin America. In this paper, we investigate the extent to which, ultimately, panel regressions could explain why some banks have a higher influence on financial market stability than others.[13] With this objective in mind, we collect a dataset on idiosyncratic bank characteristics, as well as information concerning countries' regulatory environments (regulatory stringency and quality, deposit insurance) and macroeconomic conditions. The data on banks' cash flows, balance sheets, and profit/loss statements is obtained from *Thomson Reuters Worldscope* (for a full variable definition, see Appendix 1). Where available, we fill data gaps manually with data from banks' websites.

Our first explanatory variable is *Assets*, which is defined as the decimal logarithm of a bank's total assets, thus representing bank size. Large banks may be better diversified and carry less *individual* (idiosyncratic) risk. But we expect bank size, obviously, to have a clear and positive influence on systemic risk, since large banks are more closely

[12] The *Latin America Datastream Financials Index* (Datastream code: FINANLA) offers the best available coverage for the Latin American financial sector. We also create our own indices by value weighting the stock returns of all banks in our samples (as proposed by e.g. Weiß et al. 2014), leading to the same core results for our regression. However, as we are more interested in analysing the determinants for systemic risk in the Latin American financial sector as a whole, those results are not presented in this paper.

[13] Interestingly and in contrast to most of the literature, Dungey et al. (2012) find cases where firm characteristics make little difference to the systemic risks of banks.

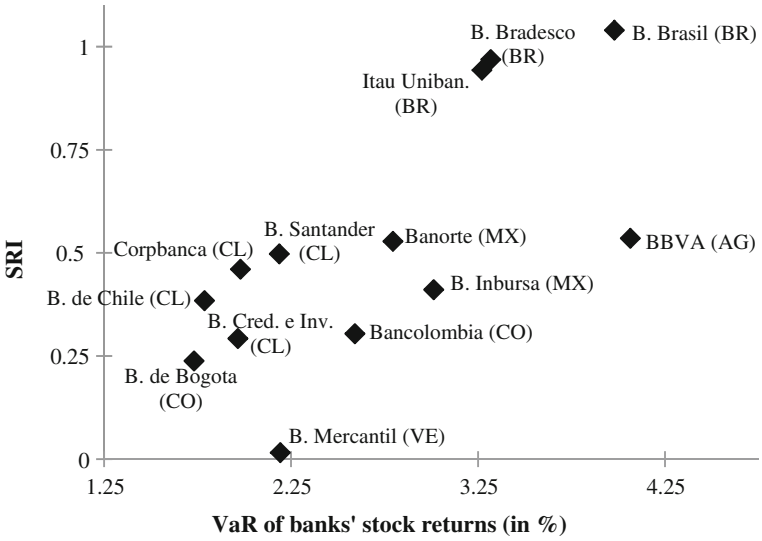

Fig. 3 Average VaR of banks' stock returns (in %) and SRIs during stable period (2003–2005 & 2012–2014). The figure presents a comparison of the value at risk (VaR) and the systemic risk index (SRI) for Latin American banks from our sample for 2003–2005 & 2012–2014. The country codes are denoted in brackets

connected to and within the financial system through interbank liabilities and other exposures to the financial system, making them particularly hard to replace[14] Additionally, banks deemed "too big to fail" are thought to receive implicit state guarantees, so that subsequent bailout expectations increase the risk appetite of banks enjoying this governmental support, as protected actors feel less incentivised to apply market discipline (Gropp et al. 2010; Kleinow and Horsch 2014).

To describe the liability portfolio of a bank and as a proxy for the business type of a bank, we utilize the *Deposit Ratio*, i.e. the ratio of total deposits to total liabilities. Traditional commercial banks with a focus on non-securitized savings and loan business usually have high deposit ratios. In particular, banks with high deposit ratios are financed less via securities issues/the capital market, so that they are less connected to other banks or other institutional investors. For these reasons, we expect the *Deposit Ratio* have a negative influence on banks' systemic risk.

Next, we employ the ratio of market (capitalization) to book value of bank's common equity: *Market to Book.* A high *Market to Book* ratio can be an indicator of disproportionately high expectations for future earnings prospects on the side of investors. These earning prospects are normally associated with higher risks. In most cases, this development is intensified by bank managers, since they are incentivised for excessive risk taking in order to increase firm value to form a "glamour bank", as Weiß et al. (2014) argue. Following a different line of thought, Demsetz et al. (1996) earlier argued that a high *Market to Book* ratio helps to reduce excessive risk taking, because banks have a great deal to lose if a risky business strategy leads to insolvency. Therefore, we expect the *Market to Book* ratio to be unrestricted in the panel regressions.

[14] Basel Committee on Banking Supervision (2014): The BCBS uses exposures (a method comparable to ours) as an indicator of systemic importance.

Table 1 Regional bank samples distribution

	Argent.	Brazil	Chile	Colombia	Mexico	Peru	Venez.	Sum
Crisis period 2006–2011	28	66	28	13	12	12	2	161
Stable period 2003–2005 & 2012–2014	20	48	28	14	14	5	2	131

The table presents the regional distribution of banks among countries we analyse in our 2008 and 2012 sample

To control for the influence of a bank's loan portfolio quality, we use *Non-performing Loans* – the share of loan loss provisions to the total book value of loans – as an explanatory variable in our regression. We assume that *Non-performing Loans* captures the risk level of a bank's loan portfolio, and we expect banks with higher individual risks to affect the financial system more negatively than others. To measure the influence of banks' capital structure, we also utilize their *Leverage* in our regression, expecting a positive relationship between the ratio of debt to equity and the systemic risk a bank poses on the financial system, because higher leverage means a smaller cushion that could absorb losses.

We also control for the influence of banks' profitability on systemic risk by employing *Operating Margin* (the ratio of operating income to net sales) and the rather capital-oriented *Return on Invested Cap.* (return on invested capital). In principle, as Weiß et al. (2014) argue, both measures could be coincident with stability or risk: High values of *Operating Margin* or *Return on Invested Cap.* could shield from the risk of defaulting, so that those banks could be a pillar of stability. Higher profitability, on the other hand, could also be the result of extended yet successful engagement in risky lending/non-lending activities, which may suddenly cause or contribute to the bank's as well as general systemic instability.

To describe the type of business a bank is mainly engaged in on the asset side and the level of revenue diversification, we obtain data on banks' share of total loans to total assets (*Loan Ratio*) and the share of non-interest income to total income (*Loan Ratio*). Although employing different approaches, both are indicators for the banks' dependency on – riskier – non-commercial-banking activities such as investment banking or trading. It is argued (and proved) in the literature that low ratios of total loans to total assets and relatively high noninterest incomes in banks are an indicator of being better diversified, with innovative business models and lower systemic risk exposures (see e.g., Laeven and Levine 2007, Demsetz and Strahan 1997, Stiroh and Morgan 2006). However, for the case of small banks in countries with more private/asymmetric information and more corruption – such as the Latin American banks – De Jonghe et al. (2014) show that the "bright side of innovation" disappears. Consequently, we expect *Loan Ratio* to negatively – and *Non-interest Income* to positively – affect the systemic risk of banks.

As another explanatory variable, we use *Financial Power*, which is the net cash flow of operating activities over total liabilities. We consider it to be a good proxy for bank liquidity, since it is comparatively less vulnerable to manipulations. Banks that are able to hold cash reserves – especially during crisis periods – indicate sound business. The last bank-specific variable we consider for our panel regression is *Cash Ratio* (the ratio of cash and tradable securities to total deposits). A large portion of cash and security reserves is probably advantageous at times of negative shocks in the financial system,

when interbank markets easily dry out and liquidity becomes scarce (e.g. Brunnermeier, 2009). According to this account, *Cash Ratio* is expected to decrease systemic risk. For the crisis and the stable period, Table 2 reports annual mean values on all bank characteristics.

In Latin America, bank characteristics did not change as dramatically as they did in other regions (e.g. US/EU): The information provided emphasises that – relatively seen – the Latin American banking sector only faced minor turmoil during the subprime/financial crisis and could recover quickly, so that e.g. the mean values of *Assets*, *Market to Book*, and *Operating Margin* increased from 2003 to the beginning of the crisis. They then dropped but started to recover since 2009. The descriptive statistics do already give a first impression. Although various reporting standards apply in the Latin American countries in our sample, they do not differ substantially. Historically, most of their accounting rules have their roots in the Iberian (Portuguese, Spanish) reporting standards, while there have been serious efforts to move on to the IFRS for the last 10 years. IFRS are mandatory for listed companies in Brazil (from the financial year 2010), Chile (2010), Mexico (2012), Peru (2011), and Venezuela (2011), see IFRS Foundation (2014); Santana et al. (2014). However, our results on determinants of systemic risk could have been driven by slight differences in the reporting standards.

3.2.3 Country and regulatory controls for panel regression

To control for the impact of different macroeconomic conditions and regulatory systems in Latin American jurisdictions, we include another six variables. Differences in (capital) regulation are of special interest, because stricter regulations and powerful supervisors could limit systemic risks. The data we use is provided by the *World Bank* or databases in regulation literature (Appendix 1 provides detailed definitions and data sources).

To capture the influence of inter-relations between a country and its banks, we use the World Bank's data on bank's claims on their respective central government (as a percentage of GDP) as another variable called *Bank Claims*. If the national banking sector holds a relatively high share of its government's public debt, this should increase the systemic risk of banks in the financial system.

To additionally examine to what extent concentration of the banking industry affects the stability of the financial system, we use *Bank Concentration*: the sum of assets of the three largest national commercial banks as a share of total commercial banking assets. Theoretical literature and empirical literature disagree regarding the influence of concentration on the stability of a banking system. To extend this argumentation, Blundell-Wignall et al. (2011) and Carletti and Hartmann (2002) find that the trade-off between banking concentration and stability does not generally hold. In this case, we would expect high banking concentration to raise stability. However, there are also good theoretical justifications and relevant empirical papers that defend the opposing view of fragility increasing with competition, such as e.g. Beck et al. (2013), while Kleinow et al. (2014) argue that this appears particularly plausible for systemically important financial institutions (SIFIs).

Following the database on deposit insurance systems originally compiled by Demirgüç-Kunt et al. (2008), we use the dummy variable *Interbank Deposit Insurance* that takes the value of one if interbank deposits are covered by an explicit deposit

Table 2 Mean values of bank characteristics

	Stable period			Crisis period						Stable period		
Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Banks	12	13	15	15	17	31	32	31	35	33	37	21
Bank characteristics												
Assets	7.103	7.112	7.144	7.206	7.265	7.067	7.003	7.145	7.194	7.194	7.245	7.518
Deposit Ratio	0.557	0.661	0.693	0.710	0.646	0.566	0.619	0.607	0.620	0.603	0.607	0.548
Market to Book	1.953	2.356	2.703	2.941	2.756	1.144	1.904	2.523	1.630	1.664	1.722	1.605
Non-Performing Loans	0.024	0.014	0.017	0.018	0.018	0.026	0.036	0.020	0.024	0.027	0.026	0.023
Leverage	2.420	1.921	2.027	1.845	2.020	2.659	2.288	2.827	2.565	2.715	2.611	3.256
Operating Margin	0.145	0.228	0.211	0.191	0.196	0.141	0.181	0.219	0.175	0.172	0.160	0.164
Return on Invested Cap.	0.115	0.126	0.117	0.126	0.140	0.125	0.105	0.113	0.114	0.102	0.092	0.095
Loan Ratio	0.594	0.573	0.630	0.630	0.627	0.580	0.584	0.615	0.617	0.636	0.644	0.628
Financial Power	0.005	0.039	0.015	0.018	0.026	0.037	0.033	0.012	0.007	0.025	0.020	0.004
Non-interest Income	0.494	0.451	0.381	0.402	0.359	0.324	0.373	0.384	0.394	0.331	0.439	0.456
Cash Ratio	0.899	0.644	0.556	0.560	0.610	0.759	0.699	0.662	0.652	0.712	0.689	0.848
Country and regulatory controls												
Bank Claims	0.216	0.193	0.169	0.129	0.144	0.248	0.221	0.204	0.183	0.201	0.185	0.195
Bank Concentration	0.516	0.538	0.655	0.606	0.591	0.558	0.621	0.558	0.548	0.547	0.543	0.541
Foreign Deposit Insur.	0.417	0.385	0.467	0.400	0.588	0.355	0.375	0.387	0.400	0.394	0.432	0.333
Capital Regulation	5.583	5.846	6.000	6.333	5.941	5.613	5.625	5.645	5.629	5.485	5.459	5.905
Interbank Deposit Insur.	0.333	0.308	0.333	0.267	0.235	0.161	0.156	0.161	0.143	0.152	0.135	0.238

The table presents mean values of the bank-specific financial data (from balance sheets and profit and loss statements) and mean values of the country or regulatory control variables employed in the panel regressions. Bank-specific data are taken from the databases *Thomson Worldscope* and *Thomson Reuters Financial Datastream*. The country or regulatory control variables are provided by the *World Bank* or other databases in regulation literature. Further variable definitions and data sources are provided in Appendix 1. Additional information on means, medians, minimum and maximum numbers, and standard deviations can be found in Appendix 2

insurance, and zero otherwise. We also use the dummy variable *Foreign Deposit Insurance* that takes the value of one if foreign deposits are covered by the deposit insurance scheme, and zero otherwise. For both explanatory variables, we argue that the effect of the deposit insurance scheme is ambiguous: On the one hand, guaranteeing interbank and foreign deposits could lead market participants to conclude that the banking market is governmentally protected and, therefore, less prone to the spreading of systemic risk. Conversely, it could also lead to higher risk taking among banks, since they are incentivised to lend money to counterparties that promise the highest interbank rates.

The index of capital regulation stringency *Capital Regulation* proposed by Barth et al. (2013) captures whether capital requirements contain certain elements of risk weighting and deductions of market value losses from capital before minimum capital adequacy is determined. We expect regulations to demonstrate their desired effects – e.g. for *Capital Regulation* to limit systemic risks in the financial sector. Another index we employ from the *Worldbank's Worldwide Governance Indicators* database is *Political Stability*: It is designed as an indicator of the likelihood that a government will be destabilised or overthrown by unconstitutional or violent means (e.g. political violence or terrorism). We expect high instability to increase banks' (systemic) risk, as demonstrated by Weiß et al. (2014) and Uhde and Heimeshoff (2008). The lower part of Table 2 provides the mean values for all country and regulatory controls of our panel regressions during the crisis and the stable period.

4 Results: determinants of systemic risk

In this section, we first present the results of the estimates of systemic risk for Latin American banks and then turn to the panel regressions for our systemic risk measure SRI in the crisis (2006–2011) and the stable period (2003–2005 & 2012–2014).

4.1 Systemic risk of Latin American banks

To analyse the determinants of systemic risk of banks, we first compute our systemic risk measures (namely SRC, SRS, and SRI) for all banks in the samples. The distribution results demonstrate that – during the financial crisis – systemic risk is higher than in the stable period before and afterwards (see Table 3). The mean as well as median values of the systemic risk measures are higher during the crisis period, although the observations with the highest systemic risk for one bank in 1 year can be found in the stable period.

A look at the annual mean values of the systemic risk measures in Tables 3 and 4 confirms the findings of Fig. 1 that the systemic risk among Latin American banks peaked in 2008 before declining until 2012 to the previous level of 2005.

After disentangling two dimensions of banks' systemic risk and employing a measure of the systemic risk of financial institutions (SRI) that can be decomposed into two subcomponents (SRS, SRC), empirically, we show quantitatively how bank characteristics actually drive systemic risk of banks in Latin America in the following section.

4.2 Panel regressions of systemic risk among Latin American banks

Turning to our main research question, we identify the drivers of systemic risk for banks in Latin America. For this purpose, we estimate several panel regression models using the banks' systemic risk measure *SRI* as the dependent variables. For the estimation of the unknown parameters in our panel regression models, we use the random effects model with generalized least squares (GLS). A more detailed analysis of drivers for systemic risk *contribution* and systemic risk *sensitivity* would certainly be of interest. Due to issues of space, however, we report the results of the panel regressions using the computed values of SRI as the dependent variable in the following section and provide the results of the panel regressions using SRC, SRS as dependent variables in Appendix 3 and Appendix 4 only.

Our main results are presented in Table 5: In order for them to be statistically traceable, we started the estimation of the determinants of systemic importance by employing *all* the explanatory variables introduced above, i.e. 11 bank characteristics and six macroeconomic control variables. In the second round, we exclude (stepwise) two bank-specific and two macroeconomic variables from the regression with high mean *p*-values. In general, the resulting regressions on drivers of systemic importance of Latin American banks during the stable and the crisis period deliver comparably good results, as the reported R^2 values in Table 5 show. Furthermore, we test/control for the existence of time-fixed effects, random effects, cross sectional dependence, auto-correlation and heteroscedasticity of the explanatory variables in our regressions (1) in Table 5 (Results see Appendix 5).

Regression models (1) through (3) present the interesting result that some explanatory variables have a significant effect on systemic risk as measured by the *SRI*. Most resulting coefficients, however, match closely with our estimated direction of the influence, which is derived from theory and existing empirical literature. For example, *Bank Claims* (the banks' claims against national governments) demonstrates a significant positive influence on systemic risk in most cases. Large government bond/loan exposures of banks stand for a strong interconnectedness of the financial and the governmental system, making the transfer of (financial) problems between them more likely. A higher volume of those assets could also be seen as a particular diversification failure, as the government is already a source of political/regulatory/legal risk, and now adds credit and market price risk. We could also confirm the negative correlation of systemic risk and *Market to Book* with significant negative coefficients for the crisis

Table 3 Distribution of SRC, SRS and SRI

	Crisis period 2006–2011 (n=161)					Stable period 2003–2005 & 2012–2014 (n=131)				
	Mean	Median	Min	Max	St.dev.	Mean	Median	Min	Max	St.dev.
SRC	0.49	0.48	−0.09	1.00	0.19	0.27	0.24	−0.11	1.19	0.20
SRS	0.85	0.80	−0.74	1.78	0.40	0.72	0.60	−0.45	2.12	0.50
SRI	0.67	0.69	−0.41	1.10	0.24	0.49	0.42	−0.23	1.21	0.30

The table presents descriptive statistics for the calculated risk measures. Definitions of the risk measures are provided in Section 3.1

Table 4 Mean of SRC, SRS and SRI from 2003 to 2014

Mean	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
SRC	0.21	0.26	0.24	0.45	0.54	0.62	0.45	0.42	0.45	0.27	0.30	0.27
SRS	0.37	0.96	0.73	0.74	0.78	1.00	0.78	0.85	0.85	0.72	0.71	0.76
SRI	0.29	0.61	0.49	0.60	0.66	0.81	0.62	0.63	0.65	0.50	0.50	0.52

The table presents descriptive statistics for the calculated risk measures. Definitions of the risk measures are provided in Section 3.1

period 2006–2011 – and thus support the argumentation that a high *Market to Book* ratio reduces excessive risk taking, because banks have a great deal to lose if a risky business strategy leads to insolvency. Other variables, such as *Political Stability*, however, demonstrate no influence different from what the literature proposed and from what we expect: Political stability and absence of violence do affect the systemic risk of Latin American banks.

Furthermore, most coefficients demonstrate consistent and equal signs within the observed crisis and stable period. For example, *Assets* and *Bank Concentration* always demonstrate positive coefficients, while *Deposit Ratio*, *Non-interest Income* and *Interbank Deposit Insurance* demonstrate consistently negative coefficients in all regression models (1)–(3) for both periods. It means that, as measured by the Systemic Risk Index, large banks and low competition among banks is likely to increase systemic risk whereas banks that engage largely in traditional banking and are located in countries with interbank deposit insurance have less systemic risk. This appears quite reasonable, as interbank deposit insurance hinders contagion among banks, thus making them resistant against financial distortions.

The coefficient of *Assets* means that size is significant for systemic risk: The larger banks are, the larger the probability that they infect others should they get into financial problems. Analogously observed from a macroeconomic view, a system is more vulnerable if it relies to a large extent on a small number of banks, as it makes their being rescued or replaced by a competitor more unlikely. A high *Deposit Ratio* means that a bank is financed to a large extent by private depositors/creditors, exposing them to less jumpy private market participants compared to professional institutional investors in particular. Compared to institutional and equity investors, depositors are expected to react with lower speed to signs of financial distress.

5 Conclusion

In this study, we analyse the major drivers for systemic risk of banks in Latin America. In particular, we identify why some banks are expected to contribute more to systemic events in the Latin American financial system than others. In our panel regressions, we find empirical evidence supporting existing literature on systemically important financial institutions, identifying bank size, market valuation, loan portfolios, and several macroeconomic conditions as drivers of systemic importance. We can confirm this for Latin America. We also find that simpler approaches in measuring systemic risk – as proposed by Rodríguez-Moreno and Peña (2013) – would not be suitable because, in

Table 5 Regression of banks' systemic risk index

	Exp. sign	Crisis period 2006–2011 (n=161)			Stable period 2003–2005 & 2012–2014 (n=131)		
		(1)	(2)	(3)	(1)	(2)	(3)
Assets	+	**0.211*** **	**0.188*** **	**0.184*** **	**0.130*** **	**0.120*** **	**0.143*** **
		(0.000)	**(0.000)**	**(0.000)**	**(0.009)**	**(0.007)**	**(0.003)**
Deposit ratio	−	**−0.317****	**−0.322*** **	**−0.362*** **	−0.370	−0.236	**−0.363****
		(0.042)	**(0.003)**	**(0.001)**	(0.091)	(0.121)	**(0.035)**
Market to book	+/−	**−0.049****	**−0.051****	**−0.046****	0.031	0.022	0.013
		(0.023)	**(0.020)**	**(0.036)**	(0.422)	(0.348)	(0.610)
Non-performing loans	+	**−2.740****	**−2.475***	**−2.186***	0.651	0.951	1.801
		(0.044)	**(0.068)**	**(0.089)**	(0.640)	(0.485)	(0.215)
Leverage	+	**−0.027****	−0.023	−0.023	0.022	0.020	0.009
		(0.027)	(0.104)	(0.107)	(0.274)	(0.350)	(0.654)
Operating marging	−	−0.180	−0.216	−0.227	0.278	0.267	0.409
		(0.270)	(0.166)	(0.158)	(0.340)	(0.323)	(0.153)
Return on Invested Cap.	−	−0.179	−0.147	0.009	0.361	0.336	0.389
		(0.450)	(0.533)	(0.973)	(0.400)	(0.397)	(0.354)
Loan ratio	−	0.096	0.118		−0.373	**−0.301****	
		(0.626)	(0.348)		(0.110)	**(0.010)**	
Financial power	−	−0.135	−0.093		0.672	**0.714****	
		(0.618)	(0.738)		(0.037)	**(0.012)**	
Non-interest income	+	**−0.135****			−0.031		
		(0.029)			(0.702)		
Cash ratio	−	0.018			−0.076		
		(0.812)			(0.216)		
Bank claims	+	**1.100*** **	**1.100*** **	**0.700*** **	0.493	**0.692***	**0.946*** **
		(0.001)	**(0.002)**	**(0.000)**	(0.236)	**(0.090)**	**(0.000)**
Bank concentration	+	0.207	**0.219***	0.115	0.240	0.303	**0.467****
		(0.127)	**(0.082)**	(0.285)	(0.188)	(0.133)	**(0.015)**
Foreign deposit Insur.	+/−	0.130	**0.124***		−0.078	−0.011	
		(0.104)	**(0.083)**		(0.448)	(0.894)	
Capital regulation	−	0.002	−0.009		−0.041	**−0.039***	
		(0.952)	(0.707)		(0.079)	**(0.077)**	
Interbank deposit Insur.	+/−	−0.015			−0.102		
		(0.867)			(0.552)		
Political stability	−	0.016			0.003		
		(0.726)			(0.957)		
Observations		161	161	161	131	131	131
Groups		37	37	37	41	41	41
R^2 (between)		0.734	0.730	0.683	0.707	0.704	0.620

The table presents the results of the panel regression of banks' systemic risk on the Latin American financial sector. For the estimation of the linear panel regression model, we use heteroskedasticity-robust Huber-White (1980) standard errors. The p-values are denoted in bold and in parentheses. */**/*** indicate coefficient significance at the 10 %/5 %/1 % levels. Variable definitions and sources are provided in Appendix 1

times of crisis (2006–2011), systemic risk was driven by other factors than in the stable periods before and afterwards (2003–2005 & 2012–2014).

Regulators (and bank stakeholders) have to consider a broad variety of indicators for systemic importance. During the last crisis, high earning prospects (*Market to Book*), good income diversification (*Non-Interest Income*) and *Foreign Deposit Insurance*, for example, exhibited a declining effect on systemic risk, though in the stable period they amplified the systemic risk of banks. Conversely, during the stable period Latin American banks mainly engaged in traditional banking activities (*Loan Ratio*) located in a surrounding with a well-developed national *Capital Regulation* were able to mitigate systemic risks. Although we propose different measures for systemic risk than those suggested by the Basel Committee on Banking Supervision (2014), we empirically confirm the urgency of recent regulatory approaches to identify systemically important financial institutions (SIFIs), as well as the validity of approaches to identify systemically important banks in Latin America by using a broad set of financial indicators.

Some limitations of our research, however, remain: Due to the fact that comparable accounting data on insurance companies, investment funds and other financial conglomerates in Latin America are still rare, we could not include those financial institutions in our sample. Finally, the next crisis may be different: To confirm our findings in the long run, future research could try to make use of financial and country data over longer periods.

Appendix 1

Table 6 Definitions and data sources of explanatory variables

Variable name	Definition	Data source
Bank characteristics		in % or USD
Assets	Logarithm of total assets: log(total assets)	Worldscope WC02999
Deposit ratio	$\frac{\text{total deposits}}{\text{total liabilities}}$	WC03019, WC03351
Market to book	$\frac{\text{market capitalization}}{\text{book value common equity}}$	WC09704
Non-performing loans	$\frac{\text{loan loss provisions}}{\text{total loans}}$	WC01271, WC02271
Leverage	$\frac{\text{long+short term debt \&\#x0026; current portion of long term debt}}{\text{common equity}}$	WC08231
Operating margin	$\frac{\text{operating income}}{\text{net sales}}$	WC08316
Return on invested Cap.	$\frac{\begin{array}{c}\text{Net Income}-\text{Bottom Line}+\\(\text{Interest Expense on Debt}-\text{Interest Capitalized})\times(1-\text{Tax Rate})\end{array}}{\begin{array}{c}\text{Average of Last and Current Year's (Total Capital}+\\\text{Short Term Debt \#x0026; Current Portion of Long Term Debt)}\end{array}}$	WC08376
Loan ratio	$\frac{\text{total loans}}{\text{total assets}}$	WC02271, WC02999
Financial power	$\frac{\text{net cash flow operating activities}}{\text{total liabilities}}$	WC04860, WC03351
Non-interest income	$\frac{\text{non}-\text{interest income}}{\text{total interest income}}$	WC01021, WC01016
Cash ratio	$\frac{\text{cash \& securities}}{\text{deposits}}$	WC15013

Table 6 (continued)

Variable name	Definition	Data source
Country regulatory and controls		
Bank claims	Banks' claims on central government as a percentage of GDP include loans to central government institutions net of deposits.	World Development Indicators FS.AST.CGOV.GD.ZS
Bank concentration	Assets of three largest commercial banks as a share of total commercial banking assets.	Global Financial Development GFDD.OI.01
Foreign deposit insurance	Dummy variable that equals one if Foreign Deposit Insurance are covered by the deposit insurance scheme, and zero otherwise.	Demirgüç-Kunt et al. (2008)
Capital regulation	Index of the stringency of capital regulations in the banking system, capturing whether the capital requirement reflects certain risk elements and deducts certain market value losses from capital before minimum capital adequacy is determined. Additionally it captures whether certain funds may be used to initially capitalize a bank and whether they are officially approved by regulators. Index ranges from 0 to 10. Higher values denote greater stringency.	Barth et al. (2013)
Interbank deposit insurance	Dummy variable that equals one if Interbank Deposit Insurance are covered by the deposit insurance scheme, and zero otherwise.	Kane (2000)
Political stability	Political Stability and Absence of Violence/Terrorism captures perceptions of the likelihood that the government will be destabilised or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately −2.5 to 2.5.	Worldwide Governance Indicators PV.PER.RNK

The table provides definitions and data sources for the explanatory variables that are used in the regressions

Appendix 2

Table 7 Descriptive statistics for bank characteristics and macroeconomic control variables

	Crisis period 2006–2011 (n=161)					Stable period 2003–2005 & 2012–2014 (n=131)				
	Mean	Median	Min	Max	St.dev.	Mean	Median	Min	Max	St.dev.
Bank characteristics										
Assets	7.13	7.01	6.07	8.69	0.62	7.24	7.13	6.23	8.81	0.61
Deposit ratio	0.62	0.66	0.20	0.93	0.18	0.61	0.66	0.15	0.90	0.19
Market to book	2.00	1.88	0.32	5.29	1.09	1.88	1.82	0.52	3.99	0.87

Table 7 (continued)

	Crisis period 2006–2011 (n=161)					Stable period 2003–2005 & 2012–2014 (n=131)				
	Mean	Median	Min	Max	St.dev.	Mean	Median	Min	Max	St.dev.
Non-performing L.	0.02	0.02	0.00	0.08	0.02	0.02	0.02	−0.16	0.10	0.02
Leverage	2.45	2.19	0.05	7.16	1.76	2.59	2.39	0.07	6.60	1.76
Operating margin	0.18	0.19	−0.19	0.47	0.11	0.18	0.19	−0.36	0.40	0.19
Return on invested Cap.	0.12	0.10	0.01	0.40	0.80	0.10	0.08	0.01	0.32	0.07
Loan ratio	0.61	0.62	0.35	0.90	0.14	0.63	0.64	0.29	0.88	0.14
Financial power	0.02	0.03	−0.26	0.21	0.07	0.02	0.03	−0.27	0.16	0.06
Non-interest income	0.37	0.33	−0.17	1.27	0.27	0.41	0.32	0.04	1.13	0.28
Cash ratio	0.67	0.50	0.14	2.18	0.43	0.72	0.50	0.17	2.97	0.57
Country regulatory and controls										
Bank claims	0.20	0.17	−0.08	0.43	0.14	0.19	0.17	−0.10	0.45	0.11
Bank Concentr.	0.58	0.60	0.33	0.87	0.14	0.55	0.57	0.34	0.84	0.11
Foreign deposit Insur.	0.40	0.00	0.00	1.00	0.49	0.40	0.00	0.00	1.00	0.49
Capital regulation	5.73	6.00	3.00	9.00	1.26	5.65	6.00	3.00	9.00	1.31
Interbank deposit Insur.	0.17	0.00	0.00	1.00	0.38	0.21	0.00	0.00	1.00	0.41
Policitcal stability	−0.43	−0.24	−1.84	0.67	0.68	−0.47	−0.28	−2.19	0.85	0.73

The table presents descriptive statistics for bank-specific financial data (from balance sheets and profit and loss statements) used in the panel regressions. Bank-specific data are taken from the databases Thomson Worldscope and Thomson Reuters Financial Datastream. The country or regulatory control variables are provided by the World Bank or other databases in regulation literature. Further variable definitions and data sources are provided in Appendix 1

Appendix 3

Table 8 Regression of banks' systemic risk contribution

	Exp. sign	Crisis period 2006–2011 (n=161)			Stable period 2003–2005 & 2012–2014 (n=131)		
		(1)	(2)	(3)	(1)	(2)	(3)
Assets	+	**0.222*** **	**0.245*** **	**0.226*** **	**0.072***	**0.064***	**0.065***
		(0.000)	**(0.000)**	**(0.000)**	**(0.053)**	**(0.076)**	**(0.088)**
Deposit ratio	−	**−0.191***	**−0.194*** **	**−0.211****	−0.095	−0.069	−0.131
		(0.078)	**(0.022)**	**(0.013)**	(0.547)	(0.410)	(0.148)
Market to book	+/−	**−0.068*** **	**−0.071*** **	**−0.064*** **	0.042	**0.051*** **	**0.038****
		(0.000)	**(0.000)**	**(0.000)**	(0.208)	**(0.008)**	**(0.036)**
Non-performing loans	+	**−2.870*** **	**−3.310*** **	**−3.380*** **	0.977	0.836	0.977
		(0.000)	**(0.000)**	**(0.000)**	(0.464)	(0.517)	(0.442)

Table 8 (continued)

	Exp. sign	Crisis period 2006–2011 (n=161)			Stable period 2003–2005 & 2012–2014 (n=131)		
		(1)	(2)	(3)	(1)	(2)	(3)
Leverage	+	**−0.040*** **	**−0.037*** **	**−0.036*** **	0.012	0.012	0.016
		(0.000)	**(0.000)**	**(0.000)**	(0.533)	(0.518)	(0.334)
Operating margin	−	−0.239	−0.245	−0.177	0.099	0.062	0.105
		(0.138)	(0.104)	(0.192)	(0.707)	(0.793)	(0.653)
Return on invested Cap.	−	−0.178	−0.135	−0.115	**−0.274***	**−0.278***	−0.200
		(0.356)	(0.504)	(0.538)	**(0.091)**	**(0.060)**	(0.334)
Loan ratio	−	0.090	**0.242** **		0.119	0.109	
		(0.591)	**(0.017)**		(0.565)	(0.353)	
Financial power	−	−0.089	−0.064		0.078	0.125	
		(0.534)	(0.661)		(0.642)	(0.442)	
Non-interest income	+	−0.011			0.004		
		(0.807)			(0.948)		
Cash ratio	−	0.024			−0.016		
		(0.704)			(0.694)		
Bank claims	+	**0.700** **	**0.600** **	0.100	−0.596	**−0.609***	−0.155
		(0.010)	**(0.027)**	(0.226)	(0.104)	**(0.056)**	(0.466)
Bank concentration	+	**0.623*** **	**0.627*** **	**0.582*** **	−0.030	−0.016	0.161
		(0.000)	**(0.000)**	**(0.000)**	(0.877)	(0.927)	(0.320)
Foreign deposit Insur.	+/−	0.182***	0.125		−0.107	−0.111	
		(0.006)	(0.102)		(0.327)	(0.133)	
Capital regulation	−	0.021	0.033		−0.056	**−0.056** **	
		(0.280)	(0.120)		(0.032)	**(0.022)**	
Interbank deposit Insur.	+/−	**0.200*** **			−0.055		
		(0.002)			(0.734)		
Political stability	−	0.019			−0.038		
		(0.615)			(0.443)		
Observations		161	161	161	131	131	131
Groups		37	37	37	41	41	41
R^2 (between)		0.689	0.595	0.531	0.406	0.425	0.325

The table presents the results of the panel regression of banks' systemic risk on the Latin American financial sector. For the estimation of the linear panel regression model, we use heteroskedasticity-robust Huber-White (1980) standard errors. The p-values are denoted in parentheses. */**/*** indicate coefficient significance at the 10 %/5 %/1 % levels. Variable definitions and sources are provided in Appendix 1

Appendix 4

Table 9 Regression of banks' systemic risk sensitivity

	Exp. sign	Crisis period 2006–2011 (n=161)			Stable period 2003–2005 & 2012–2014 (n=131)		
		(1)	(2)	(3)	(1)	(2)	(3)
Assets	+	**0.194****	**0.125****	**0.134****	**0.204****	**0.188****	**0.241*****
		(0.002)	**(0.038)**	**(0.014)**	**(0.010)**	**(0.011)**	**(0.002)**
Deposit ratio	−	−0.413	**−0.431****	**−0.488****	**−0.727****	**−0.438***	**−0.646****
		(0.129)	**(0.039)**	**(0.019)**	**(0.031)**	**(0.099)**	**(0.024)**
Market to book	+/−	−0.029	−0.031	−0.030	0.003	−0.020	−0.021
		(0.415)	(0.404)	(0.407)	(0.956)	(0.604)	(0.622)
Non-performing loans	+	−2.602	−1.778	−1.287	0.840	1.510	3.071
		(0.228)	(0.410)	(0.541)	(0.679)	(0.449)	(0.129)
Leverage	+	−0.015	−0.007	−0.006	0.027	0.026	−0.003
		(0.477)	(0.770)	(0.788)	(0.340)	(0.399)	(0.913)
Operating margin	−	−0.099	−0.170	−0.257	0.438	0.424	0.643
		(0.663)	(0.432)	(0.261)	(0.324)	(0.302)	(0.106)
Return on invested Cap.	−	−0.215	−0.185	0.069	1.023	0.956	1.056
		(0.513)	(0.602)	(0.865)	(0.166)	(0.173)	(0.116)
Loan ratio	−	0.139	0.020		**−0.867****	**−0.668*****	
		(0.684)	(0.925)		**(0.032)**	**(0.000)**	
Financial power	−	−0.214	−0.130		**1.116****	**1.173****	
		(0.653)	(0.792)		**(0.038)**	**(0.016)**	
Non-interest income	+	**−0.243****			−0.068		
		(0.013)			(0.603)		
Cash ratio	−	0.038			−0.155		
		(0.761)			(0.138)		
Bank claims	+	**1.500*****	**1.400****	**1.400*****	**1.770****	**2.196*****	**2.037*****
		(0.008)	**(0.014)**	**(0.000)**	**(0.011)**	**(0.003)**	**(0.000)**
Bank concentration	+	−0.243	−0.263	**−0.376****	**0.536****	**0.665****	**0.738****
		(0.229)	(0.217)	**(0.036)**	**(0.029)**	**(0.030)**	**(0.020)**
Foreign deposit Insur.	+/−	0.065	0.094		0.005	0.141	
		(0.593)	(0.421)		(0.976)	(0.349)	
Capital regulation	−	−0.020	−0.059		−0.014	−0.008	

Table 9 (continued)

	Exp. sign	Crisis period 2006–2011 (n=161)			Stable period 2003–2005 & 2012–2014 (n=131)		
		(1)	(2)	(3)	(1)	(2)	(3)
		(0.669)	(0.182)		(0.654)	(0.797)	
Interbank deposit Insur.	+/−	−0.189			−0.149		
		(0.204)			(0.473)		
Political stability	−	0.038			0.022		
		(0.617)			(0.762)		
Observations		161	161	161	131	131	131
Groups		37	37	37	41	41	41
R^2 (between)		0.731	0.711	0.666	0.739	0.739	0.678

The table presents the results of the panel regression of banks' systemic risk on the Latin American financial sector. For the estimation of the linear panel regression model, we use heteroskedasticity-robust Huber-White (1980) standard errors. The p-values are denoted in parentheses. */**/*** indicate coefficient significance at the 10 %/5 %/1 % levels. Variable definitions and sources are provided in Appendix 1

Appendix 5

Table 10 Tests for panel regressions (1) of Table 5

Test/diagnostic	2006–2011 Crisis period (1) in Table 5	2003–2005 & 2012–2014 Stable period (1) in Table 5
Time-fixed effects	Prob>F=0.203	Prob>F=0.000
Random effects		
LM test	Prob>chi^2=0.182	Prob>chi^2=0.266
Hausman test	Prob>chi^2=0.046	Prob>chi^2=0.810
Cross sectional dependence		
Breusch-Pagan-LM test	Not enough obs.	Not enough obs.
Pesaran test	Not enough obs.	Not enough obs.
Friedman test	Not enough obs.	Not enough obs.
Frees test	Not enough obs.	Not enough obs.
Autocorrelation (Wooldridge test)	Prob>F=0.081	Prob>F=0.600
Heteroskedasticity	We use heteroskedasticity-robust standard error estimates (Huber/White) to account for heteroskedasticity.	

The table provides results of eight tests for time-fixed/random effects, panel dependence, and autocorrelation for all shown panel regressions. There are time-fixed effects in the stable period, and random effects. We are not able to reject panel dependence for the panel. Although autocorrelation is not a problem in panels with few years, we test it anyway. Tests do not indicate autocorrelation. To account for heteroskedasticity, we use heteroskedasticity-robust standard errors estimates (Huber/White-estimators)

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