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Who can better monitor a bank than another bank? Mechanisms of discipline in the Mexican interbank market

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ABSTRACT

Basel III proposes market discipline (banking disclosure requirements) as a key instrument to achieve soundness in the banking system. Consequently, it is necessary to test the presence of responses to bank risk on the part of the economic agents. This article empirically studies the mechanisms of market discipline (price, quantity, and maturity) in the interbank market: whether higher risk banks have to pay higher interest rate, and have less access to credit in the interbank market, especially for long maturity borrowing. Theoretically, bankers are well equipped to monitor other banks, but the interbank market also is a channel for contagion. Using a sample of 37 Mexican banks, from December 2008 to September 2012, and a dynamic panel model (SYS GMM estimator), I did not find evidence for discipline induced by peers.

Keywords: market discipline; interbank market; bank risk; contagion; Mexico.
JEL classification: E59; G21; G39.
MSC2010: 62P05; 91B24; 91B28.

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¿Quién mejor que un banco para monitorear otro banco? Mecanismos de disciplina en el mercado interbancario mexicano

RESUMEN

Basilea III propone disciplina de mercado (requisitos de revelación de información bancaria) como herramienta clave para alcanzar un sistema bancario sólido. Consecuentemente, es necesario verificar la presencia de reacciones al riesgo bancario por parte de los agentes económicos. Este artículo empíricamente estudia los mecanismos de disciplina de mercado (precio, cantidad y vencimiento) en el mercado interbancario: si los bancos más riesgosos tienen que pagar tasas de interés ms altas y tienen menor acceso al crédito interbancario, especialmente de préstamos con vencimiento de largo plazo. Teóricamente, los banqueros están bien equipados para monitorear otros bancos, pero el mercado interbancario también es un canal para contagio. Usando una muestra de 37 bancos mexicanos, de diciembre de 2008 a septiembre de 2012, y un modelo dinámico con datos de panel (el estimador SYS GMM), no se encontró evidencia a favor de la disciplina inducida por pares bancarios.

Palabras claves: disciplina de mercado; mercado interbancario; riesgo bancario; contagio; México.
Clasificación JEL: E59; G21; G39.
MSC2010: 62P05; 91B24; 91B28.

1. Introduction

Market discipline is postulated as a key instrument to moderate risky behavior of banks through market forces, complementing the regulatory activities of the monetary authorities as proposed by Basel III (Ayadi, 2013; Basel Committee on Banking Supervision, 2013; Martínez Castillo, 2007; Tovar-García and Kozubekova, 2016). In this way, we can gain soundness in the banking and financial systems. Furthermore, market discipline might become in a substitute for regulatory discipline, which is actually more expensive and complex due to financial innovations (Calomiris, 1999).

The market discipline hypothesis has been extensively tested in the retail deposit market (Berger and Turk-Ariss, 2014; Hasan *et al.*, 2013; Tovar-García, 2014). The major findings suggest that the depositors discipline their banks by means of three mechanisms. First, price-based mechanism: depositors request higher interest rates from riskier banks. Second, quantity-based mechanism: depositors demand their money back as a response to riskier behavior of their banks. Third, maturity-based mechanism: depositors shift their financial assets from long- to short-term because of excessive bank risk-taking (Tovar-García, 2014). In general, market discipline deteriorated because of the introduction of deposit insurance schemes, but it is still supported by uninsured depositors and incredulity about government support.

Interbank borrowing is considered par excellence as an uninsured deposit. Accordingly, this market should response strongly to bank risk-taking. In addition, who can better monitor a bank than another bank? The answer seems intuitive, but the theory is ambiguous and the empirical evidence on the market discipline hypothesis in interbank operations is still scarce. Given this, the present investigation is motivated by the following question: which mechanisms of market discipline do banks use to regulate the risky behavior of their peers?

The market discipline hypothesis in the interbank market has been tested in USA, Portugal, Italy, Netherlands and in Central and Eastern Europe countries (Angelini *et al.*, 2009; Cocco *et al.*, 2009; Dinger and Hagen, 2009; Distinguin *et al.*, 2013; Furfine, 2001; King, 2008; Liedorp *et al.*, 2010; Semenova and Andrievskaya, 2012). In general, the peer monitoring hypothesis is supported, but the interbank market also can be a channel through which liquidity shocks and other risks are transmitted (Allen and Gale, 2000; Freixas *et al.*, 2000). In the Dutch case, Liedorp *et al.* (2010) found evidence in favor of the contagion hypothesis.

Financial and banking crises have strongly affected the economic growth of Latin America during the last 30 years. Mexico is an interesting case because its banking system has been expropriated in 1982 due to the debt crisis, privatized in 1991 and bailed out in 1997 soon after the so-called Tequila crisis in 1994-1995. Mexican banks were recapitalized with foreign investments, principally from Spanish and American banks, countries that in the last few years have suffered due to financial and banking crises.

In Mexico, Martinez-Peria and Schmukler (2001) found evidence in favor of the market discipline hypothesis in the retail deposit market, especially after the Tequila crisis, even with the deposit insurance scheme. Conversely, recent findings suggest a weak discipline induced by depositors, subordinated debt holders and borrowers (Tovar-García, 2012, 2014).

In this article, I extend the tests on market disciplines in Mexican interbank operations. Tovar-García (2015b) found that banks with a larger exposure to the interbank market do not have strong bank fundamentals, contradicting the market discipline hypothesis. This work contributes to this literature in several ways. First, it tests the third mechanism of market discipline, maturity-based, which has not been tested before in the interbank market. Second, it uses a large range of dependent and independent variables to check robustness. Third, it employs panel data in a dynamic model (the SYS GMM estimator), which has not been used before to test the mechanisms of market discipline in the interbank operations.

The remainder of the paper is organized as follows. Section 2 discusses previous research and formalizes the hypotheses to be tested. Section 3 describes the data set, a sample of 37 Mexican banks over the period from December 2008 to September 2012. Section 4 specifies econometric models and reports and discusses the results. Finally, conclusions, recommendations and proposals for future research are outlined.

2. Previous research and hypotheses

The idea that banks are superior equipped to monitor other banks is not new. Nicholas (1907, as cited in Calomiris and Kahn, 1991: 499, footnote 7) wrote, “if a bank is actually in bad shape there is far more likelihood of its initial condition being discovered by other banking institutions than by the individual depositors of the bank”. Calomiris and Kahn (1996: 773) mention that “bankers are especially familiar with the

business of banking and therefore have a comparative advantage in determining whether a run on another bank was called for".

Banks, as any creditor, have incentives to monitor borrowers (in this case other banks) because of the possibility of losing money. Good monitoring can minimize losses in comparison with other uninformed economic agents. The informed bank will be able to claim debt and escape first than others. Nevertheless, interbank relationships are complex, and this market can be understood as cooperation and coordination in the payment system, especially in times of financial stress (Calomiris and Kahn, 1996).

The banks can avoid bank runs and panic using the interbank market as a type of coinsurance. A borrowing bank appeals to other banks to balance its payments, usually this is for a very short-term, and the lending bank will avoid monitoring tasks. Nonetheless, in modern interbank relationships these operations are reiterated, have grown considerably, and are shifting from the overnight to medium and long-term. These new characteristics motivate banks to monitor their peers more carfully.

As modelled by Rochet and Tirole (1996), peer monitoring can regulate the risky behavior of the borrowing bank. This monitoring can be effective with the correct incentives: the lending bank must feel at risk and must be formally responsible for losses due to its decisions in interbank transactions. The monetary authority must not rescue each bank in troubles, sending clear signals to the market. Moreover, "the monetary authority should never lend to individual banks because private lenders can best identify solvent-but-illiquid institutions" (Goodfriend and King, 1988, as cited in Flannery, 1996: 805). Nonetheless, private lenders in the interbank market cannot distinguish solvent banks in times of financial crisis, and government intervention is desirable (Flannery, 1996). However, this implies that government intervention (as protection) is an amplifier of risk-taking by banks.

The financial crises during the last 30 years have shown that shocks in the financial sector are transmitted quickly by contagion among sectors and countries. The financial sector is very susceptible, and a small shock in one or a few banks is able to spread by contagion to the entire economy. The interbank market is clearly a channel for contagion.

Allen and Gale (2000) provide a model to analyze this financial contagion among regions (among markets of the banks). When a bank (or banks) in a region cannot borrow in the interbank market to face a liquidity shock; then, the contagion comes from the fall in the value of bank assets in adjacent regions. However, "if the

interbank market is complete and each region is connected to all the other regions, the initial impact of a financial crisis in one region may be attenuated" (p. 4). The opposite result will be found if the interbank market is incomplete, with few connections among regions. A complete interbank market means that all banks can collaborate to face liquidity problems. On the contrary, in the incomplete interbank market we will find overlapping bank liabilities. Note that the central bank can complete the interbank market, but its participation is not explained in the cited model.

Freixas *et al.* (2000) includes the intervention of the central bank as a coordinator to avoid inconveniences of incomplete interbank markets. The central bank must identify and close insolvent banks, with low returns on their investments, providing liquidity to banks with problems because of a specific bank failure, and with an option to rescue banks in a key position in the interbank market (in accordance with the policies too-big-to-fail and too-interconnected-to-fail). This model states that the interbank market exposes the system to a coordination failure (contagion) because of speculations even if all banks are solvent.

Based on network theory, Nier *et al.* (2007) argue that initially the interbank exposure increases the contagion effect. After a certain threshold value, this exposure improves the ability of a banking system to absorb shocks. The problem is that the interbank market can allow operations of an insolvent bank when it must be blocked because of inefficiencies.

2.1 Empirical evidence

The previous empirical literature explores two mechanisms of market discipline. First, the price-based mechanism of market discipline: whether riskier banks pay higher borrowing interest rates in the interbank market. Second, the quantity-based mechanism: whether riskier banks receive less credit.

Furfine (2001) is the first to test the price-based mechanism in the interbank market, using a sample of American commercial banks, he found that borrowing banks with higher profitability, higher capital ratios, and fewer bad loan problems pay lower interest rates when they borrow overnight. King (2008) includes a test for the quantity-based mechanism, and his findings support both mechanisms of market discipline where riskier banks pay more for interbank loans and they are less likely to use these loans as a source of liquidity.

Evidence in favor of the price-based mechanism was found in the Portuguese interbank market, where personal relationships between bankers play a special role in having access to credit (Cocco *et al.*, 2009). In Italy, the evidence support the peer monitoring hypothesis, but banks were not reactive to borrowers' creditworthiness before the global financial crisis in 2007-2008 (Angelini *et al.*, 2009). In Russia, banks with higher capital adequacy ratios enjoy lower interest rates (Semenova and Andrievskaya, 2012). These studies agree that larger banks pay lower rates in the interbank market.[1]

Note that the present work is not focused on direct tests on the contagion hypothesis, whether the failure of a bank triggers the subsequent failure of others. The literature on this question is extensive and is still growing (Upper, 2011). There are several studies empirically exploring the idiosyncratic and systemic risk, and the contagion in banking systems. In particular, the empirical tests based on network theory and simulation methods show evidence in favor of the domino effect.

As pointed out by Upper (2011), these tests do not include reactions of the banks, for example, cutting credit lines. In other words, the bank behavior is not incorporated, and in this context, I focus on a related topic, the mechanisms of market discipline. It is important to note that the absence of market discipline in the interbank market (by peer monitoring) is a warning for the contagion. However, this is a necessary but insufficient condition for contagion. There are many channels of contagion, and in practice contagion due to interbank exposures is uncommon.

To sum up, theoretically, we find that the interbank market is a place where peer monitoring can work, but also this market is a channel for contagion. Moreover, in this concern, government intervention is currently under discussion. Empirically, most of the evidences suggest the presence of market discipline in the interbank market, but also there are evidences for the contagion hypothesis (Liedorp *et al.*, 2010).

2.2 Hypotheses

For studying the mechanisms of market discipline in the Mexican interbank market, I test the following hypotheses:

[1] It is worth noting that Dinger and Hagen (2009), Distinguin *et al.*, (2013), Liedorp *et al.*, (2010), and Nier and Baumann, (2006) study the bank risk- exposure nexus: whether bank risks are explained by their exposure in the interbank market.

H1: Riskier banks pay higher interest rate in the interbank market (the price-based mechanism of market discipline).

H2: Riskier banks have less access to credit in the interbank market (the quantity-based mechanism of market discipline).

H3: Riskier banks have less access to long-term credit in the interbank market (the maturity-based mechanism of market discipline).

3. Data

Mexican banks are required to disclose their financial statements to the Central Bank of Mexico (Banxico), and this information is available on its web site. The National Banking and Securities Commission (known by its Spanish acronym, CNBV) oversees Mexican banks, and provides statistics, news, information, and reports about the financial and banking systems.

Following Tovar-García (2012, 2014), the data used in this research are drawn from the historical statistics of the CNBV, covering the period 2000-2012. The data were recorded monthly, but many variables have a quarterly nature. During these twelve years many banks were removed, merged, or founded. Consequently, the original panel data of banks is unbalanced, and the statistics are seriously incomplete for some years and banks. Therefore, it is difficult to develop a robust analysis for a long period.

It is well known that after financial or banking crises, the economic agents monitor more carefully the behavior of their banks; a wake-up call as proposed by Martinez-Peria and Schmukler (2001). For example, Angelini *et al.* (2009) found in the Italian interbank market that the rates became reactive to borrowers' creditworthiness especially after the failure of Lehman Brothers in September 2008. Furthermore, the number of links among Mexican banks decreased after the failure of Lehman Brothers (Martinez-Jaramillo *et al.*, 2014). Accordingly, this research covers the period December 2008 to September 2012 (quarterly basis) after the failure of Lehman Brothers, and during the global financial crisis, which put the Mexican economy on alert. This period provides statistics covering 37 of the current 44 Mexican banks.

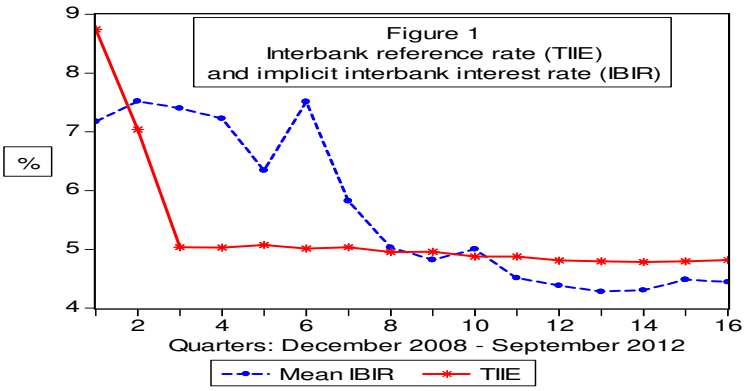
3.1 Measures of the mechanisms of market discipline

To test the price-based discipline mechanism in the interbank market, I use as a dependent variable, an implicit interest rate: the ratio of 12 month interest payments due to interbank borrowing to the amount of the annual average interbank borrowing (IBIR).

The implicit interest rates have been used extensively in the literature on market discipline (Tovar-García, 2014).

As in other countries, Mexico has interbank reference rates established by the Central Bank, which uses offered rates of at least six financial institutions. These reference rates have maturity periods of 28, 91 and 182 days, and Banxico does not set the rate at which individually banks trade financial assets.

Figure 1 shows the interbank reference rate at 91 days (TIIE) and the average at quarter end of the implicit interest rate (IBIR). In general, both rates follow similar trends, but from March 2009 to September 2010 the banks, on average, paid rates above the reference rate, and from June 2011 to September 2012 they paid rates below the TIIE. The correlation between TIIE and IBIR is 0.17. Thus, Banxico may influence the interbank rate, yet market factors pressure strongly the rates effectively paid.



With imperfect information, the price-based mechanism might be biased (Park and Peristiani, 1998; Park, 1995; Tovar-García, 2014). Therefore, I use the growth of interbank borrowing (GROWTHIB – borrowing_t / $\text{borrowing}_{\text{last-quarter}}$) as a dependent variable to test the quantity-based discipline mechanism: whether high-risk banks receive less credit in the interbank market. I use this measure because the absolute amount can be biased by bank characteristics as size and business orientation.

King (2008) also points out the relevance of the quantity mechanism. He uses the ratio of interbank borrowing to total liabilities as a dependent variable. Accordingly, I use the ratio of interbank borrowing to total deposits (EXPOSURE) as a second dependent variable to explore the quantity mechanism.

Note that the interbank market is particularly short-term. Because of this characteristic, Nier and Baumann (2006) use the interbank market directly as a proxy of

market discipline (proportion of deposits received from other banks), arguing that these funds are uninsured liabilities. Any bank is able to recuperate its loans rapidly because of their short-term nature, and the risk premium should be very low. Furthermore, the riskiest banks cannot participate in this market; therefore, it is a good idea to explore the quantity mechanism (King, 2008).

Nevertheless, nowadays, the long-term interbank market is continuously increasing. Consequently, I explore the maturity-based discipline mechanism: whether high-risk banks obtain less long-term credit in the interbank market. I use subtraction to measure the maturity shift; the long-term minus the short-term of interbank borrowing, both as a proportion of total interbank borrowing (MATURITYIB).[2] Higher values of MATURITYIB should reflect low-bank risk. In September 2012, the long-term Mexican interbank borrowing represented around 24% of the transacted amount, the over-night 21%, and the short-term 55%. The largest Mexican banks operated only 33% of the long-term interbank borrowing. Hence, the maturity-based mechanism might discipline of Mexican banks.

3.2 Measures of bank risk (bank fundamentals)

In emerging economies, many banks do not have credit ratings, and bank fundamentals frequently are used to capture the bank risk, for example, CAMEL indicators: capital adequacy, asset quality, management, earnings and liquidity (Tovar-García, 2014). Similarly, I use the ratio of capital to total assets to measure capital adequacy (CAPITALR). For asset quality, I use reserve for loan losses (RESERVE) defined as the balance at the end of the quarter used as a provision for possible credit losses divided by nonperforming loans. A higher RESERVE value indicates a lower probability of bank failure. With an inverse relationship with bank risk, I employ nonperforming loans divided by total loans (DOUBTFUL). For management quality, I use the ratio of 12 month managerial expenses to annual average total assets (MANAGEMENT1), and the ratio of 12 month managerial expenses to 12-month total income (MANAGEMENT2). Earnings are captured with the 12 month return on assets (ROA), and the 12-month return on capital (ROE). For liquidity, I use the ratio short-term (circulating) assets to

[2] Murata and Hori (2006) analyzed this third mechanism in the deposit market. In their econometrics models they used separately the change of the long or short term ratio as dependent variables, later on, they compared the results to explore the shift from long-term to short-term. On the contrary, here I follow a similar strategy to Tovar-García (2014).

total assets (LIQUIDITY1), and the ratio short-term assets to short-term liabilities (LIQUIDITY2).

All the previous empirical studies suggest that the bank's size is a relevant explanatory variable. Therefore, in this research I approach the size effect using the logarithm of total assets (SIZE). In addition, I analyze bank subsamples.

3.3 Descriptive statistics and bank subsamples

The summary statistics of the variables can be seen in Table 1. As a first step, I reviewed the data to eliminate outliers (due to reporting or recording errors). As Tovar-García (2012, 2014), following the classification of Banxico, in this research I use four subsamples of banks to take into account their nature. The first subsample contains seven of the largest banks (G7), which are usually a cutoff point in the reports of Banxico. In September 2012, they operated around 92% of interbank lending and around 62% of interbank borrowing. The second subsample includes 14 commercial banks with typical activities, but smaller than the G7. The third subsample includes 9 retail banks, which specialize in transactions with consumers. The fourth subsample includes seven investment banks, working on the issuance of securities.

The standard deviations of the variables indicate that Mexican banks present a large dispersion of their characteristics. However, this dispersion considerably diminishes by bank subsamples. On average, the seven largest banks are around 30 times larger (by total assets) than the rest of banks, and the difference between the smallest bank and the largest bank is colossal (see columns of minimums and maximums in Table 1). These differences are also appreciable in terms of capital, where the capital ratios (CAPITALR) indicate that the G7 banks are below the mean, better than commercial banks, and far away from retail banks, which show the higher ratios.

On average, IBIR (the implicit interbank borrowing rate) equals 5.9%, and the G7 and investment banks are below the mean. In other words, they paid lower rates for borrow in the interbank market in comparison to retail and commercial banks. The growth of received credit in the interbank market (GROWTHIB) shows that the investment banks have the higher values. On average, the investment banks paid the lowest rate, and relatively received more credit in the interbank market, yet they show the highest standard deviations on these variables. In addition, the interbank deposits are more relevant for investment banks than for the rest of banks, as we can expect, because

non-investment banks have better positions in the retail deposit market (see EXPOSURE in Table 1).

Table 1
Descriptive statistics

	Sample 37 banks					G7		Commercial		Retail		Investment (a)	
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Capital*	592	14665.5	29863.3	103.5	146238.9	66790.2	36659.1	2451.9	2430.2	2085.9	1982.9	3141.6	2392.3
Interbank borrowing*	586	5587.6	9486.9	0.0	67123.2	18768.6	13250.9	3445.1	4611.9	890.3	1494.8	2569.5	5747.1
Interbank lending*	592	4322.2	12247.8	0.0	78013.8	20964.1	21237.3	827.2	1063.3	21.5	75.2	199.6	395.3
Total assets*	592	140438.4	279564.6	127.5	1295406.0	615430.0	361107.2	33806.2	29388.5	13862.3	20220.0	41451.9	46934.7
IBIR	500	5.6	3.9	0.3	61.7	5.1	2.2	5.8	2.1	7.1	1.7	4.1	8.1
GROWTHIB	482	3.6	35.9	0.0	654.1	1.0	0.3	3.6	31.3	1.1	1.0	10.2	74.5
MATURITYIB (b)	400	-0.2	0.6	-1.0	1.0	-0.6	0.3	-0.1	0.5	0.4	0.7	-0.9	0.3
EXPOSURE	588	19.2	24.4	0.0	100.0	5.6	2.3	18.5	17.9	22.2	31.1	30.6	31.0
CAPITALR	592	15.9	14.1	1.3	81.2	12.2	4.4	10.8	9.8	28.5	19.0	13.5	10.3
RESERVE	484	803.9	4354.5	45.3	57772.3	214.2	131.5	298.0	727.3	172.8	78.5	8806.9	14872.2
DOUBTFUL	489	4.1	4.9	0.0	30.3	2.4	1.3	2.7	2.1	8.0	7.0	1.4	3.0
ROA	590	-0.5	9.0	-83.9	19.8	1.4	0.6	0.3	2.4	-4.5	17.4	0.9	1.4
ROE	590	5.8	21.4	-131.3	66.6	11.9	5.7	8.1	9.6	-6.5	36.5	10.6	15.4
MANAGEMENT1	586	8.4	10.5	0.2	79.3	3.4	1.4	4.5	5.6	21.1	13.0	5.2	6.0
MANAGEMENT2	571	102.3	142.0	10.7	1978.6	67.8	16.1	79.1	22.5	187.0	268.4	76.5	49.0
LIQUIDITY1	591	11.2	9.3	0.1	65.9	11.8	2.9	10.3	10.7	12.4	8.5	11.1	11.2
LIQUIDITY2	497	63.0	67.0	6.1	801.7	40.1	14.3	54.1	47.1	64.0	63.8	114.1	113.8

(a) RESERVE and DOUBTFUL include only information of Monex and Royal Bank of Scotland
(b) It does not include information of the banks: American Express; Autofin; Banco Ahorro (they only borrowed on long-term) and The Royal Bank of Scotland; Bank of America; JP Morgan; ING; Deutsche Bank; Banco Fácil (they only borrowed on short-term).
* Balances at quarter end, in millions of Mexican pesos; the rest of variables are ratios in percent, excepting MATURITYIB and Z-SCORE.
G7: Banamex, Banorte, BBVA Bancomer, HSBC, Inbursa, Santander, and Scotiabank
Retail banks: American Express, Autofin, Banco Azteca, Bancoppel, Compartamos, Banco Fácil, Banco Ahorro Famsa, Volkswagen Bank, and Banco Wal-Mart.
Commercial banks: ABC Capital, Afirme, Banco del Bajío, Banregio, Bansí, CIBanco, Interacciones, Inter Banco, Invex, Ixe, Banca Mifel, Multiva, Bank of Tokyo-Mitsubishi Ufj, and Ve por Más.
Investment banks: Actinver, Bank of America, Deutsche Bank, ING, JP Morgan, Monex, and Royal Bank of Scotland.
Source: Author's calculations using CNBV data

MATURITYIB equals -0.2, it means that 60% of the amount borrowed in the interbank market correspond to agreements of short-term, and 40% to long-term (on average). I do not include information of banks that only borrowed for short-term or long-term for computing of this variable. The G7 and investment banks particularly borrowed on short-term. On the contrary, retail banks borrowed on long-term probably because of their nature, and business on consumer products of their subsidiaries.

Investment banks show better positions in the variables RESERVE and DOUBTFUL, but this result must be treated with caution because these variables include information only for two investment banks, and they have the largest values. In the case of retail banks, on average, ROA and ROE are negative. The indicators about quality of management show that these banks are in the worst positions, yet they are above the mean in indicators about liquidity. The higher values of ROA and ROE

correspond to the G7, and the investment banks have a very good position in the variable LIQUIDITY2 (ratio short-term assets to short-term liabilities).

The correlation matrix (see Table 2) shows relevant positive relationships among total assets, capital and the amount borrowed in the interbank market. These correlations are in line with previous findings on the relevance of the largest banks in the interbank transactions. The CAMEL indicators present some high correlations among them, so in the regression analysis these variables are included with prudence to avoid multicollinearity concerns. Thanks to these correlations I am able to elaborate different tests in order to check the robustness of the results to different indicators of the theoretical explanatory variables.

Table 2
Correlation matrix (pairwise)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital (1)	1.00						
Interbank borrowing (2)	0.79	1.00					
Interbank lending (3)	0.84	0.64	1.00				
Total assets (4)	0.97	0.82	0.75	1.00			
IBIR (5)	-0.12	-0.21	-0.09	-0.13	1.00		
GROWTHIB (6)	-0.03	-0.04	-0.02	-0.03	0.07	1.00	
MATURITYIB (7)	-0.39	-0.41	-0.35	-0.39	0.33	-0.05	1.00
EXPOSURE (8)	-0.22	-0.02	-0.17	-0.21	-0.16	0.08	0.10
CAPITALR (9)	-0.13	-0.22	-0.10	-0.19	0.19	0.00	0.17
RESERVE (10)	-0.07	-0.08	-0.05	-0.07	-0.23	-0.01	-0.08
DOUBTFUL (11)	-0.20	-0.23	-0.21	-0.20	0.36	-0.02	0.38
ROA (12)	0.11	0.13	0.08	0.11	-0.11	0.01	-0.05
ROE (13)	0.17	0.19	0.11	0.18	-0.10	0.02	-0.16
MANAGEMENT1 (14)	-0.22	-0.26	-0.18	-0.23	0.19	-0.05	0.21
MANAGEMENT2 (15)	-0.12	-0.13	-0.08	-0.12	0.04	-0.04	0.28
LIQUIDITY1 (16)	0.01	-0.03	0.01	-0.01	-0.01	-0.06	-0.03
LIQUIDITY2 (17)	-0.17	-0.21	-0.12	-0.17	0.02	-0.03	0.36
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
EXPOSURE (8)	1.00						
CAPITALR (9)	0.19	1.00					
RESERVE (10)	0.05	0.00	1.00				
DOUBTFUL (11)	0.15	0.34	-0.13	1.00			
ROA (12)	0.01	-0.43	0.01	-0.47	1.00		
ROE (13)	-0.03	-0.45	-0.04	-0.53	0.89	1.00	
MANAGEMENT1 (14)	0.12	0.68	-0.05	0.46	-0.44	-0.39	1.00
MANAGEMENT2 (15)	0.09	0.39	0.00	0.37	-0.74	-0.66	0.51
LIQUIDITY1 (16)	0.00	0.17	0.03	0.09	0.03	0.05	0.25
LIQUIDITY2 (17)	0.06	0.17	-0.05	-0.10	0.08	0.08	0.04
	(15)	(16)	(17)				
MANAGEMENT2 (15)	1.00						
LIQUIDITY1 (16)	0.02	1.00					
LIQUIDITY2 (17)	-0.06	0.25	1.00				

Source: Author's calculations using CNBV data.

4. Research method

As previous tests on market discipline, this research uses regression analysis. Note that the dependent and independent variables might face problems of endogeneity because of measurement error, omitted variables, and reverse causality.[3] Under these conditions, earlier studies, but not all of them, employed econometric models with instrumental variables. Frequently, researchers basically employed lags of the independent variables as instruments because it is difficult to find good instrumental variables due to data limitations. In addition, we are analyzing relationships with past dependence, that is, the dependent variables are autoregressive.

Because of these concerns, Tovar-García (2012, 2014) recommends dynamic panel models. The SYS GMM estimator of Blundell and Bond (1998) allows for lagged values of the dependent variable to be entered as regressors, and it uses lags of independent variables in first differences and in levels as instruments correcting endogeneity. It is assumed that the error term is not serially correlated and Sargan's over-identification test is used to validate the instruments.

Note that the banks reporting zero exposure to the interbank market during the full period of analysis were removed from the regression analysis. Obviously, banks that are not operating in the interbank market will not face market discipline induced by peers.[4]

4.1 Price-based mechanism of market discipline

The equation [1] is used to test the price-based mechanism of market discipline. The dependent variable is the implicit interest rate in the interbank borrowing market (IBIR). Note the use of the reduced-form specification comprehensively employed in the literature on market discipline due to data limitations to analyze simultaneously models specifying demand and supply schedules (Park, 1995; Tovar-García, 2014). I lag the key explanatory variables by one quarter to account for the fact that the information is available to the bankers with a certain delay, and the variables enter in logarithms to achieve linearity and elasticity coefficients.

$$LnIBIR_{it} = LnCAMEL_{it-1}'\beta + \gamma_1 EXPOSURE_{it} + \gamma_2 SIZE_{it-1} + \gamma_3 TIIE_t + BANK_t'\alpha + T_t'\tau + u_{it} \quad [1]$$

[3] I am using proxy variables for sophisticated concepts as bank risk, exposure to the interbank market, and discipline.

[4] The excluding banks are: Activner, Banco WalMart, Bancoppel, Bank of Tokyo and Volkswagen Bank.

The CAMEL indicators are the major explanatory variables,[5] which are included in the regressions taking into account collinearity concerns. EXPOSURE is controlling the participation of an individual bank in the interbank borrowing market. The reference interest rate of the interbank market TIIE is controlling a possible influence of the monetary authority. SIZE is controlling bank size, and BANK is a dummy variable for each type of bank (G7, Commercial, Retail and Investment), where the G7 is the reference group. Finally, *T* is a dummy variable for years.

The central hypothesis of interest is that IBIR is higher for banks showing low-quality bank fundamentals (higher bank risk). In other words, the price paid for borrowing in the interbank market (IBIR) depends inversely upon the level of CAPITALR, RESERVE, ROA, ROE and LIQUIDITY1-2, and positively upon the level of DOUBTFUL and MANAGEMENT1-2. This is interpreted as evidence for market discipline induced by peers in the interbank market through the price mechanism.

Table 3 summarizes the main results. In columns there are results of the regressions using the full sample and subsamples. In general, the reported estimations pass the Sargan and the serial correlation tests. The dynamic model is justified for the full sample because the dependent variable as regressor enters with statistically significant coefficients at the 1% level, see columns (1) and (2), but it lost significance in the regressions of bank subsamples, see columns (3) and (6)-(9) in Table 3.

In general, the findings do not show evidence in favor of the peer monitoring hypothesis by price-based mechanism. RESERVE and DOUBTFUL enter in the model with statistically significant coefficients and with the opposite sign. That is, banks with larger loan losses pay lower interbank interest rates for borrowing. CAPITALR also shows evidence against the market discipline hypothesis, but it lacks robustness. On the contrary, LIQUIDITY1 enters with the predicted sign and significance, but LIQUIDITY2 does not support the result.

Other control variables show some interesting results, for example, EXPOSURE enters in the model with negative sign and significance. It seems that banks with higher exposure to the interbank market as borrower pay lower interest rates, but this result is not supported by the analysis of bank subsamples. TIIE shows positive signs and

[5] The first models testing discipline in the deposit market utilized in a first step bank fundamentals (as CAMEL) to elaborate a measure of the probability of bank failure, and in a second step, employed that measure as an explanatory variable of the mechanism of market discipline (in this case, of the interest rate). However, the latest empirical studies use directly bank fundamentals, as I propose in this study, to observe which are the variables and types of risk influencing market discipline (Tovar-García, 2014).

significance, predictably, because of the natural relationship between IBIR and TIIE (see Figure 1). The time dummies show some negative and significant coefficients according to the general trend of the variable IBIR during the period of analysis.

The dummies for commercial and investment banks present some significant and negative coefficients. This result means that these banks pay lower rates in comparison to the G7 banks, but these results are not robust. Furthermore, the regressions by bank subsamples show a few significant coefficients with contradictory implications. It is not possible to indentify evidences in favor or in opposition of the price-based mechanism. This lack of significance in the subsamples implies that the relationships take place from one banking sector to another.

Table 3
IBIR: price-based mechanism of market discipline

	Pred Sign	Full Simple		G7 Banks		Commercial Banks		Retail Banks		Investment Banks	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Lagged Dependent		0.51*** (0.07)	0.71*** (0.04)	0.45 (0.58)	2.95*** (1.19)	3.26** (1.37)	-0.03 (0.46)	-0.62 (1.55)	1.30 (13.08)	-0.81 (1.23)	2.36* (1.28)
CAPITALR	-	0.13*** (0.03)	0.04 (0.03)			4.78* (2.54)	-1.84** (0.79)				
RESERVE	-	0.06*** (0.01)		-0.96 (0.85)		0.96* (0.51)		-3.09 (6.04)			
ROA	-	-0.003 (0.01)		0.73* (0.38)		0.14 (0.16)		-0.01 (0.05)		-0.30 (1.17)	
MANAGEMENT1	+	0.16 (0.11)		5.51** (2.55)		-3.00 (2.52)				1.77 (2.67)	
LIQUIDITY1	-	-0.05*** (0.01)		1.00* (0.62)		-0.21 (0.17)		-0.55 (1.52)		0.26 (0.31)	
DOUBTFUL	+		-0.02** (0.01)		-2.46* (1.30)		-0.01 (0.03)		0.35 (10.03)		
ROE	-		0.001 (0.001)		-0.15 (0.11)		-0.01 (0.01)		0.001 (0.02)		-0.04 (0.04)
MANAGEMENT2	+		0.14 (0.11)		-3.42 (2.35)						
LIQUIDITY2	-		0.02 (0.01)		-1.57 (1.09)		0.48 (0.44)		0.45 (5.75)		-0.21 (0.26)
EXPOSURE		-0.003***	-0.01***	0.05	-0.11*	-0.001	-0.01**	-0.004	-0.01	-0.02	-0.01***
SIZE		0.02	-0.05*			1.88*	-1.57***				
TIIE		0.05***	0.07***			-1.05	0.05				
Commercial Banks		-0.58***	0.02								
Retail Banks		-0.35	0.09								
Investment Banks		-1.17***	-0.96								
Year 2010		-0.11***	-0.04			-0.04	0.02				
Year 2011		-0.14***	-0.004***			0.003	0.06				
Year 2012		-0.16***	0.07	-2.65*	3.85	-0.24	0.13	0.74	5.12	4.41	0.71
Period		December, 2008 - September, 2012									
Observations		405	370	105	105	180	156	90	86	77	56
N x T		28 x 15	26 x 15	7 x 15	7 x 15	13 x 15	11 x 15	6 x 15	6 x 15	6 x 15	5 x 15
Sargan test (p-value)		17.26 (0.99)	21.11 (0.98)	2.71e-26 (1.00)	1.73e-24 (1.00)	0.70 (1.00)	4.17e24 (1.00)	3.45e25 (1.00)	4.60e23 (1.00)	1.39e25 (1.00)	6.29e26 (1.00)
First order serial correlation test (p-value)		-1.58 (0.11)	-1.87 (0.06)	-0.89 (0.37)	-0.78 (0.43)	-1.03 (0.29)	-.96 (0.33)	0.51 (0.61)	0.08 (0.93)	0.68 (0.49)	-1.09 (0.27)
Second order serial correlation test (p-value)		0.53 (0.59)	-0.31 (0.76)	-0.38 (0.69)	-	-	0.19 (0.84)	0.44 (0.65)	-0.05 (0.95)	0.07 (0.94)	6.38 (0.00)

Regressions are estimated using the dynamic SYS GMM estimator (Blundell and Bond, 1998)
In parentheses are standard errors (only for the key explanatory variables and the dependent as regressor).
(*) [**] y {***} indicate statistical significance at the (10%) [5%] and {1%} levels.

4.3 Quantity-based mechanism of market discipline

The equation [2] is used to test the quantity-based mechanism of market discipline. The dependent variables are the growth of interbank borrowing in logarithms (GROWTHIB), and the ratio of interbank borrowing to total deposits (EXPOSURE). Note the use one quarter lag and logarithmic transformation of the key explanatory variables.

$$QUANTITY_{it} = LnCAMEL_{it-1}'\beta + \gamma_1 SIZE_{it-1} + \gamma_2 TIIE_t + BANK_t'\alpha + T_t'\tau + u_{it} \qquad [2]$$

where QUANTITY can be GROWTHIB or EXPOSURE and the CAMEL indicators are the key explanatory variables. The reference interest rate of the interbank market (TIIE) controls the price influence on the quantity demanded, and a possible influence of the monetary authority on the market. As in the previous model, I include the variables SIZE, BANK, and *T*.

The central hypothesis of interest is that GROWTHIB and EXPOSURE are lower for banks with low-quality bank fundamentals. The amount that an individual bank borrows in the interbank market (GROWTHIB or EXPOSURE) depends positively upon the level of CAPITALR, RESERVE, ROA, ROE and LIQUIDITY1-2, and inversely upon the level of DOUBTFUL and MANAGEMENT1-2. This is interpreted as evidence for market discipline induced by peers in the interbank market through the quantity mechanism.

Table 4 summarizes the main results when the dependent variable is GROWTHIB. In columns there are results of the regressions using the full sample and subsamples. All reported estimations pass the Sargan and the second order serial correlation tests, but the coefficients of the dependent variable as regressors are not statistically significant. In other words, the amount that a bank borrows in the interbank market does not depend on previous borrowed amounts. This result makes economic sense; otherwise, it might indicate systemic problems in the banking system. The SYS GMM estimator is still a good option because the inclusion of the lagged dependent variable functions as a control variable.[6]

In the analysis of the full sample, the explanatory variables present some mixed results. DOUBTFUL, ROE and LIQUIDITY2 enter in the model with the predicted sign and with statistically significant coefficients (see column 2 in Table 4). In other words,

[6] I also analyzed regressions with fixed and random effects, without the lagged dependent as regressor, and the major results did not change (these results are not reported).

banks with better values in these bank fundamentals receive more credit in the interbank market in favor of the market discipline hypothesis. However, these findings are not robust because RESERVE, ROA and LIQUIDITY1 do not show statistical significance (see column 1 in Table 4). The only explanatory variable with robustness is CAPITALR, its coefficient is positive and significant, suggesting that banks with higher capital ratios receive more interbank credit.

Table 4
GROWTHIB: quantity-based mechanism of market discipline

	Pred Sign	Full Sample		G7 Banks		Commercial Banks		Retail Banks		Investment Banks	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Lagged Dependent		-0.04 (0.03)	-0.02 (0.04)	-1.70 (1.47)	-8.87 (6.73)	-0.03 (0.07)	0.66 (0.67)	1.80 (1.86)	1.88 (1.93)	3.16 (4.87)	0.10 (3.80)
CAPITALR	+	0.31*** (0.09)	0.27* (0.15)			0.07 (0.08)	4.38 (5.66)	-0.97 (1.10)			
RESERVE	+	0.06 (0.05)		-0.70 (0.46)		0.21*** (0.07)					
ROA	+	0.01 (0.01)		-0.06 (0.48)		0.03 (0.04)		-0.02 (0.02)		-0.68 (0.49)	
MANAGEMENT1	-	-0.08 (0.15)		4.14 (3.18)		0.01 (0.25)					
LIQUIDITY1	+	0.02 (0.07)		0.50 (0.36)		-0.01 (0.06)		0.44 (0.50)		-0.16 (1.74)	
DOUBTFUL	-		-0.18*** (0.06)		2.09 (1.95)		-0.52 (0.87)		-8.77 (6.66)		
ROE	+		0.01** (0.002)		-0.28 (0.25)		-0.10 (0.14)		0.01 (0.005)		0.09 (0.11)
MANAGEMENT2	-		0.03 (0.09)		1.40 (1.32)		-5.32 (7.94)				7.54 (6.06)
LIQUIDITY2	+		0.17*** (0.06)		0.78* (0.46)		-0.42 (0.79)		2.61 (1.91)		
SIZE		-0.06**	-0.08***			-0.08*	2.95				
TIIE		-0.04	-0.05*	-0.11**	-0.07	-0.02	-0.39	-0.13	-0.38	2.62	-5.75
Commercial Banks		-0.31*	-0.11								
Retail Banks		-0.71*	-0.44								
Investment Banks		0.11	0.11								
Year 2010		-0.11**	-0.05			-0.52**	-5.72				
Year 2011		-0.13**	-0.09			-0.51*	-10.94				
Year 2012		-0.16**	-0.08	0.12	-0.69	-0.66*	-11.40	1.33	17.79	2.26	1.43
Period		December, 2008 - September, 2012									
Observations		384	362	105	105	169	153	84	82	59	60
N x T		28 x 15	26 x 15	7 x 15	7 x 15	13 x 15	11 x 15	6 x 15	6 x 15	6 x 15	6 x 15
Sargan test (p-value)		12.58 (0.99)	12.51 (0.99)	1.33e-25 (1.00)	5.00e-24 (1.00)	3.22 (1.00)	2.15e17 (1.00)	9.23e24 (1.00)	3.97e25 (1.00)	2.89 (1.00)	1.01 (1.00)
First order serial correlation test (p-value)		-2.31 (0.02)	-2.36 (0.01)	-1.48 (0.13)	-0.68 (0.49)	-1.19 (0.23)	-0.22 (0.81)	-0.69 (0.48)	-0.01 (0.99)	-0.63 (0.52)	-0.10 (0.91)
Second order serial correlation test (p-value)		-0.92 (0.35)	-0.88 (0.37)	-1.12 (0.25)	0.29 (0.76)	0.73 (0.46)	-0.70 (0.48)	-0.85 (0.39)	0.73 (0.46)	0.80 (0.41)	0.45 (0.64)

Regressions are estimated using the dynamic SYS GMM estimator (Blundell and Bond, 1998)
In parentheses are standard errors (only for the key explanatory variables and the dependent as regressor).
(*) [**] y {***} indicate statistical significance at the (10%) [5%] and {1%} levels.

The bank size enters in the model with significance and negative coefficients, suggesting that larger banks received less interbank credit. This makes sense, because the descriptive statics show that the largest banks (G7) are net lenders. TIIE enters with a negative sign, unsurprisingly, lower prices correspond to higher quantities demanded

(although, it presents a few significant coefficients). The rest of dummy variables show results without robustness. In the case of the subsamples, the model practically loses its meaning; a few independent variables enter with significant coefficients, and they are not robust.

Table 5 summarizes the main results when the dependent variable is EXPOSURE. In general, the reported estimations pass the Sargan and the order serial correlation tests. In the full sample the lagged EXPOSURE as regressor presents positive and significant coefficients, suggesting that the ratio of interbank borrowing to total deposits depends positively on previous ratios (the interbank deposit can function as substitute of retail deposits).

Table 5
EXPOSURE: quantity-based mechanism of market discipline

	Pred Sign	Full Simple		G7 Banks		Commercial Banks		Retail Banks		Investment Banks	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Lagged Dependent		0.72*** (0.02)	0.65*** (0.03)	-0.36 (0.67)	-1.30 (0.96)	-0.10 (0.35)	0.39 (0.65)	0.75 (1.12)	-2.71 (2.16)	1.17 (3.31)	1.48*** (0.54)
CAPITALR	+	-2.92 (2.03)	-1.43 (2.12)			34.17 (29.73)	85.97 (61.04)	-473.57 (512.81)	286.51 (214.88)	-8.88 (56.12)	
RESERVE	+	-3.32*** (0.33)		-1.84 (6.64)		-0.83 (10.73)		188.64 (224.48)			
ROA	+	-0.33*** (0.08)		-5.57 (7.50)		-2.34** (1.07)		-1.63 (4.53)		-6.44 (70.85)	
MANAGEMENT1	-	6.64*** (0.94)		28.13 (35.62)		-26.55 (18.27)		134.26 (104.12)			
LIQUIDITY1	+	5.35*** (0.91)		85.14* (48.99)		1.82 (2.75)		222.91 (373.73)		27.82 (17.62)	
DOUBTFUL	-		3.29*** (0.23)		29.03* (15.16)		10.80 (10.93)		-87.56 (103.98)		
ROE	+		-0.22*** (0.08)		2.18 (1.43)		-2.45 (1.55)		-0.87 (0.83)		6.37 (8.35)
MANAGEMENT2	-		-3.78* (2.35)		44.67* (25.69)		-75.52* (46.57)				
LIQUIDITY2	+		6.20*** (0.87)		4.15 (7.65)		-9.00 (7.50)		-88.47 (69.23)		20.52* (10.70)
SIZE		-0.55	-0.91			-0.60	23.03	13.42	-33.07		
TIIE		-0.31	0.34	-3.13*	-0.99	-1.20	1.24	-20.50	-8.76	-12.10	-20.01
Commercial Banks		22.19***	5.54								
Retail Banks		25.77***	19.58								
Investment Banks		21.11***	23.76***								
Year 2010		0.60	0.33			-3.69	-2.72				
Year 2011		1.44**	-0.18			-7.03**	-10.74**				
Year 2012		1.90**	2.18***	7.05*	40.85	-2.28	-20.25	62.78	-18.66	2034.04	2.16
Period		December, 2008 - September, 2012									
Observations		448	399	105	105	183	156	130	116	100	73
N x T		32 x 15	29 x 15	7 x 15	7 x 15	14 x 15	12 x 15	9 x 15	8 x 15	7 x 15	6 x 15
Sargan test (p-value)		17.63 (0.99)	13.05 (0.99)	5.75e-27 (1.00)	7.98e-28 (1.00)	3.78 (1.00)	0.51 (1.00)	1.08e19 (1.00)	5.21e17 (1.00)	2.05 (1.00)	0.56 (1.00)
First order serial correlation test (p-value)		-2.45 (0.01)	-2.19 (0.02)	-0.91 (0.35)	0.24 (0.80)	0.15 (0.87)	-1.46 (0.14)	-0.56 (0.57)	-0.17 (0.86)	0.15 (0.87)	-0.08 (0.93)
Second order serial correlation test (p-value)		-1.03 (0.29)	-1.17 (0.23)	-0.04 (0.96)	0.24 (0.80)	0.28 (0.77)	-0.07 (0.94)	-0.86 (0.38)	-1.14 (0.25)	0.57 (0.56)	-0.52 (0.59)

Regressions are estimated using the dynamic SYS GMM estimator (Blundell and Bond, 1998)
In parentheses are standard errors (only for the key explanatory variables and the dependent as regressor).
(*) [**] y {***} indicate statistical significance at the (10%) [5%] and {1%} levels.

Once more, the regressions show some mixed results, and the evidence is stronger in opposition to the market discipline hypothesis because RESERVE and DOUBTFUL, and ROA and ROE enter in the model with the opposite sign and statistically significant coefficients. In other words, banks with larger loan losses and lower earnings receive more interbank credit. By contrast, LIQUIDITY1 and 2 enter with the predicted sign and significant coefficients; then, banks with better liquidity borrow more in the interbank market in favor of the market discipline hypothesis.

In the analysis of the full sample some dummies of types of banks enter in the model with significant coefficients, as in the previous case. However, in the analysis of subsamples the model loses its meaning, see columns (3)-(10) in the Table 5.

Both indicators on the amount of interbank credit received by banks (GROWTHIB and EXPOSURE) show mixed results in favor and in opposition of the quantity-based mechanism of market discipline. It appears that banks might discipline their peers providing more interbank credit to banks previously showing a superior liquidity.

4.3 Maturity-based mechanism of market discipline

The equation [3] is used to test the maturity-based mechanism of market discipline. The dependent variable is the shift from short- to long-term agreements in the interbank borrowing market (MATURITYIB). In this analysis, I excluded banks that in the period of analysis only borrowed in short-term or only in long-term (see Table 1). I use one quarter lag and logarithmic transformation of the key explanatory variables.

$$MATURITYIB_{it} = LnCAMEL_{it-1}'\beta + \gamma_1 SIZE_{it-1} + \lambda_1 TIIE_t + BANK_t'\alpha + T_t'\tau + u_{it} \qquad [3]$$

The equation [3] includes the control variables TIIE, SIZE, BANK, and *T*, previously defined. As in the former models, the CAMEL indicators are included with caution because of collinearity. The central hypothesis of interest is that MATURITYIB is lower (a shift from long to short-term interbank borrowing) for banks with low-quality bank fundamentals. MATURITYIB depends positively upon the level of CAPITALR, RESERVE, ROA, ROE and LIQUIDITY1-2 and inversely upon the level of DOUBTFUL and MANAGEMENT1-2. This is interpreted as evidence for market discipline induced by peers in the interbank market through the maturity mechanism.

Table 6 summarizes the main results. In general, the reported estimations pass the Sargan and the order serial correlation tests. The lagged dependent variable as regressor presents positive and significant coefficients only in the full sample, suggesting that the shift to long-term agreements depends positively on previous long-term agreements.

Table 6
MATURITYIB: maturity-based mechanism of market discipline

	Pred Sign	Full Simple		G7 Banks		Commercial Banks		Retail Banks	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged Dependent		0.22*** (0.08)	0.36*** (0.08)	-2.08 (2.27)	-3.78 (3.08)	0.18 (0.62)	-8.17 (15.66)	-0.28 (0.87)	-2.45 (3.45)
CAPITALR	+	-0.18*** (0.05)	0.0001 (0.18)	3.11 (4.16)	-5.27 (3.83)	-0.02 (0.11)	8.37 (20.01)		
RESERVE	+	-0.20*** (0.04)		0.36 (0.51)		0.85 (0.90)		0.25 (0.36)	
ROA	+	-0.02 (0.02)		0.30 (0.21)		0.04 (0.06)		-0.52 (0.59)	
MANAGEMENT1	-	0.07 (0.29)				0.34 (0.89)			
LIQUIDITY1	+	0.05 (0.04)		-1.27 (1.00)		-0.10 (0.17)		0.01 (0.32)	
DOUBTFUL	-		0.11*** (0.02)		-0.82* (0.49)		1.33 2.99		-2.96 (4.48)
ROE	+		-0.01 (0.01)		0.03 (0.03)		-0.85 2.07		0.04 (0.06)
MANAGEMENT2	-		-0.27 (0.91)				-29.51 70.05		
LIQUIDITY2	+		-0.10* (0.05)		-2.11* (1.14)		1.28 2.49		1.70 (2.35)
SIZE		0.05**	0.02			-0.39	10.03		
TIIE		0.06***	0.08***	0.02	0.05	-0.11	0.08		
Commercial Banks		0.22	-1.83						
Retail Banks		0.82	0.45						
Investment Banks		-2.47*	-5.91*						
Year 2010		0.14***	0.09			0.40*	0.93		
Year 2011		0.17***	0.09			0.58	3.46		
Year 2012		0.18***	0.06	-9.63	-9.07	0.59	6.05	-0.10	3.33
Period		December, 2008 - September, 2012							
Observations		363	343	105	105	170	153	73	72
N x T		26 x 15	24 x 15	7 x 15	7 x 15	13 x 15	11 x 15	5 x 15	5 x 15
Sargan test (p-value)		16.22 (1.00)	9.60 (1.00)	2.50e-27 (1.00)	7.41e-27 (1.00)	1.84 (1.00)	2.44e18 (1.00)	6.30e30 (1.00)	7.65e26 (1.00)
First order serial correlation test (p-value)		-1.80 (0.07)	-2.11 (0.03)	0.04 (0.96)	0.03 (0.97)	-0.87 (0.38)	-1.12 (0.25)	0.14 (0.88)	-0.02 (0.98)
Second order serial correlation test (p-value)		1.22 (0.22)	1.34 (0.17)	0.68 (0.49)	0.91 (0.35)	0.08 (0.92)	0.33 (0.73)	0.31 (0.75)	0.18 (0.85)

Regressions are estimated using the dynamic SYS GMM estimator (Blundell and Bond, 1998)
In parentheses are standard errors (only for the key explanatory variables and the dependent as regressor).
(*) [**] y {***} indicate statistical significance at the (10%) [5%] and {1%} levels.

The regressions do not show evidence in favor of the maturity-based mechanism of market discipline. On the contrary, RESERVE and DOUBTFUL enter in the model with the opposite sign and statistically significant coefficients at the 1% level. Banks with larger loan losses are shifting their interbank agreements from short- to long-term. CAPITALR and LIQUIDITY2 also show evidence in opposition to the market

discipline hypothesis, but this finding is not robust. In the analysis of subsamples, the model loses its meaning, see columns (3)-(8) in the Table 6. The subsample of investment banks is not included because of data limitations.

5. Conclusions

Market forces can regulate bank risk-taking. In this paper, I explored the mechanisms of market discipline in the interbank market, whether banks monitor other banks. Theoretically bankers are well equipped to identify low-quality banks, and riskier banks should pay higher interest rates and receive less credit in comparison with high-quality banks. Moreover, riskier banks should shift their loan agreements from long- to short-term, and *vice versa*. Nevertheless, the interbank market also is a channel for contagion.

In general, previous empirical studies found evidence in favor of the peer monitoring hypothesis (Angelini *et al.*, 2009; Cocco *et al.*, 2009; Dinger and Hagen, 2009; Distinguin *et al.*, 2013; Furfine, 2001; King, 2008; Semenova and Andrievskaya, 2012). I studied the Mexican case over the period from December 2008 to September 2012, using dynamic panel models (the SYS GMM estimator) and a large range of dependent and explanatory variables to check robustness, and I did not find evidence for market discipline, which agrees with previous findings about the lack of influence on risk-taking behavior of exposure to the interbank market (Tovar-García, 2015b). Moreover, some findings suggest that the interbank market can facilitate the contagion, similar results were found in the Dutch case (Liedorp *et al.*, 2010).

The analysis of the price-based mechanism does not indicate that low-quality banks (with low banks fundamentals or higher bank risk) pay higher interest rates for borrowing in the interbank market. Conversely, banks with larger loan losses pay lower interbank interest rates. The quantity-based mechanism presented mixed evidence, where banks with higher capital ratios receive more interbank credit (based on GROWTHIB), but banks with larger loan losses and lower earnings also receive more interbank credit (based on EXPOSURE). In general, banks with better liquidity borrow more in the interbank market. I also explored the maturity-based mechanism, whether high-quality banks shift their loan agreements from short- to long-term. I did not find evidence in favor of market discipline by maturity of agreements, although the long-term interbank market is large in the Mexican case. On the contrary, banks with larger loan losses are shifting their interbank agreements from short- to long-term. The

analyses by bank subsamples lack significance, supporting the idea that the interbank operations work region by region as modelled by Allen and Gale (2000).

The stability of the interbank market in Mexico depends on regulatory discipline, and bureaucrats are responsible for monitoring and controlling bank risk-taking in interbank operations. If these regulators and politicians respond to the interests of a few banks, for example to the G7, there are probabilities that the supervisors will show low incentives to monitor these banks, Calomiris (1999) found evidence for this during the Mexican banking reforms in the 90's. It is worth noting that Mexico is a country with corruption problems, and in the absence of market discipline, banks can take higher risk and commit fraud, which is a major cause of bank failure (Calomiris and Kahn, 1996). As a consequence, the main task of Mexican policymakers is to restore market discipline in the interbank market, sending clear signals to the market about the involvement of the government in the case of a bank failure.

This study presents data limitations, especially for investment banks. Further research is required to examine connections among groups of Mexican banks (region by region) to identify channels and probabilities of contagion because some findings in this research suggest that the Mexican interbank market is incomplete, with key connections only from the largest banks (G7) to other regions, and market forces do not stimulate correct reactions as higher rates or less credit to low-quality banks. Therefore, the conditions for contagion are higher.

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