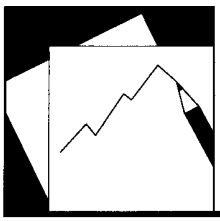
WP/12/254



IMF Working Paper

Financial Spillovers to Chile

Jiri Podpiera

INTERNATIONAL MONETARY FUND

 WP/12/254

IMF Working Paper

Western Hemisphere Department

Financial Spillovers to Chile

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October 2012

Abstract

This paper quantifies financial spillovers from global risk factors to banks' funding costs in Chile. It decomposes Chilean banks' bond and interbank spreads into domestic and external factors. The results suggest moderate spillovers. On average, global spillovers pushed up bank bond and interbank spreads in Chile by about 50 basis points in 2008–12. While in 2008–09, most spillovers originated in the U.S., in mid-2010 onwards, European distress played a prominent role.

JEL Classification Numbers: G01, G12, G15

Keywords: Credit Spread, Interbank Market Spread, Financial Spillover

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[1] The author would like to thank Dora Iakova, Yi Wu, and Alejandro Jara for helpful comments and suggestions.

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I. INTRODUCTION

Chile's economy is well integreated into the global financial system and, as such, is influenced by changes in external financial conditions. Changes in global risk aversion and liquidity directly affect costs and availability of banks' external borrowing (accounting for about 10 percent of liabilities). External pressures also transmit via arbitrage to domestic interest rates. In addition, changes in credit ratings of parent banks may affect subsidiaries, which account for almost half of the banking sector (see Figure 1). Indeed, Frank and Hesse (2009) found strong co-movements of funding markets in advanced and emering markets, including joint sharp increases during specific crisis moments.

This paper quantifies the spillover of global credit and liquidity risks to Chilean banks' funding costs. For the bond market, a model of bank credit risk is employed to study the effects of banks' fundamentals and global credit risk factors on banks' bond credit spread. For the interbank market, the paper updates and extends the analysis of Financial Stability Report (2010) by adding proxies for global risk as explanatory variables.

The results suggest that global spillovers played an important role in the dynamics of funding spreads. Spillovers on average accounted for 40 percent of the bond market spread and 60 percent of the interbank market spread. Until mid-2010, banks' bond credit spread was largely driven by banks' fundamentals and thereafter by global risk factors. Changes in the U.S. interbank market spread accounted for most of the movements in Chile's interbank market spread in 2008, while more recently, spillovers from euro area played a dominant role. Policy measures to increase liquidity, implemented in 2008–10, helped reduce the interbank market spread.

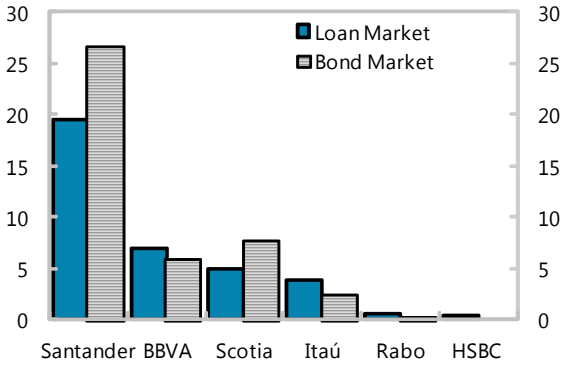
Nevertheless, the spillover effects after 2009 have been moderate and financial intermediation has not been impaired. The estimates suggest that the spillover elevated banks' bond credit and interbank market spreads in Chile by only about 50 basis points on average between mid-2010 and early-2012. In addition, since mid-2011, the increase in the interbank market spread has not transmitted fully into the lending rates (see the difference between the commercial rate spread and interbank rate spread, Figure 1) and thereby helped limit the impact of higher interbank rate on credit, which continued to grow strongly in all sectors.

The rest of the paper is organized as follows. Next section describes the data and methodology used to decompose the funding market spreads. The third section reports the baseline specification results and the fourth section contains the sensitivity analysis. Section five concludes.

Figure 1. Chile: Stylized Facts, 2008-12

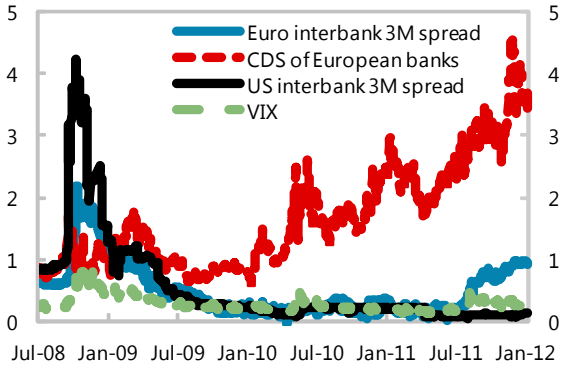
Chile's banking sector is well integrated, ...

Market shares of foreign banks
(In percent)



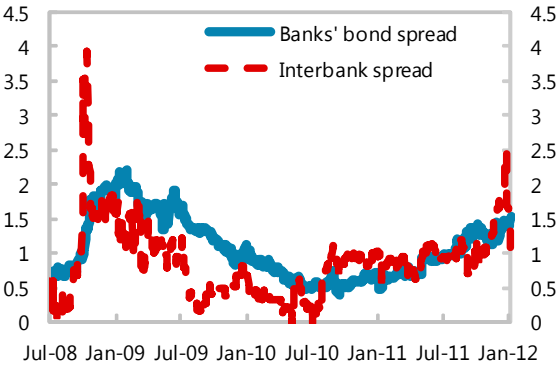
... and thus might be affected by global risk factors.

Global risk variables
(In percent)



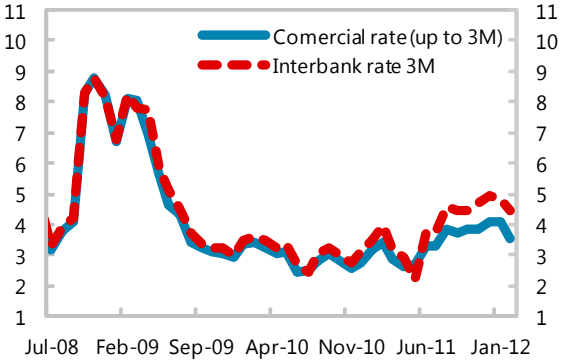
Market spreads have been elevated, ...

Interbank and bond spreads
(In percent)



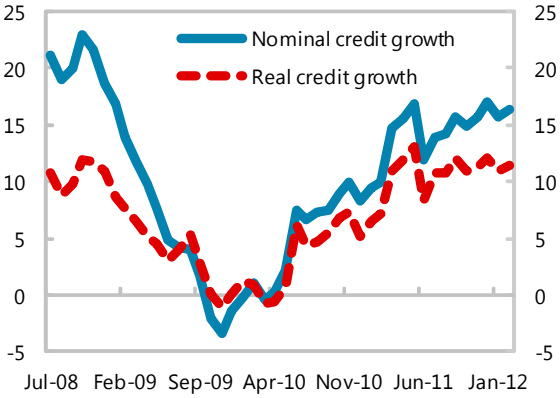
... which usually affects borrowing costs.

Lending spreads over policy rate
(In percent)



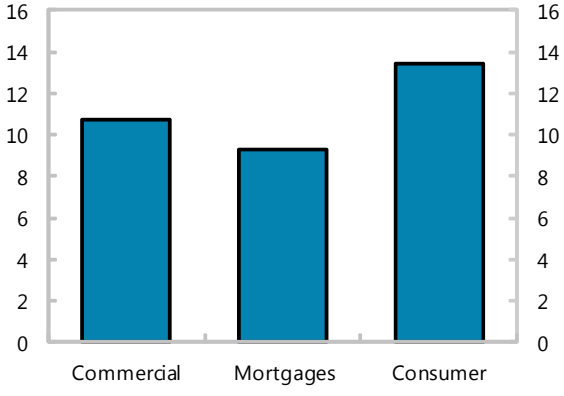
However, spillovers appear to be limited as credit grows strongly...

Credit growth
(In percent)



... in all sectors.

Sectoral credit growth
(Y/Y change 2011/10; percent)



Source: Banco Central de Chile, SBIF, Bloomberg, and own calculations.

II. Methodology and Data

The effects of domestic and external variables on banks' bond credit spread and interbank market spread are examined using least squares estimations, with standard errors adjusted for heteroscedasticity and autocorrelation. The interbank and bond markets are important bank funding sources. Interbank lending and wholesale deposits represent 20 percent of total banks' liabilities. Bonds account for about 15 percent of banks' funding. Changes in the wholesale funding rates should also affect retail deposit rates, possibly with a lag.

A. The Bond Market

Banks' bond credit spread is defined as the difference between the yield on these bonds and the risk-free yield (government bonds) of similar maturity. Although this spread is affected by liquidity premia and tax issues, it mostly measures the premium for credit default risk that investors charge for lending long-term funds to banks (such as subordinated debt). The series is compiled by the Banco Central de Chile.

The bond credit spread has been difficult to explain using standard structural models. Modeling credit default risk is usually based on the value of a firm relative to its debt – the more the value of a company approaches the value of its debt, the more risky the company becomes, and vice versa (that is, measuring the distance to default). Since Merton (1974), the equity is viewed as a call option on a firm's assets with maturity T; the equity price is the spot price and the maturing debt at time T per share is the strike price. Using equities as proxy for a company's value, the credit default risk (corporate credit spread) is a function of the debt per share, volatility of equity price, and the risk-free interest rate. However, these variables explain only a fraction of credit spread variability. This is known in the literature as the credit spread puzzle – see Duffee (1998).

This paper uses a semi-structural model to decompose banks' bond credit spread into a fundamental part and a global risk spillover part. The paper follows Otker-Robe and Podpiera (2012), who derive pricing of bank credit risk from a leveraged portfolio model. Banks are viewed as leveraged portfolios, since they borrow funds and invest them into a portfolio of risky projects. Therefore, portfolio theory could be applied to banks. In particular, there exists a risk-return efficient frontier that is the yardstick for pricing the credit risk of banks. While fundamentals anchor the long-term level of the spread, short-term volatility tends to be connected with periods of high market uncertainty and risk aversion.

The structural part of the model is based on the assumption that banks try to minimize risk and maximize profit. The spread is modelled as a funcion of a set of fundamentals, including banks' net interest margin, operating expenses, return on assets, and the slope of the yield curve. Banks balance risk and return and thus optimize along a risk frontier. Following Otker-Robe and Podpiera (2012), the banks' bond credit spread (CS) is modeled as:

$$CS_t = \mathrm{c} + \alpha NIM_t + \beta \mathrm{EFF}_t - \gamma ROA_t - \delta SLOPE_t + \vartheta_t,$$

- NIM denotes the net interest margin, which is the difference between the interest received from lending and paid for cost of funds; expressed as a ratio of interest bearing assets. It could be viewed as a risk-taking measure, since loans are priced according to their risk score. In a competitive market, banks with more risky portfolios would have higher net interest margin and would have a higher bond spread.

- EFF is the efficiency ratio, and is calculated as the ratio of operating expenses to total revenues. It could be viewed as a measure of operational risk: a strong management would allocate resources well and maintain a low ratio of operating expenses to revenues. Thus, an increasing efficiency ratio signalizes higher operational risk, which would lead to a higher bond spread.

- ROA is the return on assets, which measures profits the banking sector generates with given assets. Increasing profitability allows for strengthening capital and reserve buffers and thus increases resilience of the banking sector. As such, a higher return lowers default risks in the banking sector and the bond spread.

- SLOPE is the slope of the yield curve, which is the difference between the yields on four-year and one-year inflation-indexed bonds issued by the Chilean government. Changes in the slope indicate changes in expected growth prospects of the Chilean economy and have implications for the future profitability of the banking sector. An increase in the slope signalizes improving economic conditions and lower clients' default rates, hence better profitability of the banking sector and lower bond spread.

The data for all the above explanatory variables are from the SBIF, except for SLOPE, which is from Bloomberg.

The remaining part of the model consists of global risk measures and local liquidity factors. In particular, the structural model is enriched with global volatility index (*VIX*), *CDS* spread of European banks (both data from the Bloomberg) and domestic liquidity factors (data from the Banco Central de Chile) :

$$CS_t = \mathrm{c} + \alpha NIM_t + \beta \mathrm{EFF}_t - \gamma ROA_t - \delta SLOPE_t + \theta VIX_t + \varphi CDS_t + \vartheta \Delta MF_t + \cdots \\ \ldots + \rho \Delta PF_t + \xi_t,$$

where $\xi_t \sim \mathrm{N}(0, \sigma)$.

- *VIX* is the volatility index of the U.S. stock S&P 500 and is usually used a proxy for global investors' risk aversion. However, since it is measured on the U.S. stock market, it does not necessarily capture the risk premia in other markets (such as Europe) and submarkets (banking industry, in particular). Increasing risk aversion increases credit risk premia on banks' long-term borrowings.

- *CDS of European banks* captures the stress in the European banking system. European banks have substantial presence in Chile and an increase in the European banks' CDS could have spillover effects.

- *MF* and *PF* stand for the stock of time deposits by mutual funds and pension funds, respectively. These funds are the major provider of wholesale deposits for Chilean banks, and the amount of these deposits varies over time as funds change their portfolios.

Financial market data is in daily frequency, while banking sector's fundamentals are interpolated to daily frequency from quarterly data. The regression analysis uses daily data from July 1, 2008 to January 6, 2012.

B. The Interbank Market

Interbank market spread reflects risk premia on short-term funding. In this paper, the spread is proxied by as the difference between the 90-day peso TAB rate and the overnight interest rate swap for the same maturity. The interbank market is a platform for unsecured lending among banks and thus quoted rates incorporate liquidity and credit risk premia. The interest rate swap contains expectations about the future path of the policy interest rate but practically no credit and liquidity premia, since the swap transaction does not involve transfer of funds. Therefore the spread reflects the two risk premia. While the liquidity premium is driven by the needs and availability of funds, credit risk is linked to the counterparty risk. Under normal market conditions, the spread is positive but close to zero as the credit and liquidity risk premia are small. An increase in the spread indicates rising market pressures. Both series are downloaded from the Bloomberg.

The liquidity premium is identified through a set of proxy variables. In the literature, liquidity premia are only indirectly or partially identified. In its indicative decomposition of interbank rates, BoE (2007) identifies the liquidity premium as the residual (the so called non-credit risk premium) after accounting for credit risk. Michaud and Upper (2008) quantify market liquidity, while the liquidity of borrowing banks and technical factors of the market remain unobserved. This paper uses several proxies for market liquidity premia, including deposits of institutional investors, short-term central bank's instruments, and the central bank's temporary extended liquidity facility (see also FSR, 2010). Market premia in the U.S. and Euro interbank markets are also inlcuded to control for spillover effects.

Banks' counterparty risk can be approximated by credit spreads. Counterparty risk is essentially the risk that the unsecured loan will not be repaid due to a default of the debtor. Such a risk is embedded in banks' bond credit spreads and credit default swaps, so they are often used as the proxy variables for credit risk. For instance, BoE (2007) uses CDS spreads to identify the credit-risk component, while FSR (2010) uses banks' bond credit spreads for that purpose.

The specification of the Chilean interbank market spread (*IMS*) includes domestic and global risk factors:

$$IMS_t = \mathrm{c} + \alpha \Delta MF_t + \beta \Delta PF_t + \gamma \Delta CB_t + \delta IMS_{EU_t} + \theta IMS_{US_t} + \cdots$$

$$\ldots + \omega D_t + \rho CS_t + \varphi CDS_t + \varepsilon_t,$$

MF and *PF* stand for the stock of time deposits by mutual funds and pension funds, respectively.

CB denotes the stock of the central bank's short-term instrument. It accounts for the regular liquidity operations by the central bank.

D is a dummy for the period of expanded liquidity operations by the central bank. Since October 2008, the central bank accepted bank deposits as collateral for the 7-day repo operations. This measure, initially introduced for six months, was subsequently extended for the entire year of 2009 and the transaction tenor was prolonged up to 28 days. In December 2008, the central bank introduced a collateralized line of credit for transactions exceeding 28 days, in which it accepted General Treasury bonds, among others, as collateral. And since mid-2009, a new facility was established (tenors of 90 and 180 days), through which banks accessed funding from the central bank at prevailing monetary policy rate. Further, the central bank introduced 28-day dollar swap auctions. The Ministry of Finance transferred government's dollar funds from abroad and deposited them as term deposits in local banks and also auctioned dollar deposits. In the regressions, the effects of these policy measures are accounted for by a dummy variable, which equals one from November 2008 to mid-2010 and zero otherwise.

IMS_{EU} denotes Euro interbank market spread, which is the difference between the three-month euro interbank market rate and the overnight euro interest rate swap for the same maturity. It measures liquidity and credit risk pressures in the euro interbank market.

IMS_{US} denotes dollar interbank market spread, which is the difference between the three-month dollar federal funds rate and the overnight dollar interest rate swap at the same maturity. It measures both the liquidity and credit risk pressures in the dollar financial market.

The credit risk premium is measured by banks' bond credit spread, denoted by *CS*, and CDS of European banks, labeled as *CDS*. And $\varepsilon_t \sim \mathrm{N}(0, \sigma)$.

Additional variabels are considered in the robustness analysis:

VSTOXX is the volatility index of the European stock market index and is added as a proxy for investors' risk aversion in Europe.

CDS of Citibank US is the credit default swap spread of the Citibank in the U.S.A. and serves as a proxy for the effects of the U.S. credit spread tensions. The Citibank was chosen since it is one of the largest banks in the U.S. and has sizable indirect exposure to Chile's banking sector.

Data for the domestic variables is from the Banco Central de Chile, while IMS_{EU} , IMS_{US} and other financial series are from the Bloomberg.

III. RESULTS

The results point to moderate spillovers from global financial stress. Although the global financial spillovers were clearly one of the driving factors of domestic funding spreads, the magnitude of the effects is relatively small, especially after 2009. The estimates suggest that global spillovers pushed up funding cost in Chile by about 50 basis points on average from mid-2010 to January 2012. Pressures in the U.S. interbank market were the key driver of chnages in the Chile's interbank market spread in 2008–09. More recently, financial tensions in the euro area have been the main source of spillover. Both bank fundamentals and global factors have been important determinants of changes in the bond spread.

A. The Bond Market

The bank bond spread has been driven by banks' fundamentals as well as global risk factors. Table 1 shows the regression results for banks' bond spread. All coefficients are correctly signed and statistically significant. A decomposition of the spread shows that fundamental factors accounted for the largest portion of the spread until mid-2010 (see Figure 2). In the period since then, spillovers from global risk factors (proxied by the VIX and CDS of European banks) have become more important.

Domestic liquidity factors have also played a role. Changes in the stock of time deposits of pension funds correlate negatively with the banks' bond market spreads, which suggests that when pension funds increase the share of domestic assets in their portfolio, they invest in both deposits and bank bonds. On the other hand, an increase in the time deposits of the mutual funds increases bond market spreads, since mutual funds invest mostly in domestic assets and shift investments from bonds to deposits and vice versa.

Table 1: *Bond Market Spread*	**Baseline**
Intercept	-0.73
	(0.55)
Fundamental factos	
Return on assets	-0.34**
	(0.15)
Net interest margin	0.1***
	(0.02)
Efficiency ratio	0.034***
	(0.01)
Slope of the yield curve (between one and four years)	-0.34***
	(0.04)
Domestic liquidity factors	
Time deposits of pension funds (change in stock)	-0.13***
	(0.05)
Time deposits of mutual funds (change in stock)	0.15***
	(0.04)
Global risk spillover	
VIX	0.71***
	(0.2)
CDS of European banks	0.07*
	(0.04)
R^2 - adj.	0.81

Note: Standard errors have been adjusted for autocorrelation and heteroscedasticity; Nobs = 1254.
Stars denote significance level as follows: *** 1 percent , ** 5, and * 10.

B. The Interbank Market

The interbank market spread contains both domestic and external risk premia. As shown in Table 2, the interbank market spread has been driven by domestic liquidity and credit risk factors as well as global spillovers. These factors explain 70 percent of the variation in the spread.

Among domestic factors are local liquidity shocks, policy measures, and counterparty risk. Activities of institutional investors, such as shifts in time deposits of pension and mutual funds, affect banks' liquidity. As follows from the results in Table 2, a reduction of intitutional time deposits reduces liquidity and increases the interbank spread. The changes in the central bank's short-term instrument could also reflect liqudity pressures, as a result, the changes in the stock correlates negatively with the spread. This seems to be intiutive as during deteriorating liquidity conditions, banks return the short-term instrument back to the

centrak bank for cash. In addition, the interbank spread is influenced by the central bank's extended liquidity operations in periods of liquidity squeeze. According to the estimates, the enhanced liquidity facility by the central bank, from November 2008 till mid-2010, led to a reduction of the interbank market spread by about 24 basis points. The counterparty risk, which is represented by banks' bond credit spread, is also a significant factor of the interbank market spread. A percentage point increase in the banks' bond credit spread leads to about 50 basis points increase in the interbank market spread.

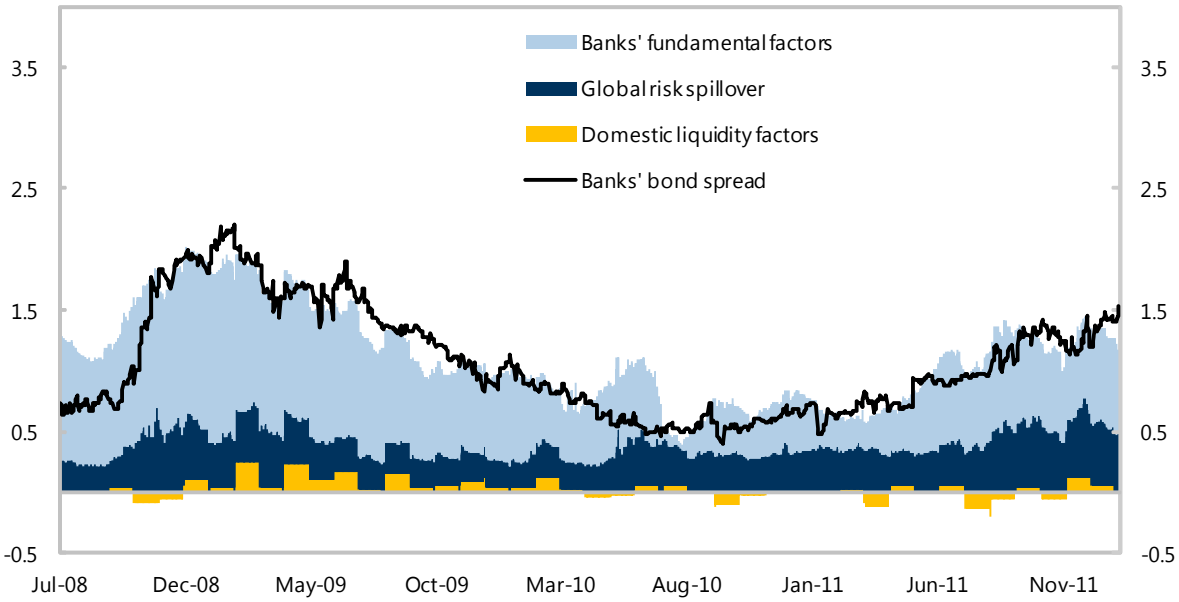
Spillovers from financial tensions abroad also affect risk premia in the interbank market. The interbank spread has been affected by changes in global risk factors (see Figure 2). In particular, a percentage increase in the interbank market spread in the U.S. or in the CDS of European banks triggers about 30 basis points rise in Chile's interbank market spread. Pressures in the U.S. interbank market drove the Chile's interbank market spread until early-2009. In the reminder of 2009 and until mid-2010, the spread fell as external pressures dissipated and domestic credit risk premium declined. Since mid-2010, however, spillovres from hightenned financial tensions in Europe have played a prominent role.

Table 2: ***Interbank Market Spread***	**Baseline**
Intercept	-0.22
	(0.15)
Domestic liquidity factors	
Central bank's short-term instrument (change in stock)	-0.14*
	(0.07)
Time deposits of pension funds (change in stock)	-0.12**
	(0.06)
Time deposits of mutual funds (change in stock)	-0.13***
	(0.04)
Central bank's crisis liquidity facility	-0.24***
	(0.07)
Domestic credit risk	
Banks' bond credit spread	0.51***
	(0.09)
Interbank risk spillover	
Euro interbank 3M spread	0.07
	(0.18)
US interbank 3M spread	0.35***
	(0.12)
Global risk spillover	
CDS of European banks	0.25***
	(0.06)
R^2 - adj.	0.7

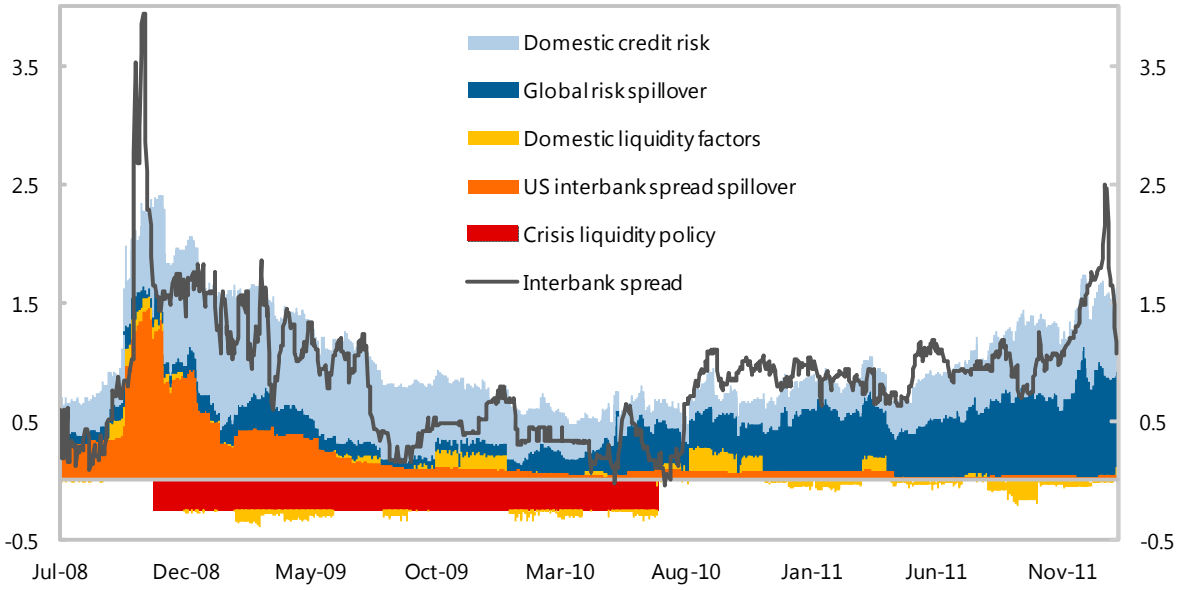
Note: Standard errors have been adjusted for autocorrelation and heteroscedasticity; Nobs = 1255. Stars denote significance level as follows: *** 1 percent , ** 5, and * 10.

Figure 2. Chile: Funding Markets, 2008-12

Banks' Bond Market
(In percent)



Interbank Market
(In percent)



Source: Banco Central de Chile, SBIF, Bloomberg, and own calculations.

IV. ROBUSTNESS ANALYSIS

The robustness analysis tests the sensitivity of the baseline formulation to additional variables or partial regressions. The robustness of the explanatory variables in the bond market is shown by a set of partial regressions, namely for the structural model, the global risk variables, and also including VSTOXX. For the interbank market, the following variables were tested: CDS of Citibank U.S., the VIX, the VSTOXX, and the stock of the short-term central bank's instrument.

A. The Bond Market

Global risk seems to be well represented by either the VIX or VSTOXX. In the baseline specification, the VIX represents the global risk aversion. However, the VIX is derived from the US stock market index only. Therefore, the regressions R1 and 2 consider also the European counterpart to the VIX – the VSTOXX. The results of R1 suggest that the VSTOXX and VIX are well correlated and including both in the regression (as in R1) results in insignificance of both. However, regressions with either the VIX (as in the baseline) or the VSTOXX (as in R2) results correctly signed and statistically significant.

Table 3: ***Bond Market Spread - Robustness***	**R1**	**R2**	**R3**	**R4**
Intercept	-0.78	-0.9*		
	(0.57)	(0.52)		
Fundamental factos				
Return on assets	-0.33**	-0.32**	-0.51***	
	(0.15)	(0.15)	(0.05)	
Net interest margin	0.1***	0.1***	0.16***	
	(0.02)	(0.02)	(0.03)	
Efficiency ratio	0.034***	0.037***	0.026***	
	(0.01)	(0.01)	(0.003)	
Slope of the yield curve (between one and four years)	-0.34***	-0.34***	-0.46**	
	(0.04)	(0.04)	(0.04)	
Domestic liquidity factors				
Time deposits of pension funds (change in stock)	-0.14***	-0.14***		
	(0.05)	(0.05)		
Time deposits of mutual funds (change in stock)	0.15***	0.15***		
	(0.04)	(0.04)		
Global risk spillover				
VIX	0.49			3.36***
	(0.5)			(0.19)
CDS of European banks	0.06*	0.06*		0.05**
	(0.04)	(0.04)		(0.02)
VSTOXX	0.23	0.72***		
	(0.52)	(0.2)		
R^2 - adj.	0.81	0.81	0.7	0.41

Note: Standard errors have been adjusted for autocorrelation and heteroscedasticity; Nobs = 1254. Stars denote significance level as follows: *** 1 percent , ** 5, and * 10.

The evidence from partial regressions confirms robustness of the regressors. Isolating the effects of the banks' fundamental factors and global risk factors in the regressions R3 and 4 (Table 3) shows whether these two blocks of variables are mutually independent explanatory variables for the bond market spread. This is indeed confirmed as these variables preserve correct signs and statistical significance.

B. The Interbank Market

The resutls in the baseline regression do not change when adding other control variables. The results in Table 4 show that adding the CDS of Citibank (a proxy for CDS of credit risk in the U.S. banks), VIX, and VSTOXX to the baseline specification, does not change baseline regression results and these added variables turn out to be statistically insignificant (see Table 2, R1, 2, and 3).

Controling for the the stock of the short-term central bank instrument does not affect the baseline results either. The change in the stock of central bank's short-term instrument preserves the sign and significance even when controlled for the actual stock of the short-term instrument, see Table 4, R4. It suggests that changes in the holdings of the instrument are more relevant for liquidity distress than the actual outstanding amount.

Table 4: ***Interbank Market Spread - Robustness***	**R1**	**R2**	**R3**	**R4**
Intercept	-0.22	-0.27	-0.16	-0.26
	(0.15)	(0.16)	(0.15)	(0.18)
Domestic liquidity factors				
Central bank's short-term instrument (change in stock)	-0.14*	-0.13*	-0.13*	-0.15*
	(0.08)	(0.07)	(0.07)	(0.08)
Central bank's short-term instrument (stock)				0.012
				(0.03)
Time deposits of pension funds (change in stock)	-0.11	-0.12*	-0.11*	-0.12**
	(0.07)	(0.06)	(0.06)	(0.06)
Time deposits of mutual funds (change in stock)	-0.15***	-0.14***	-0.14***	-0.13***
	(0.05)	(0.05)	(0.05)	(0.04)
Central bank's crisis liquidity facility	-0.25***	-0.18**	-0.18**	-0.25***
	(0.07)	(0.08)	(0.09)	(0.08)
Domestic credit risk				
Banks' bond credit spread	0.48***	0.52***	0.52***	0.53***
	(0.1)	(0.09)	(0.09)	(0.09)
Interbank risk spillover				
Euro interbank 3M spread	0.09	0.19	0.19	0.07
	(0.18)	(0.19)	(0.19)	(0.19)
US interbank 3M spread	0.34***	0.39***	0.37***	0.36***
	(0.12)	(0.13)	(0.12)	(0.13)
Global risk spillover				
CDS of European banks	0.24***	0.27***	0.28***	0.25***
	(0.06)	(0.06)	(0.07)	(0.06)
CDS of Citibank U.S.	0.03			
	(0.03)			
VIX		-0.7		
		(0.43)		
VSTOXX			-0.66	
			(0.49)	
R^2 - adj.	0.7	0.7	0.7	0.7

Note: Standard errors have been adjusted for autocorrelation and heteroscedasticity; Nobs = 1255. Stars denote significance level as follows: *** 1 percent , ** 5, and * 10.

V. CONCLUDING REMARKS

This paper analyzed pressures in the bank funding markets in Chile from mid-2008 to early 2012 with particular focus on spillovers from global risk factors. The funding markets are represented by the interbank and bank bond markets and thus show pressures in the short- and long-term funding costs. Spreads on these markets are analyzed using least squares with standard errors adjusted for heteroscedasticity and autocorrelation.

The main findings are the following:

- The interbank market in Chile had been mostly affected by tensions in the U.S. interbank market after the Lehman crisis. Pressures have dissipated by mid-2009 as a result of policy responses in Chile and abroad.

- Since mid-2010, funding market spreads have been driven mainly by European risk spillovers. However, spillovers have been so far moderate and have not had a significant impact on credit intermediation.

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