Internet Appendix to
"The International Transmission of Bank Liquidity Shocks: Evidence from an Emerging Market"[1]

This online appendix serves as a companion to the paper "The International Transmission of Bank Liquidity Shocks: Evidence from an Emerging Market." It reports results not reported in the main text due to space constraints. I present results in the order they appear in the main text.

A. Model of International Lender's Response To Liquidity Shocks

The objective of my model is to formalize the idea that bank ownership affects the provision of financing after a liquidity shock. The key assumption in the model is that owners can control the investment decisions of banks in which they have equity holdings, but arm's-length lenders cannot. This assumption is motivated by the difficulty to verify or monitor bank investment decisions at arm's length. The intuition of the model is that the control of bank investment decisions becomes more important as the cost of financing increases, leading to different responses by owners and arm's-length lenders after a liquidity shock.

More formally, I assume that the only business activity of banks is to finance investment projects. All investment projects are of the same size and are normalized to one. There are two types of projects, safe and risky. If a bank invests in a safe project, the project yields $S > 1$. If the bank invests in a risky project, the project yields $R > S$ with probability p, and zero with probability $(1 - p)$. Risky projects have a lower expected value than safe projects, such that $pR < S$. I make this assumption to allow for risk shifting by banks.

Banks refinance investment projects by borrowing from international lenders. There are two types of international lenders, arm's-length lenders and owners, and two types of banks, foreign- and domestically owned banks. Banks are operated by managers who maximize the value of bank equity.

Suppose a domestically owned bank (e.g., Banco Wiese) borrows one unit of capital from an arm's-length lender (e.g., UBS) and promises to repay D. If the manager invests in safe projects, then the payoff is $(S - D)$. If the manager invests in risky projects, then the expected payoff is $p(R - D)$. The manager maximizes the bank equity value and therefore invests in safe projects if and only if $D \leq \frac{S-pR}{(1-p)}$. I summarize this result as the first Proposition IA.1, where $D = (1 + r)$ such that r denotes the interest rate on arm's-length lending.

PROPOSITION IA.1 Banks financed by arm's-length debt can sustain safe projects if and only if

$$(1 + r) \leq \frac{S - pR}{(1 - p)}. \tag{IA.1}$$

[1] Citation format: Schnabl, Philipp, 2011, Internet Appendix to "The International Transmission of Bank Liquidity Shocks: Evidence from an Emerging Market"," Journal of Finance [vol #], [pages], http://www.afajof.org/supplements.asp. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the authors of the article.

In other words, arm's-length lenders lend if and only if interest rates are sufficiently low such that bank managers choose safe projects.

For comparison, suppose a foreign-owned bank (e.g., Citi-Peru) borrows one unit of capital from its owner (e.g., Citibank-US). If the manager invests in safe projects, then the payoff is $(S - D)$. If the manager invests in risky projects, then the expected payoff is $(pR - D)$. Since $pR < S$, the manager never invests in risky projects. This result yields Proposition IA.2.

PROPOSITION IA.2.**Banks financed by owners can sustain safe projects if and only if**

$$(1 + r) \leq S. \tag{IA.2}$$

The main difference between owners and arm's-length lenders is that the bank manager of an owner internalizes the cost of default $(1 - p)D$ but the bank manager of an arm's-length lender does not. Therefore, owners continue financing safe projects at high interest rates, whereas arm's-length lenders do not.

A simple example illustrates the model. Assume that the gross safe return $S = 120\%$, the gross risky return $R = 130\%$, and the probability of default is $p = (1/2)$. If $r = 8\%$, then $(S - D) = 12\%$ and $p(R - D) = 11\%$, such that safe projects can be financed both by arm's-length lenders and owners. If $r = 12\%$, then $(S - D) = 8\%$ and $p(R - D) = 9\%$, such that arm's-length lending breaks down because managers choose risky projects. However, owners still finance investment projects because safe projects yield a positive net present value. In fact, safe projects are financed by owners if and only if $r \leq 20\%$.

The example makes clear that there are three regions of interest for interest rate r. I summarize this result as Proposition IA.3.

PROPOSITION IA.3 If $(1+r) \leq \frac{S-pR}{(1-p)}$ (low region), safe projects can be financed by both arm's-length lenders and owners. If $\frac{S-pR}{(1-p)} < (1 + r) \leq S$ (middle region), safe projects can be financed only by owners. If $S < (1 + r)$ (high region), no safe projects can be financed.

This proposition shows that there exists a set of parameter values for interest rate r (middle region), such that arm's-length lenders forgo profitable investment opportunities in order to avoid risky projects. Hence, if a credit supply shock pushes the lender's cost of capital r from the low region to the middle region, owners continue to provide financing, whereas arm's-length lenders do not. This differential response explains why owners mitigate the transmission of credit supply shocks relative to arm's-length lenders.

One way to interpret this model is to think of it as an application of the asset substitution problem (Jensen and Meckling (1976)) to interbank lending: if interest rates rise, banks have a larger incentive to take on risky projects. If lenders can prevent banks from investing in risky projects, then they continue to lend. If lenders cannot prevent banks from investing in risky projects, then they stop lending.

The key assumption of the model is that arm's-length lenders cannot verify bank investment decisions. I interpret the nonverifiability of investment decisions as the difficulty in monitoring bank investment decision at arm's-length. It is important to note that there is a more general class of models in which arm's-length lenders cannot verify investment decisions and that generate similar predictions with respect to bank lending.

B. Estimating Credit Supply Versus Credit Demand

This section derives the estimating equation used in the main text. I extend the theoretical model to incorporate credit demand shocks. The purpose of the model is to highlight the identification problem and develop an estimator to control for changes in credit demand. The model is similar to the model in Khwaja and Mian (2008).

Assume the model lasts for two periods. For simplicity, assume that banks only finance a single firm but firms can lend from several banks. Bank b provides a loan of size L_{bj}^t to firm j, where superscript t denotes the time. On the credit supply side, assume banks are financed with debt from international lenders F_b^t and other forms of financing K_b^t (e.g., equity, deposits, bonds). Total bank assets L_b^t are equal to total bank liabilities $K_b^t + F_b^t$. I assume international investors provide funding at a constant rate and other forms of financing have a convex cost function $\gamma\frac{(K_b^t)^2}{2}$. The marginal cost of bank financing is therefore γK_b^t. The cost parameter γ denotes the slope of the marginal cost curve.

On the credit demand side, I assume firm j earns return $\theta_j L_{bi}^t - \beta\frac{(L_{bj}^t)^2}{2}$ on each loan.[2] The firm quality parameter θ_j allows for variation in loan returns across firms. The marginal loan return is given by $\theta_j - \beta L_{jb}^t$.

I solve for the first-period equilibrium by setting the marginal cost of financing γK_b^1 equal to marginal loan return $\theta_j - \beta L_{jb}^1$. This yields the equilibrium loan amount $L_{jb}^1 = \frac{\theta_j + \gamma F_b^1}{(\beta+\gamma)}$. The equilibrium loan amount is increasing in firm quality θ_j and decreasing in the financing cost parameter γ.

At the end of the first period, the economy experiences two shocks. First, there are bank-specific credit supply shocks S_b to financing by international lenders such that $F_b^2 = F_b^1 + S_b$. Second, there are firm-specific credit demand shocks D_j to marginal loan returns such that marginal loan returns in the second period are $\theta_j - \beta L_{jb}^2 + D_j$.

Solving for the second-period equilibrium, the equilibrium loan amount is $L_{jb}^2 = \frac{\theta_j + \gamma(F_b^1 + S_b) + D_j}{(\beta+\gamma)}$. The change in loan amount from first to second period $\Delta L_{jb} = L_{jb}^2 - L_{jb}^1$ is given by

$$\Delta L_{jb} = \frac{1}{(\beta+\gamma)} D_j + \frac{\gamma}{(\beta+\gamma)} S_b. \tag{IA.3}$$

The change in loan amount ΔL_{jb} consists of two terms. The first term on the right-hand side $\frac{1}{(\beta+\gamma)} D_j$ denotes the impact of the firm-specific credit demand shocks on loan amount L_{jb}. The second term on the right-hand side $\frac{\gamma}{(\beta+\gamma)} S_b$ denotes the impact of the bank-specific credit supply shock on

[2] A more general model would endogenize the allocation of loans across banks. This simplified formulation takes the allocation of loans across banks as exogenous and assumes decreasing marginal returns for each loan. This formulation can be justified by assuming that aggregate loan demand of firm j has decreasing marginal returns and firm j splits loan demand in fixed proportions across banks.

loan amount L_{jb}. Now suppose we use foreign bank ownership F_b as a proxy for credit supply shocks S_b and run the OLS regression

$$\Delta L_{jb} = \beta_0 + \beta_1 F_b + \varepsilon_{ib}, \tag{IA.4}$$

where $\varepsilon_{ib} = \eta_j + \epsilon_{jb}$. The error term ε_{jb} in the OLS regression consists of a firm-specific component η_j and a firm-bank specific component ϵ_{jb}. The model suggests that $Cov(\eta_j, F_b) \neq 0$ if the credit demand shocks D_j are correlated with foreign bank ownership. In this case, the foreign ownership coefficient F_b is biased.

It is difficult to sign this bias because the sign depends on the distribution of credit demand shocks D_j across foreign- and domestically owned banks. Consider the example in which all exporters borrow from foreign-owned banks and all non-exporters borrow from domestically owned banks. If the credit supply shock improves export opportunities (e.g., via a reduction in the exchange rate), then $Cov(\eta_j, F_b) > 0$ and the estimated coefficient β_1 is biased upwards. If the credit supply shock weakens export opportunities (e.g., because other countries devalue and export more), then $Cov(\eta_j, F_b) < 0$ and the estimated coefficient is biased downwards. More generally, variation in borrower composition across foreign- and domestically owned banks that directly affects credit demand after the shock biases the foreign ownership coefficient β_1. This problem is the standard identification problem of separating out credit supply and credit demand.

To address the identification problem, I propose a simple estimator. I exploit the fact that many firms borrow from both foreign- and domestically owned banks. Denote a foreign-owned bank with subscript F and domestically owned bank with subscript D. Consider a firm j that has one loan with each type of bank and compute the difference in changes in loan amounts:

$$\Delta L_{jF} - \Delta L_{jD} = \frac{\gamma}{(\beta + \gamma)}(S_F - S_D). \tag{IA.5}$$

Note that the firm-specific credit demand shock cancels out and the difference between foreign- and domestically owned banks captures the impact of bank-specific credit supply shocks. Using variation *within* firms across loan relationships allows me to control for firm-specific credit demand shocks and I can therefore identify the impact of the credit supply shock.

Now consider running an OLS regression that includes firm fixed effects β_j such that

$$\Delta L_{jb} = \beta_0 + \beta_j + \beta_1 F_b + \varepsilon_{ib}. \tag{IA.6}$$

The firm fixed effects β_j absorb the firm-specific credit demand shocks and the foreign ownership coefficient β_1 identifies the impact of the credit supply shock across foreign- and domestically owned banks. The identifying assumption is that $Cov(F_b, \varepsilon_{ib}) = 0$. This assumption holds if the firm-loan-specific shocks ε_{ib} are uncorrelated with foreign bank ownership F_b.

C. Additional Results

1. Table IA.I provides information on international onwers of Peruvian banks.

2. Table IA.II provides a robustness test for Table X. Table X is restricted to firms with two or more loan relationships. Table IA.II replicates the analysis in Table X for the sample of all firms.

Table IA.I
Foreign Bank Ownership

Bank	Country	Ownership	Source
Banco Credito	Peru	Grupo Romero	Bank Regulator
Banco del Pais	Chile	Empresa Econosur	Business News, Sep 2000
Banco Latino	Peru	Grupo Picasso	Financial Times, December 1998
Banco Wiese	Peru	Grupo Wiese	Financial Times, June 1999
Bancosur	Chile/Spain	Grupo Luksic/BCH	Latin Finance, June 1997
Banex	Peru	Grupo Nicolini, Tizon, Marsano	Business News Amercias, Nov 1999
Bank of Boston	United States	Bank Boston	Bank Regulator
BIF	Spain	Grupo Fierro	IFC Lending Document, 2006
Citibank	United States	Citibank United States	Bank Regulator
Comercio	Peru	Caja de Pensiones Militar Policial	Comercio, Website, October 2006
Banco Continental	Peru	BBVA/Grupo Brescia	Bank Regulator
Extebandes	Peru/Venzuela	Regional Central Banks	Financial Times, November 1995
Financiero	Ecuador	Banco Pichincha	Financial Times, January 1995
Interbank	Peru	Grupo Rodriguez-Pastor	Financial Times, 1994
Nuevo Mundo	Peru	Grupo Levy	Business News, Dec 2000
NBK	Peru	Grupo Levy	Financial Times, December 2000
Orion	Peru	Grupo Carsa	Business News America, September 2000
Progreso	Peru	Grupo Galsky	Business News America, June 1999
Republica	Chile	Grupo Errazuriz	Financial Times, November 1998
Santander	Spain	Banco Santander	Financial Times, October 1995
Serbanco	Chile	Grupo Cruz Blanca	Latin Finance, Oct 2000
Solventa	Chile	Grupo Yaconi Santa Cruz	Business News, July 1999
Sudamericano	Canada	Scotiabank/Grupo Calda	Financial Times, October 1999
Trajabo	Chile	Grupo Cummins	Bank Regulator

All municipal banks are owned by domestic residents.

Table IA.II
Transmission of Liquidity Shock to Peruvian Firms (All Firms)

The regressions in this table examine the impact of exposure to the liquidity shock on Peruvian firms. All regressions are at the firm level. I include all firms. The dependent variable in Columns (1) and (2) is the change in the natural logarithm of total borrowing. The dependent variable in Columns (3) and (4) is the change in the share of borrowing in default. The dependent variable in Columns (5) and (6) is an indicator variable for whether a firm is operating in 2005. The data are collapsed and time-averaged one year before and one year after the Russian default. I compute the 'Intermediate expousre" and the "Low exposure" as the share of firm borrowing from intermediate and low exposure banks before the liquidity shock, respectively. Columns (2), (4), and (6) control for firm characteristics. The firm control variables are the same as in Table V. All variables are defined in the Appendix. Standard errors in brackets are clustered at the firm level. *** Significant at 1%; ** significant at 5%; and * significant at 10%.

	Change in lending		Loan Default		Firm Survival	
	(1)	(2)	(3)	(4)	(5)	(6)
Intermediate exposure	0.069***	0.061***	-0.075***	-0.061***	0.018***	0.006
	(0.004)	(0.005)	(0.003)	(0.004)	(0.006)	(0.006)
Low exposure	0.063***	0.017	-0.064***	-0.040***	-0.088***	-0.084***
	(0.017)	(0.017)	(0.015)	(0.015)	(0.022)	(0.022)
Overdraft		0.076***		0.083***		-0.173***
		(0.012)		(0.008)		(0.013)
Factoring		-0.112***		0.014		-0.046***
		(0.009)		(0.015)		(0.008)
Leasing		0.077		-0.094**		0.056***
		(0.034)		(0.018)		(0.018)
Export loan		-0.125*		0.211***		0.196***
		(0.074)		(0.060)		(0.031)
Collateral		-0.011**		0.011***		0.007
		(0.005)		(0.004)		(0.006)
Firm controls	N	Y	N	Y	N	Y
Observations	69,661	69,661	69,661	69,661	26,627	26,627
R2	0.01	0.06	0.01	0.04	0.01	0.11

References

[1] Jensen, Michael, and William Meckling, 1976, Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure, *Journal of Financial Economics* 3, 305-360.

[2] Khwaja, Asim, and Atif Mian, 2008, Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market, *American Economic Review* 98, 1413-1442.