Risk Taking Channel from Monetary policy

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XXVI Meeting of the Central Bank Researchers Network.

Outline of the paper

Motivation:

- After GFC in 2009: Low MP interest rates & Financial firms at the center of transmission mechanism
- Relative to existing literature: we focus on how each bank can allocate loans differently across risky locations after a monetary policy (MP) shock.

Research Question:

- Does the heterogeneity of risk matter for credit allocation after a MP shock?
  - Need to understand the role of risk on credit allocation after MP shocks.

Methodology: We develop two approaches

1. Theory: A simple two periods model to discuss mechanisms: MP rates alters a bank's preference for issuing loans to high-risk or low-risk borrowers
2. Mainly Empirics: Both aggregate estimation and Cross-sectional estimations to have causal effects.
   - Peruvian data: Financial firm branch-level data & regional credit markets.

Results:

- Within-bank identification: Sensitivity of lending to MP changes is increasing in riskiness of borrowers, even within a financial firm.
- At higher levels of aggregation, our results hold. MP has sizable impact on the total lending.

Literature Review

- The "risk-taking channel" term was coined by Borio and Zhu (2012)
- The literature on risk-taking commonly suggests that a lower domestic interest rate increases bank risk-taking (see, e.g., Adrian and Song-Shin,2011, Jiménez et al., 2014, Chen et al., 2017).
- Agur and Demertzis, (2012), (2015); Dell'Ariccia et al., (2014), (2016): They mainly highlights two channels: the *profit* and the *leverage* channel.
  - Dell'Ariccia et al. (2014) conclude that when leverage is endogenous, low interest rates lead to higher bank risk-taking.
- Jiménez et al. (2014): a lower policy increases relaxes credit constraints, especially for those highly credit constrained banks, and hence pushes credits up.
  - In this paper, the positive general equilibrium effects of low policy rate on bank default probability drives bank incentives to take excessive risk.

Motivation

- Adrian and Song Shin (2010); Borio and Zhu (2012); Jiménez, Ongena, Peydró and Saurina (2014)

  Since the Great International Financial Crisis, two changes have emerged:

  1. Central banks have adopted more often expansionary monetary policy positions, setting rates at historically very low levels.
  2. The role of the financial system and the credit markets as mechanisms for the transmission and amplification of shocks has been a focus of greater importance among policy makers and the macro literature.

- Need to investigate more on the transmission mechanisms of monetary policy operating via changes on bank's decisions.

- This paper explore the role of risk on the transmission of MP shocks.

  Peru as a good setting:

  - credit-to-GDP ratio of around 40 percent: enough room to expand credit and risk-taking
  - Supply factors are more important to explain the effect of MP changes on credit markets.

Aggregate evidence: credit market adjustment after a MP shock (I)

How does the credit market adjust to a MP shock?

- First, go for a simple approach: specify a recursive VAR to study the dynamic relationship among monetary policy, economic activity and credit market variables.

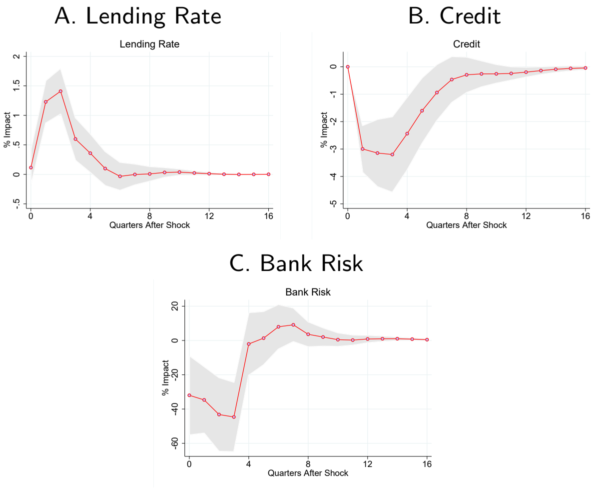
$$A_0 Y_t = a + \sum_{i=1}^{p} A_i Y_{t-i} + \epsilon_t$$

  - Foreing and domestic variables. $Y_t =$ log P_t^{comm}, log P^*, log Y^*, log Y, log P,log $Cred$, i^{MP}, log M1, $i^{lending}$, bank-risk, log FX.
  - Identification of MP shock : A_0 ordering of variables as in Christiano, Eichenbaum and Evans (1999). With Foreing variables following an exogenous VAR.
  - VAR(1) + linear trend. Sample period 2011q4 - 2019q4.
  - Our measure of bank risk-taking = realized volatility of the bank stock prices index.

Aggregate evidence: credit market adjustment after a MP shock (II)

Supply side adjustment of a credit markets and consistent with fall in risk-taking mechanism.

Figure: VAR Results: Positive Monetary Policy Shock, Credit Market and risk-taking



Note: Impulse response functions to a 1 percent increment in the domestic MP policy rate.

Limits of aggregate evidence

- VAR evidence limits:
  - Specific mechanisms are hard to disentangle.
  - Identification issues: Omitted variables.
- In what follows, we explore cross-sectional data to obtain causal effects on credit supply side of mechanism of monetary policy shock.
- Banks can allocate loans differently across risky locations after a MP shock.
- **Risk-taking channel**: After an expansionary MP shock,
  - Banks can take advantage of the better outlook of the economy and lower funding costs.
  - Banks have more appetite for risk: allocate more loans to more risky markets.
- **Two assumptions** in this paper:
  1. Regional markets: Geographic proximity reduces costs of transmitting and processing information.
  2. Risk varies geographically: By inherent characteristics regions show heterogeneous and persistent riskiness.

A Simple Two-Period Model

- Economy of identical households and banks, and non-identical firms. All agents are risk-neutral.
- The economy is composed by two provinces, $\{h, l\}$.
- In province h there are high-risk firms and in province l there are low-risk firms.
- Banks give loans to firms, and use deposits and exogenous equity to fund their lending activities.
- Key features:
  - Banks face limited liability and deposits are insured by the government.
  - Each bank has one branch in each province.

Firms

- Production function of a firm i is,

$$y_i = z_i k_i^{\alpha},$$

where $i \in \{h, l\}$, h stands for high-risk firms and l for low-risk firms,

$$ln(z_i) \sim N(\mu_i, \sigma_i^2)$$

We assume $\mu_i = \sigma_i^2/2$ so that the unconditional mean of z_i is one.

- Firms do not hold equity, so all bank loans l_i are used to purchase capital k_i.
- We assume loan lending rate is state-contingent, so the demand curve of loans of i

$$(1-\delta) + \alpha z_i k_i^{\alpha} = r_i^l.$$

Banks

- Bank's balance sheet:
$$l_h + l_l = d + n.$$
n: exogenous equity; d: deposits.
- Bank's profits are:
$$\pi^b = max\{0, r_h^l l_h + r_l^l l_l - rd\}.$$
r: risk-free interest rate. HHs supply any level of deposit at r.
- Due to limited liability and deposit insurance, there are threshold levels z_i^*
$$\Omega_{z^*} = \{(z_h, z_l) | (z_h, z_l) < (z_h^*, z_l^*)\}$$
where z_h^*, z_l^* is such:
$$(1-\delta)l_h + (1-\delta)l_l + \alpha z_h^* l_h^\alpha + \alpha z_l^* l_l^\alpha = rd$$
- Bank defaults if $(z_h, z_l) \in \Omega_{z^*}$.
- In the model the measure of bank's risk appetite is in fact
$$p = prob(\Omega_{z^*}) = F(z_h^*, z_l^*)$$

Banks (II)

- In the general equilibrium,

$$r = (1+\delta) + \alpha\mathbb{E}\{z_h|(z_h^*, z_l^*)\} l_h^{\alpha-1}, \qquad r = (1+\delta) + \alpha\mathbb{E}\{z_l|(z_h^*, z_l^*)\} l_l^{\alpha-1},$$

  Compare this to the socially efficient allocation is (UL),

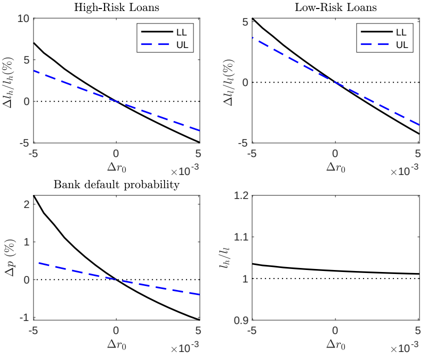
$$r = (1+\delta) + \alpha\mathbb{E}\{z_h\} l_h^{\alpha-1}, \qquad r = (1+\delta) + \alpha\mathbb{E}\{z_l\} l_l^{\alpha-1}.$$

1. Banks overestimate the return of their risky loans.
2. Banks obtain larger profits by taking more relative risk.

- This is because banks do not care on those states of nature when profits are negative (due to limited liability) and deposits rates do not capture the level of risk taken by banks (due to deposit insurance).

Monetary Policy Impact

- Main Result: A monetary policy ease produces a stronger increase on issuing high-risk loans.
  - Intuition: since banks have a higher default probability, they are relatively more interested on those loans that provide the higher return in good times. The default probability increases since the positive effects of higher total loans dominates the negative effects of a low r on p.



LL: Limited Liability, UL: Unlimited Liability. In the baseline calibration, we set $\rho = 0$, $\beta = 0.99$, $\delta = 0.20$, $\alpha = 0.33$. The other parameters n and σ_h and σ_l are set so that bank default probability and bank leverage $((l_h + l_l)/n)$ equate 3%, and 7.0, respectively, and $\sigma_l = 0.25\sigma_h$. It yields $n_0 = 0.59$, $\sigma_h = 1.48$ and $\sigma_l = 0.37$. high-risk loans are 4.3% inefficiently high and low-risk loans are 2.5% inefficiently high.

Empirical evidence with micro-data

- We turn to micro-data at Branch-level to find empirical evidence about the conclusions of our model.
- We consider credit markets at province level
  - Bank's branches serve several markets or provinces
  - Our measure of the riskiness of market is given by the Non-Performing Loan ratio (NPL)
- Our data:
  - Panel-data at province-time level on non-performing loans ratio.
  - Branch-level information on credits.

Data (I)

Input Sources:

1. Credit Registry Data (RCC):
    - SBS data on formal loan balances from a financial institution to a client: loan-level data Restricted information.
    - Quarterly frequency: 2003Q1-2010Q3 and Monthly frequency : 2010m10-2018m08.
    - Include information on loan balance, debt classification at client-level and loan-level.
    - Debtors identified by SBS code, tax ID(RUC) and National ID (DNI).
2. Tax ID - Location Data:
    - Tax administration (SUNAT) data on individual and firm Tax ID (RUC) and Location codes (UBIGEO).
3. Financial Regulator (SBS) data on direct credit at branch-level.
    - Sample : 2003m1-2017m12
4. Employment at province level: SUNAT-MTPE:
    - Sample : 2011m1-2018m12

Data (II)

Construction of indicators to measure risk-taking by bank-province :

1. Select only loans provided by banks to private non-financial firms: Bank Loans by RUC and Location (Region)
2. Construct aggregate indicators by bank-province

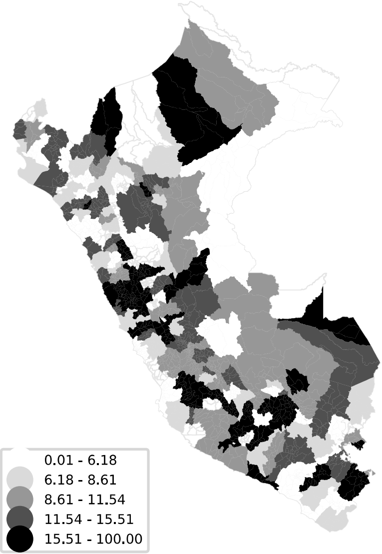
Measure of risk: non-performing loans ratio : Arrears/total credits:

$$\frac{\text{loan arrears (Big firms(15d), small firms(30d) mortgage(30d), personal(9d))}}{\text{Total credits}}$$

Our Cross-section data sample:

- We include al the Peruvian financial system: banks, CAMCs, CRACs, EDPYMES and empresas financieras.
- 3682 branches located in 189 provinces.

Data: Province risk heterogeneity - NPL_p



Note: Given data on non-performing loans ratio at a province p and month t, it shows for each province p a time average computed as $\frac{\sum_t NPL_{p,t}}{T}$, where T is the number periods in the sample. Sample: 2013m1-2017m12.

Data Statistics

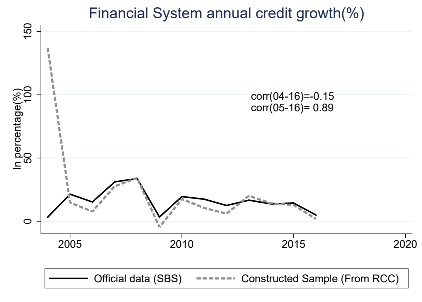
	All		Low NPL		High NPL	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Panel A. Province Characteristics						
Population (Thousand)	169.6	689.8	256.7	969.3	83.5	84.1
Area (sq. km.)	6,703.1	12,518	7,762	15,292	5,655.0	8,932.6
Formal Employment (share)	2.2	3.5	2.9	4.3	1.5	2.1
NPL-Branch (%)	15	18	6.1	3.1	24.7	21.0
Obs.(Provinces)	189		94		95	
Panel B. Branch Characteristics						
Loans (Thousand S/)	86.4	792.4	146.5	1,115.9	26.4	59.7
Loan growth (%)	3.0	11	3.1	11	3.0	10.0
Obs.(branch $\times$ month))	317,386		158,657		158,729	
Panel C. financial firms Characteristics						
Assets (Mill. S/)	4,321.6	14,111.5	7,721.9	19,189.9	926.6	2,713.2
Loans (Mill. S/)	2,789.7	8,961.6	4,957.7	12,201.3	625.2	1,593.9
NPL-Bank (%)	5.1	5.3	2.3	.68	7.8	6.5
Obs.(branch $\times$ Quarter))	2,490		1,245		1,245	

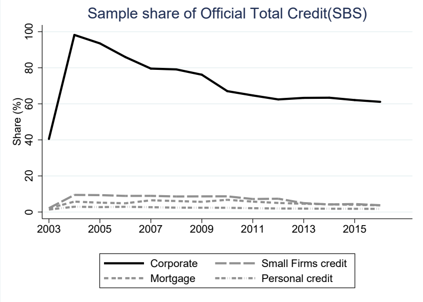
Note: This table provides summary statistics at the province, branch, bank level. All panels provide a breakdown by high and low non-performing loan (NPL), using below and above the median NPL for each respective sample. Panel A presents characteristics for all provinces with at least one financial firm branch. The underlying data are from the 2017 census. Data on employment comes from SUNAT. Panel B presents data on total credit and loan growth at the branch level. Panel C presents data about financial firms. Data from SBS. The underlying data are for NPL is based on RCC data, matched with locational data.

Matching Results: Representativeness of credit

Our sample vs official data

- In aggregate, at the financial system level, our sample mimics the dynamics of the total bank credit.
- In average, the sample represents around 48 percent of the total bank credit.



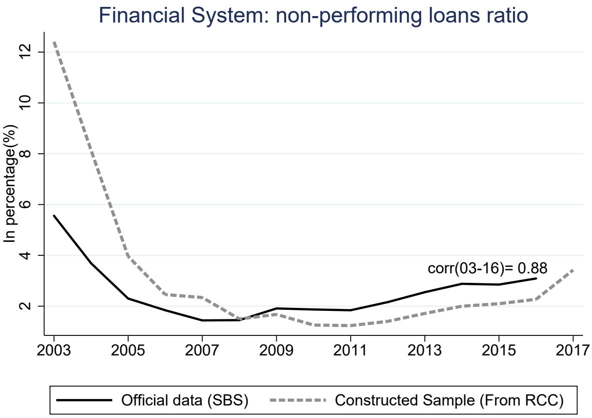


Note: Annual Sample 2004-2016. SBS Official Data from
`http://www.sbs.gob.pe/app/pp/seriesHistoricas2/Paso3_Mensual.aspx?cod=6&per=7&paso=2&secu=01`

Matching Results: Representativeness of Non-Performing loans(NPL) ratio

Our sample vs official data

- In aggregate, our sample follows similar dynamics of NPL ratio.



Note: Annual Sample 2004-2016. SBS Official Data from
`http://www.sbs.gob.pe/app/pp/seriesHistoricas2/Paso3_Mensual.aspx?cod=6&per=7&paso=2&secu=01`

Identification strategy

Under the risk-taking channel, lending supply should be more sensitive in riskier local lending markets.

- A MP shock introduces additional incentives for banks to pay cost for portfolio reallocation and take risk.
- NPL, capturing the risk taking channel mechanism, signals banks to diversify their lending portfolio to take advantage of profitable but risky local markets.
- **Key idea**: If a bank-branch faces a risky market but MP shock is expansive, the additional liquidy on excess of deposits is not costly but profitable.

Dealing with Omitted variables:

- **Problem**: Need to have variation in riskiness that is independent of bank's lending opportunities or demand factor influencing bank's decisions.
- **Solution**: we compare lending across branches of the same bank located in different provinces.

Within-Bank estimator

Our main **specification** for $\Delta y_{b(j)pt}$, is the growth rate of all loans granted by a branch j of a bank b in the province p at time t:

$$\Delta y_{b(j)pt} = \rho \Delta y_{b(j)pt-1} + \alpha_j + \alpha_{p(j)} + \alpha_{r(j)t} + \alpha_{bt} + \beta \, \text{NPL-Branch}_p \times \Delta i_t + \epsilon_{b(j)pt} \quad (1)$$

where NPL-Branch_p is our indicator of riskiness of the local credit market in province p. Δi_t is the change of the monetary policy rate, measured by changes in the interbank market.

- $\text{NPL-Branch}_p \times \Delta i_t$ captures the MP risk-taking channel.
- **Key set of controls**: α_{bt}, which absorbs all time differences across banks, to control for bank's lending opportunities. So, we compare across branches of same bank.
- Also: α_j , $\alpha_{p(j)}$, $\alpha_{r(j)t}$ are branch j, province and and region-time fixed effects.

Branch estimations results

- Results confirms the sensitivity of lending to MP rate changes, an it is increasing in the riskiness of the pool of borrowers, even within banks. ▸ Robustness
- Lending inflows into more risky regions relative to less risky regions

Table: Branch-level estimation: Results

	Dependent variable: Δy_{bdt}			
	(1)	(2)	(3)	(4)
NPL-Branch $\times$ Δi	-0.0276**	-0.0279**	-0.0174*	-0.0221**
	(0.0120)	(0.0113)	(0.0101)	(0.0101)
Δy_{t-1}		0.177***	0.180***	0.220***
		(0.00173)	(0.00172)	(0.00167)
Bank-Time FE	✓	✓	✓	
Region-Time FE	✓	✓		
Branch FE	✓	✓	✓	✓
province FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
R^2	0.278	0.291	0.274	0.155
Observations	315345	311445	311445	313237

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Aggregation: Within-province estimation

- Our previous results are at the branch level, which could not keep significant at more aggregate levels, since banks could allocate lending across branches.
- **Model prediction**: after a expansionary monetary policy banks increase lending in more risky markets (high NPL-Bank) relative to banks operating in less risky markets
- **Problem**: One needs to control for differences in lending opportunities and credit demand conditions.
- **Solution**:
  - Compare the lending of different banks in the same province , ensuring that they face similar local lending opportunities
  - compute a bank-level measure of borrower riskiness

$$\text{NPL-Bank}_{bt} = \sum_{p} \frac{Credit_{bpt}}{Credit_{bt}} \text{NPL-Branch}_{pt}$$

- Our **new specification** is:

$$\Delta y_{bpt} = \alpha_{bp} + \delta_{pt} + \gamma \, \text{NPL} - \text{Bank}_{bt-1} + \beta \Delta i_t \times \text{NPL} - \text{Bank}_{bt-1} + \varepsilon_{bpt} \qquad (2)$$

  - key set of controls: α_{bp}, to absorb changes in local lending opportunities.

Within-province results

- It shows that after an expansionary monetary policy banks that operate in more risky markets reduce lending by more relative to banks serving more risky markets

Table: Bank-Province estimation: Results

	Dependent variable: Δy_{bdt}		
	(1)	(2)	(3)
NPL-Bank $\times$ Δi	-0.122*	-0.117*	-0.134**
	(0.0662)	(0.0614)	(0.0620)
NPL-Branch $\times$ Δi		-0.0180	-0.0179
		(0.0134)	(0.0135)
NPL-Bank	0.101***	0.111***	0.0574*
	(0.0352)	(0.0310)	(0.0302)
Δy_{t-1}	0.150***	0.146***	0.214***
	(0.00448)	(0.00416)	(0.00401)
Province-Time FE	✓		
Bank FE	✓	✓	✓
Bank-Province FE	✓	✓	
Province FE	✓	✓	✓
Time FE	✓	✓	✓
R^2	0.276	0.171	0.121
Observations	51852	53531	53557

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Aggregation: Province-level estimation

- Look for effects of the risk taking channel on lending and employment at the province level.
- **Model prediction**: Provinces served by banks that lend in more risky markets after an expansionary monetary policy banks increase lending by more relative to banks operating in less risky markets.
- **Problem**: Need a measured of exposure to risky banks.
- **Solution**:
  - Compute a province-level risk-taking measure

$$\text{NPL-province}_{pt} = \sum_b \frac{Credit_{bpt}}{Credit_{pt}} \text{NPL-Bank}_{bt}$$

- Our **new specification** is:

$$\Delta y_{pt} = \rho \Delta y_{pt} + \alpha_p + \delta_t + \beta \text{ Province-NPL }_{p,t-1} + \gamma \Delta i_t \times \text{ Province-NPL }_{p,t-1} + \varepsilon_{pt} \quad (3)$$

Province-level results

- It shows that provinces whose banks lend in risky markets after an expansionary shock see a larger increases in lending.
- They also experience larger increments in employment, but it is not significant.

Table: Province-Level estimation: Results

	$\Delta Loans$		$\Delta Employment$	
	(1)	(2)	(3)	(4)
NPL-Province $\times$ Δi	-0.362**	-0.352**	-0.631	-0.572
	(0.163)	(0.163)	(0.523)	(0.524)
NPL-Branch $\times$ Δi		-0.0214		-0.0762**
		(0.0135)		(0.0381)
NPL	-0.0565	-0.0565	-0.358	-0.353
	(0.0556)	(0.0556)	(0.380)	(0.380)
$\Delta Loans_{t-1}$	0.146***	0.146***		
	(0.0111)	(0.0111)		
$\Delta Employment_{t-1}$			-0.133***	-0.134***
			(0.0153)	(0.0153)
Province FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
R^2	0.203	0.203	0.0556	0.0565
Observations	7626	7626	4388	4388

Aggregation: Bank-level estimation

- Look for effects of the risk taking channel on components of the banks balance sheet.
- **Model prediction**: Bank operating in more risky markets after an expansionary monetary policy banks increase lending by more and obtain more profits relative to banks operating in less risky markets.
- Our **specification** is:

$$\Delta y_{bt} = \rho \Delta y_{bt-1} + \alpha_b + \delta_t + \gamma \text{ NPL-bank }_{b,t-1} + \beta \Delta i_t \times \text{ NPL-bank }_{b,t-1} + \varepsilon_{bt} \quad (4)$$

where Δy_{bt} is change in

- Lending: Total, Domestic currency and foreign currency
- Financial margin (FM): financial income - financial expenses.

Bank-level results

- Banks that raise deposits in more risky markets expand more credit in particular, in foreign currency.
- risk-taking channel: banks operating in risky markets obtain higher financial margins.

Table: Bank-Level estimation: Results

	Total loans	Domestic currency loans	Foreign currency loans	Financial margin
NPL-Bank $\times \Delta i$	-0.1878**	-0.0861	-0.449**	-0.8645**
	(0.0951)	(0.1095)	(0.213)	(0.291)
Bank FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
R^2	0.296	0.317	0.246	0.99
Observations	2358	2344	2137	2,358

Note: This table show estimates of the effect of the risk-taking channel on bank-level lending and profits. The data are at the bank-quarter level and cover all financial firms from 2004Q1 to 2018Q12. We consider the change of log on total lending, log on domestic currency lending, log on foreign currency lending. Our profit variable is the financial margin to assets ratio. Fixed effects are denoted at the bottom. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Conclusions

- We have shown that the risk-taking channel is operative in Peru and it is heterogeneous across banks.
- Our aggregate evidence and theoretical model shows the relevance of supply frictions.
- Financial firms rebalance their lending portfolio across different local markets that varies in levels of riskiness.
- After an expansionary monetary policy shock, financial firms operating in more risky markets tend to expand lending by more relative to banks operating in less risky markets.
- The incentives to rebalance lending portfolio to more risky loans does not disappear at higher level of aggregation.

Appendix

Branch estimation Robustness: all banks

Table: Branch-level estimation: All banks sample

	Dependent variable: Δy_{bdt}			
	(1)	(2)	(3)	(4)
NPL-Branch $\times$ Δi	-0.0389***	-0.0319***	-0.0221*	-0.0249**
	(0.0150)	(0.0115)	(0.0114)	(0.0110)
Δy_{t-1}		0.218***	0.220***	0.282***
		(0.0140)	(0.0139)	(0.0140)
Region-Time FE	✓	✓		
Branch FE	✓	✓	✓	
Province FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
R^2	0.137	0.172	0.155	0.113
Observations	317158	313237	313237	313259

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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Branch estimation: Robustness

Table: Branch-level estimation:

	Dependent variable: Δy_{bdt}			
	(1) Banks	(2) Large Banks	(3) Non-Banks	(4) No Metropolitan Area
NPL-Branch $\times$ Δi	-0.0840***	-0.0281	-0.0154	-0.0193*
	(0.0304)	(0.0432)	(0.00955)	(0.0105)
Δy_{t-1}	0.00193	-0.108***	0.420***	0.259***
	(0.00277)	(0.00389)	(0.00203)	(0.00201)
Bank-Time FE	✓	✓	✓	✓
Region-Time FE	✓	✓	✓	✓
Branch FE	✓	✓	✓	✓
province FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
R^2	0.218	0.171	0.493	0.371
Observations	133366	69390	177710	218919

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

back

Within-province robustness

Table: Bank-Province estimation: Robustness

	Dependent variable: Δy_{bdt}			
	(1) Banks	(2) Large Banks	(3) Non-Banks	(4) No Metropolitan
NPL-Bank $\times$ Δi	0.366	-4.104	-0.255***	-0.130*
	(0.285)	(2.838)	(0.0870)	(0.0677)
NPL-Bank	-0.328*	-1.741*	-0.0207	0.0966***
	(0.181)	(0.913)	(0.0488)	(0.0359)
Δy_{t-1}	0.126***	-0.0759***	0.178***	0.148***
	(0.00807)	(0.0120)	(0.00576)	(0.00460)
Province-Time FE	✓	✓	✓	✓
Bank FE	✓	✓	✓	✓
Bank-Province FE	✓	✓	✓	✓
Province FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
R^2	0.309	0.449	0.363	0.276
Observations	18216	9408	32125	49591

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.