

International Spillovers and Local Credit Cycles¹

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¹This project does not represent official views of the CBRT.

International Transmission of Shocks

Extensive work on the Global Financial Cycle (Rey, 2013)

- Synchronized surges and retrenchments in gross capital flows, and booms and busts in risky asset prices and leverage
- Key driver is a common component (VIX) that is related to US monetary policy and changes in risk aversion and uncertainty

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Not much work on: How does the GFC impact domestic credit market conditions in emerging market economies?

- Is there a causal effect?
- What mechanisms are at work in the transmission of the GFC?
- What fraction of domestic credit growth in these economies can be explained by the GFC?

This Paper: What we do

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2. Quantify the **aggregate** impact of the GFC on domestic credit growth given the micro estimates
3. Exploit the micro-level **heterogeneity** of the data to support identification and to test for different mechanisms
 - Transmission via internationally connected domestic banks
 - Uncovered interest rate parity (UIP) violation: cyclical and heterogeneity
 - Firm-level financial constraints

This Paper: What we find

1. GFC-driven capital inflows have an important impact:

Elasticities w.r.t. changes in VIX:

- **Loan growth:** $-0.067 \Rightarrow$ can explain 43% of the observed average cyclical loan growth of the aggregate corporate sector

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- \Rightarrow (2)-(3) imply **change in risk premium** key for transmission

Literature

- **The GFC (VIX) and aggregate capital flows**
 - Forbes and Warnock (2012), Bruno and Shin (2015), Cerutti et al. (2015), Fratzscher et al. (2016), Miranda-Agrippino and Rey (2018)
- **Failure of UIP**
 - Empirics: Fama (1984), Chinn and Frankel (2002), Hassan (2013)
 - Theory: Engel (2016), Salomao and Varela (2016) [exogenous]; Gopinath and Stein (2017) [endogenous]
- **Heterogeneity, borrowing constraints, leverage, credit cycles**
 - Holmstrom and Tirole (1997), Fostel and Geanakoplos (2015), Guerrieri and Lorenzoni (2017), Gopinath, Kalemli-Ozcan, Karabarbounis, and Villegas-Sanchez (2017)
- **Collateral constraints and credit cycles**
 - Kiyotaki and Moore (1997), Bernanke, Gertler, and Gilchrist (1999), Calvo (1998), Caballero and Krishnamurthy (2001), Mendoza (2010), Aoki, Benigno, and Kiyotaki (2009), Brunnermeier and Sannikov (2015)

Outline

1. **Conceptual Framework**
2. Data
3. Identification
4. Benchmark Results
5. Aggregation
6. Channels
7. Conclusion and Policy Implications

Conceptual Framework

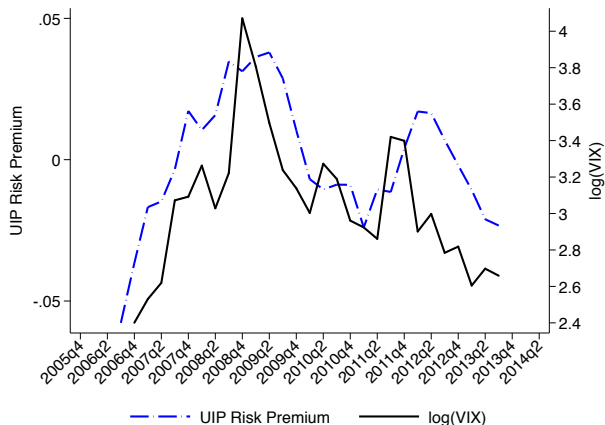
- UIP violation due to **country-level** time varying risk premium:

$$i_{c,t} = i_t^* + \mathbb{E}_t \Delta e_{t+1} + \gamma_{c,t}, \quad \text{where}$$
$$\gamma_{c,t} \equiv \omega \text{VIX}_t + \alpha_{c,t}$$

- **At firm-bank level:**

$$i_{f,b,t} = i_t + \epsilon_{f,t}$$
$$i_{f,b,t} = i_t^* + \mathbb{E}_t(\Delta e_{t+1}) + \omega \text{VIX}_t + \alpha_{c,t} + \epsilon_{f,t}$$

UIP Risk Premium and VIX



- $i_t - i_t^* = \alpha + \lambda_t + \beta \mathbb{E}_t \Delta e_{TL/USD,t+1} + \epsilon_t$
- i : Turkish interest rate calculated as the loan value weighted average of all Turkish lira loans outstanding in a given quarter
- i^* : US Fed Funds rate

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Transmission of the GFC

Identify the effect of GFC (VIX)-driven capital flows on firm-bank-loan level lending

Transmission of the GFC

Identify the effect of GFC (VIX)-driven capital flows on firm-bank-loan level lending

1. Instrument capital flows with VIX to observe the different effects of **endogenous** and **exogenous** capital flows on cost of borrowing
2. Identify from **within** variation by using **bank**×**firm** fixed effects
3. Condition on **macro** fundamentals/expectations/policy rate and **bank** variables
4. Identify from firms borrowing from multiple banks to control for **firm demand** for credit by using **firm**×**quarter** fixed effects

Transmission of the GFC

$$\log Y_{f,b,d,q} = \alpha_{f,b} + \lambda \text{Trend}_q + \beta \log \text{Capital inflows}_{q-1} + \delta \text{FX}_{f,b,d,q} \\ + \Theta_1 \mathbf{Bank}_{b,q-1} + \Theta_2 \mathbf{Macro}_{q-1} + \varepsilon_{f,b,d,q}$$

- Y: Loan or nominal interest rate at firm (f) \times bank (b) \times currency denomination (d) \times quarter (q) level
- Capital inflows: Turkish real inflows
 \Rightarrow Instrument with VIX
- FX: FX dummy (0 = TL, 1 = FX)
- **Bank**: log(Assets), capital ratio, liquidity ratio, noncore ratio, ROA
- **Macro controls**: GDP growth, inflation, exchange rate change, Turkish policy rate (or US Federal Fund rate and expected XR changes)

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OLS Results for Capital Inflows

	Panel A.		Panel B.	
	Nominal Interest Rate		Loan Volume	
	(1)	(2)	(3)	(4)
log(K Inflows)	-0.005 ^a (0.001)	-0.003 ^c (0.002)	0.040 ^a (0.006)	0.037 ^a (0.007)
FX	-0.070 ^a (0.003)	-0.066 ^a (0.003)	0.645 ^a (0.012)	0.638 ^a (0.013)
Observations	19,982,267	18,569,346	19,982,267	18,569,346
R-squared	0.791	0.810	0.850	0.855
Macro controls & trend	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes
Bank×firm F.E.	Yes	Yes	Yes	Yes

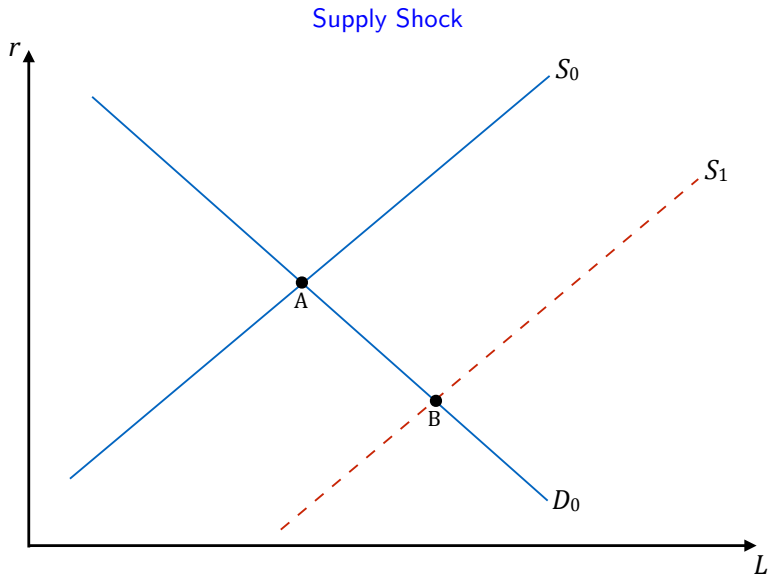
Notes: Regressions are all weighted-least square, where weights are equal to the loan share, and standard errors are double clustered at the firm and quarter levels. 'a' indicates significance at the 1% level, 'b' at the 5% level, and 'c' at the 10% level. **Columns (1) and (3) include domestic policy rate. Columns (2) and (4) include US Federal Fund rate and expected XR changes, where we lack data at beginning of sample.** **Macro controls:** GDP growth, inflation, changes in exchange rate

IV Results for Capital Inflows

<i>Second-stage of IV</i>				
	Panel A.		Panel B.	
	Nominal Interest Rate		Loan Volume	
	(1)	(2)	(3)	(4)
log(K Inflows)	-0.011 ^a (0.002)	-0.014 ^a (0.002)	0.039 ^b (0.017)	0.047 ^b (0.020)
FX	-0.070 ^a (0.003)	-0.066 ^a (0.003)	0.644 ^a (0.012)	0.638 ^a (0.013)
Observations	19,437,464	18,569,346	19,437,464	18,569,346
R-squared	0.793	0.812	0.850	0.855
Macro controls & trend	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes
Bank×firm F.E.	Yes	Yes	Yes	Yes

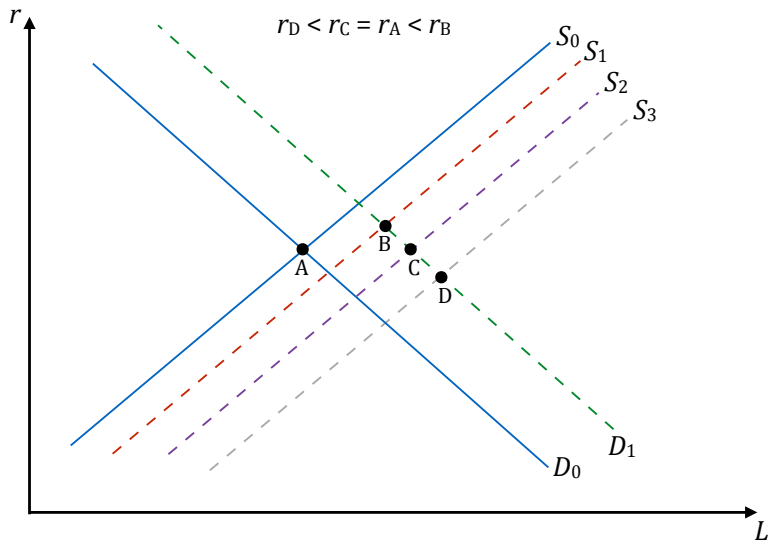
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IV-OLS Estimated Differential for Interest Rates



IV-OLS Estimated Differential for Interest Rates

Demand and Supply Shocks



$$r_D < r_C = r_A < r_B$$

$$0.011 = |\hat{\beta}_r^{IV}| > |\hat{\beta}_r^{OLS}| = 0.005$$

Elasticities from Reduced-form \Rightarrow Aggregation

	Panel A.		Panel B.	
	Nominal Interest Rate		Loan Volume	
	(1)	(2)	(3)	(4)
log(VIX)	0.019 ^a (0.003)	0.020 ^a (0.003)	-0.067 ^b (0.029)	-0.069 ^b (0.029)
FX	-0.070 ^a (0.003)	-0.066 ^a (0.003)	0.645 ^a (0.012)	0.638 ^a (0.013)
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Macro controls & trend	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes
Bank \times firm F.E.	Yes	Yes	Yes	Yes

- Column (1) $\hat{\beta} \Rightarrow$ 1 p.p. point fall in the borrowing costs
- Column (3) $\hat{\beta}$ and observed changes in VIX \Rightarrow can explain 43% of aggregate cyclical credit growth

► Robustness: VIX spike, foreign banks, maturity...

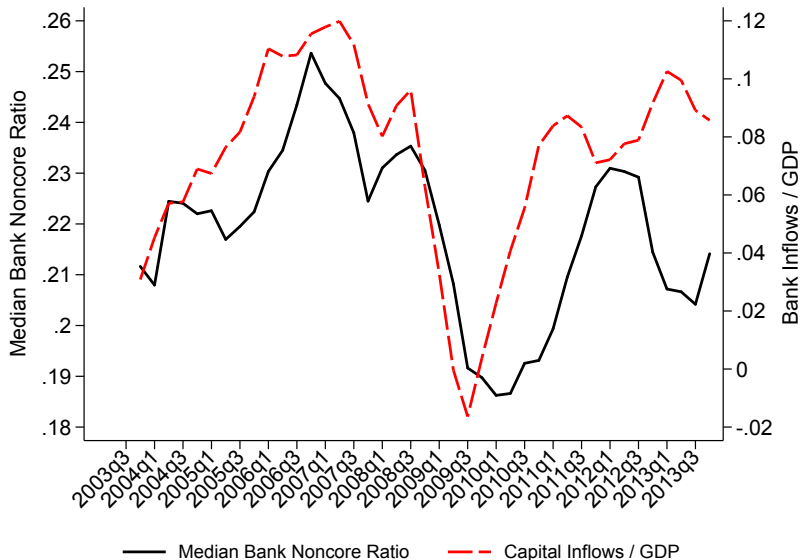
Transmission of the GFC

International Exposure of Domestic Banks

$$\log Y_{f,b,d,q} = \alpha_{f,b} + \alpha_{f,q} + \kappa(\text{NonCore}_b \times \log \text{VIX}_{q-1}) + \delta_2 \text{FX}_{f,b,d,q} + \vartheta_{f,b,d,q}$$

- NonCore: dummy based on bank's non-core (wholesale) liability ratio, which depends on access to international capital markets
- $\alpha_{f,q}$: firm \times quarter fixed effects, which controls for unobserved time-varying firm characteristics

Capital/Banking Flows and Non-Core Liabilities



Bank Heterogeneity and Transmission of the GFC

$$\log Y_{f,b,d,q} = \alpha_{f,q} + \kappa(\text{NonCore}_b \times \log \text{VIX}_{q-1}) + \delta_2 \text{FX}_{f,b,d,q} + \vartheta_{f,b,d,q}$$

	Panel A. Nominal Interest Rate		Panel B. Loan Volume	
	(1)	(2)	(3)	(4)
log(VIX)	0.015 ^a (0.003)		-0.051 ^c (0.028)	
NonCore×log(VIX)	0.015 ^a (0.004)	0.013 ^a (0.003)	-0.058 ^a (0.016)	-0.035 ^b (0.017)
Observations	19,982,267	9,280,825	19,982,267	9,280,825
R-squared	0.794	0.858	0.850	0.876
Macro controls & trend	Yes	No	Yes	No
Bank controls	Yes	No	Yes	No
Bank×firm F.E.	Yes	Yes	Yes	Yes
Firm×quarter F.E.	No	Yes	No	Yes

Notes: Regressions are all weighted-least square, where weights are equal to the loan share, and standard errors are double clustered at the firm and quarter levels. 'a' indicates significance at the 1% level, 'b' at the 5% level, and 'c' at the 10% level. **Columns (1) and (3)** include domestic policy rate and other **macro controls**: GDP growth, inflation, changes in exchange rate.

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Conclusion

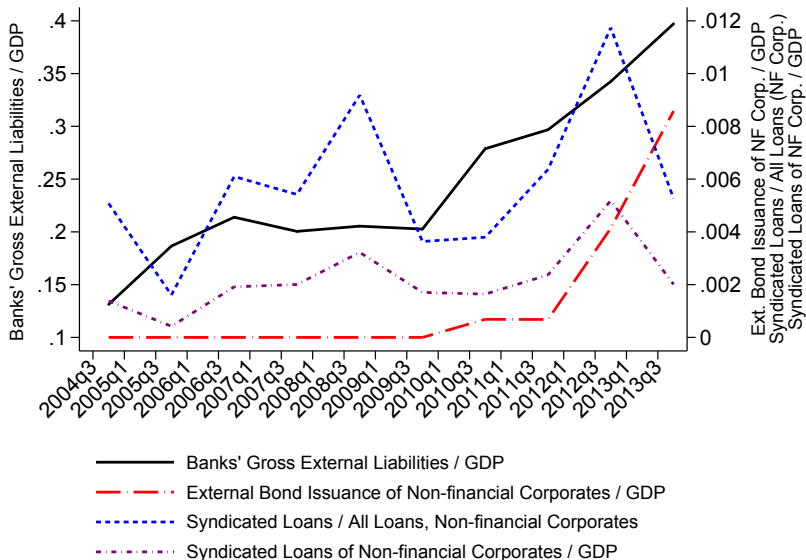
- Provide novel micro-level evidence on impact of the GFC-driven capital flows for domestic credit market conditions
- Key channel is fall in the risk-premium, which lowers borrowing costs for average firm regardless of collateral constraints
- The cyclical in the UIP risk premium implies that local currency borrowing also increases alongside with FX borrowing

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- Key channel is fall in the risk-premium, which lowers borrowing costs for average firm regardless of collateral constraints
- The cyclical in the UIP risk premium implies that local currency borrowing also increases alongside with FX borrowing
- **Implication for macropru policies and theoretical work:**
 - Limiting private agents' foreign currency borrowing during credit boom events/lean against appreciation may not be sufficient
 - Lower borrowing costs also fuel local currency borrowing if banks can fund themselves cheaply in international markets

Appendix Slides

External Finance in Turkey



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Data

1. **Credit register data** have information on **all** loans in economy to households and firms (monthly). [▶ Data details](#)

Focus on loans to corporate sector [▶ Comparison to whole economy](#)

- Bank, firm, currency, quarter level: 50+ million loans
- Loan value, interest rate, maturity, collateral, firm/loan-risk measures, ...
- Roughly 80% of observations in value are firms with loans from multiple banks (50% in number, 2.8 bank per firm)
- TL/FX approximately 50-50 split in value but majority is in TL (count)

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2. **Bank-level data** on all the balance sheet items and portfolio items for 45 banks
 - Banks capture 90 percent of corporate liabilities and 86 percent of country's financial assets

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 - Banks capture 90 percent of corporate liabilities and 86 percent of country's financial assets
 3. **Macro data** on capital flows, VIX, domestic and foreign variables

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Aggregate Impact: "Macro" Regression

$$\log Y_{f,b,d,q} = \tilde{\alpha}_{f,b} + \tilde{\lambda} \text{Trend}_q + \tilde{\beta} \log \text{VIX}_{q-1} + \xi_{f,b,d,q}$$
$$\Rightarrow \log(\widehat{\text{Loan}}_{f,b,d,q}) = \widehat{\beta} \log(\text{VIX}_{q-1})$$

Differentiate and multiply by $w_{f,b,d,q-1}$, such that $\sum w_{f,b,d,q-1} = 1$:

so,

$$w_{f,b,d,q-1} d \log(\widehat{\text{Loan}}_{f,b,d,q}) = w_{f,b,d,q-1} \widehat{\beta} d \log(\text{VIX}_{q-1})$$

$$w_{f,b,d,q-1} \left(\frac{\Delta \widehat{\text{Loan}}}{\widehat{\text{Loan}}} \right)_{f,b,d,q} = w_{f,b,d,q-1} \widehat{\beta} \left(\frac{\Delta \text{VIX}}{\text{VIX}} \right)_{q-1}$$

Summing above equation over $\{f, b, d\}$ in a given quarter q :

$$\left(\frac{\Delta \widehat{\text{Agg. Loan}}}{\widehat{\text{Agg. Loan}}} \right)_q = \widehat{\beta} \left(\frac{\Delta \text{VIX}}{\text{VIX}} \right)_{q-1}$$

$$\frac{\text{Avg} \left\{ \left(\frac{\Delta \widehat{\text{Agg. Loan}}}{\widehat{\text{Agg. Loan}}} \right)_q \right\}}{\text{Avg} \left\{ \left(\frac{\Delta \widehat{\text{Agg. Loan}}}{\widehat{\text{Agg. Loan}}} \right)_q \right\}} = 0.43$$

Aggregate Impact: “NonCore” Regression

$$\log Y_{f,b,d,q} = \alpha_{f,b} + \lambda \text{Trend}_q + \beta_1 \text{VIX}_{q-1} + \beta_2 (\text{Noncore}_b \times \log \text{VIX}_{q-1}) + \vartheta_{f,b,d,q}$$

$$w_{f,b,d,q-1} \left(\frac{\widehat{\Delta \text{Loan}}}{\text{Loan}} \right)_{f,b,d,q} = w_{f,b,d,q-1}^{\text{HNC}} (\hat{\beta}_1 + \hat{\beta}_2) \left(\frac{\Delta \text{VIX}}{\text{VIX}} \right)_{q-1} + w_{f,b,d,q-1}^{\text{LNC}} \hat{\beta}_1 \left(\frac{\Delta \text{VIX}}{\text{VIX}} \right)_{q-1}$$

Summing above equation over $\{f, b, d\}$ in a given quarter q :

$$\left(\frac{\widehat{\Delta \text{Agg. Loan}}}{\text{Agg. Loan}} \right)_q = \sum w_{q-1}^{\text{HNC}} (\hat{\beta}_1 + \hat{\beta}_2) \left(\frac{\Delta \text{VIX}}{\text{VIX}} \right)_{q-1} + \sum w_{q-1}^{\text{LNC}} \hat{\beta}_1 \left(\frac{\Delta \text{VIX}}{\text{VIX}} \right)_{q-1}$$

$$\frac{\text{Avg} \left\{ \sum w_{q-1}^{\text{HNC}} (\hat{\beta}_1 + \hat{\beta}_2) \left(\frac{\Delta \text{VIX}}{\text{VIX}} \right)_{q-1} \right\}}{\text{Avg} \left\{ \left(\frac{\widehat{\Delta \text{Agg. Loan}}}{\text{Agg. Loan}} \right)_q \right\}} = 0.95$$

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Channels: FX and Local Currency Loan Pricing

$$\log(1 + i_{f,b,d,q}) = \alpha_{f,b,q} + \rho(\text{FX}_{f,b,d,q} \times \log \text{VIX}_{q-1}) + \delta \text{FX}_{f,b,d,q} + u_{f,b,d,q}$$

	(1)	(2)	(3)	(4)
log(VIX)	0.020 ^a (0.003)			
FX	-0.070 ^a (0.003)	-0.070 ^a (0.003)	-0.070 ^a (0.003)	-0.070 ^a (0.003)
FX×log(VIX)	-0.013 ^a (0.004)	-0.013 ^b (0.006)	-0.012 ^b (0.006)	-0.012 ^c (0.007)
Observations	19,982,267	9,280,825	9,280,757	888,972
R-squared	0.793	0.858	0.884	0.731
Macro controls & trend	Yes	No	No	No
Bank controls	Yes	Yes	No	No
Bank×firm F.E.	Yes	Yes	Yes	No
Bank×quarter F.E.	No	No	Yes	No
Firm×quarter F.E.	No	Yes	Yes	No
Bank×Firm×quarter F.E.	No	No	No	Yes

Channels: Loan-Level Evidence of Financial Constraints

$$\log Y_{f,b,l,m} = \alpha_{f,b,m} + \beta_1 \text{Collateral}_{f,b,l,m} + \beta_2 (\text{Collateral}_{f,b,l,m} \times \log \text{VIX}_{m-1}) + \beta_3 \text{FX}_{f,b,l,m} + e_{f,b,l,m}$$

- $Y_{f,b,l,m}$: Loan or nominal interest rate at the firm (f) \times bank (b) \times loan (l) \times month (m) level for new loan issuances
- Collateral: collateral-loan-ratio at loan origination
 - \Rightarrow Measure of **financial constraint**
 - \Rightarrow Alternative to firm-level **net worth**: NOT ALLOW to control for firm-level demand and credit risk
- Control for firm-bank-month unobserved characteristics/
demand/supply
- Include fixed effects for loan characteristics (e.g., risk rating, sector)

Transmission of the GFC

Loan-Level Financial Constraints: Evidence from new loan issuances

	Panel A. Nominal Interest Rate			
	(1)	(2)	(3)	(4)
log(VIX)	0.032 ^a (0.004)			
Collateral/Loan	-0.002 ^b (0.001)	-0.002 ^a (0.001)	-0.004 ^a (0.001)	-0.004 ^a (0.001)
Collateral/Loan×log(VIX)	-0.004 ^a (0.001)	-0.003 ^a (0.001)	-0.0002 (0.001)	0.002 (0.002)
Observations	16,578,792	16,578,646	11,618,532	10,096,920
R-squared	0.620	0.696	0.841	0.859
Bank×firm F.E.	Yes	Yes	Yes	No
Bank×month F.E.	No	Yes	No	No
Firm×month F.E.	No	No	Yes	No
Bank×firm×month F.E.	No	No	No	Yes

Transmission of the GFC

Loan-Level Financial Constraints: Evidence from new loan issuances

	Panel B. Loan Volume			
	(1)	(2)	(3)	(4)
log(VIX)	-0.090 ^a (0.015)			
Collateral/Loan	0.105 ^a (0.005)	0.111 ^a (0.005)	0.089 ^a (0.010)	0.091 ^a (0.011)
Collateral/Loan×log(VIX)	0.017 ^c (0.010)	0.034 ^a (0.008)	0.025 ^c (0.013)	0.030 ^b (0.015)
Observations	16,578,792	16,578,646	11,618,532	10,096,920
R-squared	0.736	0.741	0.840	0.851
Bank×firm F.E.	Yes	Yes	Yes	No
Bank×month F.E.	No	Yes	No	No
Firm×month F.E.	No	No	Yes	No
Bank×firm×month F.E.	No	No	No	Yes

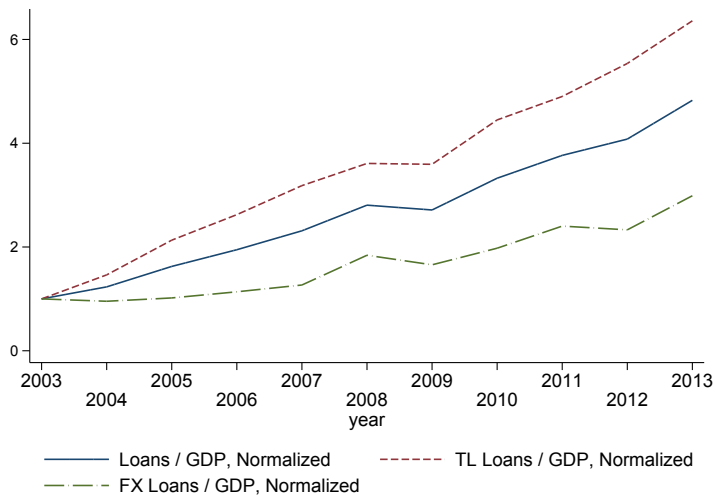
Implications of Loan-Level Regressions

- Collateral constraint exists on average, but
 - No variation over the GFC for interest rate regressions once controlling for firm-time variation with fixed effects
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 - No variation over the GFC for interest rate regressions once controlling for firm-time variation with fixed effects
 - Overall impact implied by estimated coefficients from loan regressions is very small relative to aggregate impact
- ⇒ “Hard” financial constraint as often modeled in literature do not play an important role on the supply side
- ⇒ Rather, fall in cost of borrowing for average firm is the key

FX and TL Loan Growth in Turkey



Data Details

1. Credit register data have information on all loans in economy to households and firms
 - Number of (cash) loans: 114 million
 - Number of loans to firms: 57 million
 - Share of firm loans: 87% in value
 - Number of bank-firm pairs: 3.3 million
2. We collapse credit register at firm-bank-quarter level going from 57 to 20.9 million observations (45 banks)
 - 50% represent firms borrowing from multiple banks
 - Multiple loans to a firm by a bank in a given quarter; do a weighted average
3. Average nominal rate (TL): 15%, average nominal rate (FX): 6%,
Average real rate (TL): 7%, average nominal rate (FX): -1%,
Average maturity (TL): 18m, average maturity (FX): 14m.

Loan Growth Comparison of Corporate Sector and the Whole Economy



Notes: Firm sample and whole credit registry loan growth.

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First-Stage Regression

<i>First-stage of IV</i>				
Dependent variable: log(K inflows)				
	(1)	(2)	(3)	(4)
log(VIX)	-1.667 ^a (0.427)	-1.354 ^a (0.450)	-1.667 ^a (0.427)	-1.354 ^a (0.450)
Observations	1,685	1,137	1,685	1,137
R-squared	0.562	0.557	0.562	0.557
Macro controls & trend	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes
F-stat	15.2	9.1	15.2	9.1

Notes: Regressions are run at the bank-quarter level, and standard errors are double clustered at the bank and quarter levels. 'a' indicates significance at the 1% level, 'b' at the 5% level, and 'c' at the 10% level. **Columns (1) and (3) include domestic policy rate. Columns (2) and (4) include US Federal Fund rate and expected XR changes, where we lack data at beginning of sample.**

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Reduced-form Results: Robustness

Nominal Interest Rate

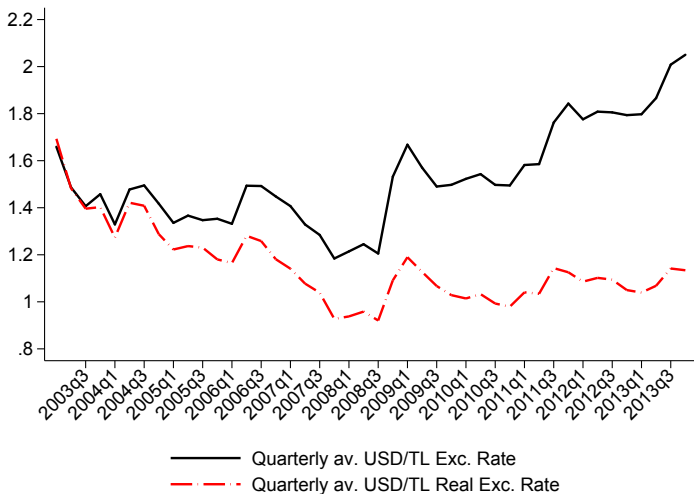
	<i>Whole Sample</i>		<i>Multi-Bank</i>	<i>Maturity</i>	
	Firm×year F.E. (1)	Risk Aversion (2)	<i>Links</i> (3)	Short (4)	Long (5)
log(VIX)	0.012 ^a (0.002)	0.010 ^a (0.002)	0.020 ^a (0.003)	0.019 ^a (0.003)	0.021 ^a (0.003)
FX	-0.070 ^a (0.003)	-0.070 ^a (0.003)	-0.070 ^a (0.003)	-0.077 ^a (0.003)	-0.050 ^a (0.002)
Observations	19,173,132	19,982,267	9,176,769	9,891,414	9,758,665
R-squared	0.881	0.792	0.761	0.805	0.846
Bank×firm F.E.	Yes	Yes	Yes	Yes	Yes
Macro controls & trend	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes
Firm×year F.E.	Yes	No	No	No	No
	<i>Crisis Period</i>		Private (8)	<i>Bank Type</i>	
	Pre (6)	Post (7)		Domestic (9)	Foreign (10)
log(VIX)	0.036 ^a (0.008)	0.018 ^a (0.004)	0.025 ^a (0.003)	0.022 ^a (0.004)	0.008 ^a (0.003)
FX	-0.091 ^a (0.004)	-0.056 ^a (0.001)	-0.071 ^a (0.003)	-0.069 ^a (0.003)	-0.071 ^a (0.003)
Observations	3,419,896	13,714,022	13,376,195	14,514,150	5,440,975
R-squared	0.778	0.873	0.795	0.721	0.871
Bank×firm F.E.	Yes	Yes	Yes	Yes	Yes
Macro controls & trend	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes
Firm×year F.E.	No	No	No	No	No

Impact of the GFC on Exchange Rate Fluctuations and Risk-Taking

	Panel A.		Panel B.	
	Nominal Interest Rate		Loan Volume	
	(1)	(2)	(3)	(4)
Leverage _b × FXshare _f × log(VIX)	-0.003 ^b (0.002)		0.041 (0.032)	
Leverage _b × FXshare _f × Δlog(XR)		-0.009 (0.007)		-0.053 (0.096)
FX	-0.070 ^a (0.003)	-0.070 ^a (0.003)	0.688 ^a (0.013)	0.688 ^a (0.013)
Observations	9,280,825	9,280,825	9,280,825	9,280,825
R-squared	0.884	0.884	0.877	0.877
Bank × firm F.E.	Yes	Yes	Yes	Yes
Firm × quarter F.E.	Yes	Yes	Yes	Yes
Bank × quarter F.E.	Yes	Yes	Yes	Yes

Exchange Rates

vis-à-vis the USD



Capital Flows, VIX, and Credit Growth in Turkey, 2004–13

