The bank lending channel in a frontier economy
Evidence from loan-level data

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Research question and contribution

Research question: Exploit large changes in the monetary policy stance to examine the **bank lending channel** (BLC) in Uganda during 2010-2014. Focus on local currency loans: almost 90% of loan applications and 70% of granted loans.

Literature: Credit register data has been used to examine the BLC in EMs and AEs (Khwaja & Mian 2008; Jimenez et al. 2012; 2014; Gobbi & Sette 2014).

Contribution: Use **loan-level data** to control for changes in credit demand and examine the intensive and extensive margins of credit *supply* adjustment – looking at both *quantity* and *price*.

Monetary conditions and credit growth: 2010-2014
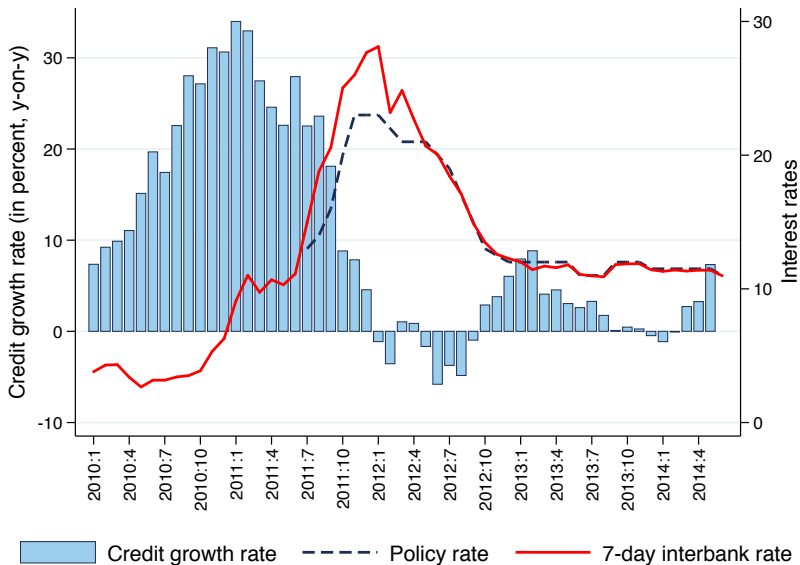
Monetary conditions, loan rejection rates, and lending rates
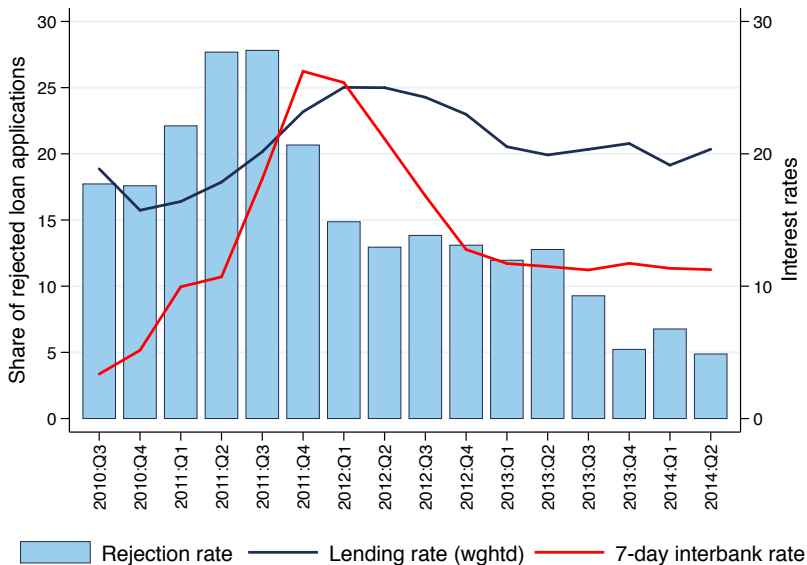
Empirical strategy

Challenges

1. Monetary policy is **endogenous** to economic conditions.
2. It is empirically difficult to **disentangle supply and demand** effects.

Our identification strategy

1. Exploit **large changes in the monetary policy stance** — associated with an institutional change — the magnitude of which may have been partly unanticipated.
2. Use loan-level supervisory data set to **control for shifts in borrower demand for credit** by means of borrower x time fixed effects.

Monetary policy framework

Inflation targeting-lite

- Jul 2011: from monetary aggregate targeting to IT-*lite*.
- The policy rate is the operating target, inflation target set at 5%.
- Our measure of monetary policy stance is the 7-day interbank rate.

Changes in monetary policy stance

- The policy rate was raised by 1,000 bps during Jul-Nov 2011.
- The policy rate was cut by 1,200 bps bw Feb 2012 and Mar 2013.
- These are large variations in interest rates (over a a relatively short period of time) that can be exploited to examine the BLC.

Policy and market interest rates

7-day interbank rate --- 91-day T-bill rate --- Policy rate

Discount rate --- Overnight interbank rate
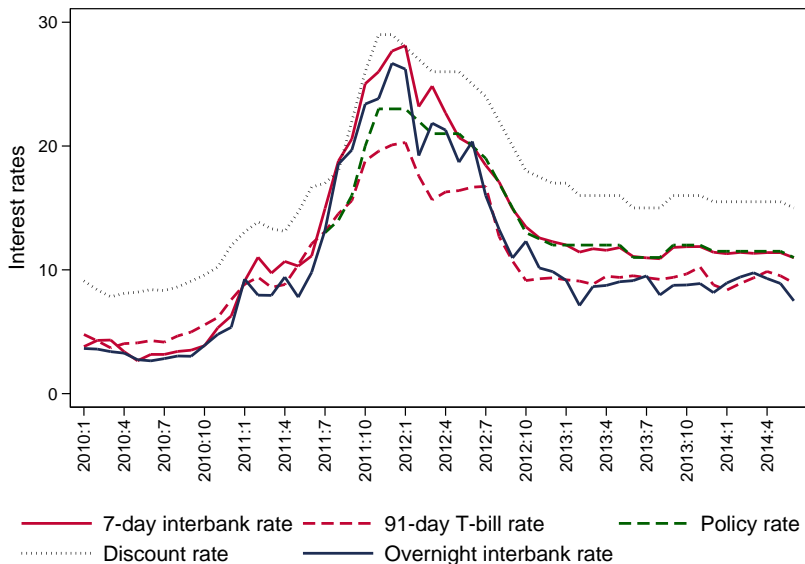
The banking system

- Banking system: 25 banks, mostly foreign- and privately-owned.
- Total banking assets/GDP = 19%; top-5 banks hold 73% of assets.
- Banks are highly capitalized and liquid.
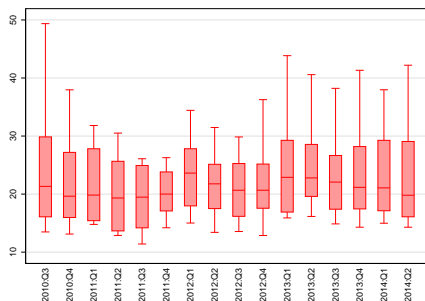
Total regulatory capital/RWA

Liquid assets/total deposits

Credit register data

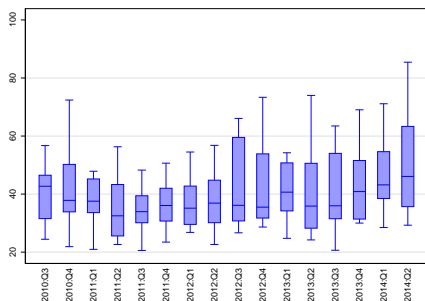- The Ugandan Credit Reference Bureau was set up in 2008 by Compuscan CRB Ltd. and collects data on loan applications and granted loans from all deposit-taking credit institutions.

- The dataset covers the largest 15 banks (95% of total banking assets) and refers to loan applications and originations granted to non-financial firms between 2010:Q3 and 2014:Q2. We focus on local currency loans.

- For borrowers, we have data on location (district) and sector of activity (industry).

- Prevalence of single-bank firms suggests relationship borrowing (80% of firms borrow from a single bank).

- Merge with bank balance sheet and macroeconomic data.

Sample composition: By industry and region

Local currency loan applications and granted loans, 2010:Q3 – 2014:Q2.

Industry	Loan applications		Granted loans		Applicants firms		Borrowing firms	
	#	%	#	%	#	%	#	%
Agriculture	1,762	10.31	3,323	12.81	553	8.91	904	10.38
Mining & Quarrying	241	1.41	272	1.05	71	1.14	48	0.55
Manufacturing	974	5.7	2,708	10.44	291	4.69	454	5.21
Trade	3,016	17.65	4,776	18.41	891	14.36	1,170	13.44
Transport & Communication	1,988	11.63	1,972	7.6	764	12.31	573	6.58
Electricity & Water	52	0.3	133	0.51	19	0.31	35	0.4
Building, Constr. & Real Estate	1,877	10.98	3,324	12.81	567	9.14	647	7.43
Community, Social & Other Serv.	2,187	12.8	1,989	7.67	709	11.43	607	6.97
Central & Local Government	585	3.42	309	1.19	229	3.69	135	1.55
Other	4,406	25.78	7,138	27.51	2,111	34.02	4,134	47.48
Region								
Central	12,253	71.71	21,200	81.71	4,246	68.43	6,455	74.14
East	1,643	9.61	1,803	6.95	720	11.6	846	9.72
North	1,572	9.2	1,449	5.59	614	9.9	691	7.94
West	1,620	9.48	1,492	5.75	625	10.07	715	8.21
Total	17,088	100	25,944	100	6,205	100	8,707	100

Testable hypotheses

Bank lending channel: Tighter monetary policy reduces the supply of bank credit:

Extensive margin: $\uparrow$ IR $\Rightarrow$ $\downarrow$ probability of loan granting

Intensive margin: $\uparrow$ IR $\Rightarrow$ $\downarrow$ volume and $\uparrow$ price of granted loans

Bank balance sheet channel: When monetary policy tightens, banks with *stronger* balance sheets adjust the supply of loans *less* than other banks.

- The external finance premium paid by banks is inversely related to the strength of their balance sheets (Bernanke, 2007).
- Banks near the capital requirement may pass up profitable lending opportunities during contractions more than other banks to avoid future losses and potential undercapitalization (Van den Heuvel, 2012).

Extensive margin

Linear model for the probability of loan granting (Jimenez et al 2012):

$$LOAN\ GRANTED_{ibt} = \eta_i + \psi_b + \alpha_1 \Delta IR_t + \beta_1 \Delta GDP_t + \gamma_1 \Delta CPI_t +$$
$$+ \delta_1 LIQUIDITY_{b,t-1} + \delta_2 CAPITAL_{b,t-1} +$$
$$+ \alpha_2 \Delta IR_t \times LIQUIDITY_{b,t-1} + \alpha_3 \Delta IR_t \times CAPITAL_{b,t-1} +$$
$$+ \beta_2 \Delta GDP_t \times LIQUIDITY_{b,t-1} + \beta_3 \Delta GDP_t \times CAPITAL_{b,t-1} +$$
$$+ \gamma_2 \Delta CPI_t \times LIQUIDITY_{b,t-1} + \gamma_3 \Delta CPI_t \times CAPITAL_{b,t-1} + \epsilon_{ibt}$$

- Dependent variable is the probability of loan granting to firm i by bank b in quarter t.
- We interact ΔIR_t with capital and liquidity to test for the bank balance sheet channel.
- We splice the variables during contraction and expansion to test for symmetric effects.

Extensive margin – Results

Dep. Var.: LOAN GRANTED$_{ibt}$	(1)	(2)	(3)	(4)
ΔIR_t	-0.0074***	-0.0049***	-0.0030**	
	(0.001)	(0.001)	(0.001)	
ΔGDP_t		0.0095***	0.0085***	
		(0.002)	(0.002)	
ΔCPI_t		-0.0067***	-0.0046***	
		(0.002)	(0.001)	
$LIQUIDITY_{b,t-1}$			0.0035***	0.0036***
			(0.001)	(0.001)
$CAPITAL_{b,t-1}$			0.0074***	0.0067***
			(0.001)	(0.001)
$\Delta IR_t \times contraction$				-0.0038**
				(0.002)
$\Delta IR_t \times expansion$				-0.0002
				(0.002)
$\Delta GDP_t \times contraction$				0.0101***
				(0.003)
$\Delta GDP_t \times expansion$				0.0058
				(0.004)
$\Delta CPI_t \times contraction$				-0.0055***
				(0.002)
$\Delta CPI_t \times expansion$				-0.0007
				(0.003)
Observations	14,199	14,199	14,199	14,199
R^2	0.410	0.413	0.418	0.419
Firm FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Quarter FE	No	No	No	No

Extensive margin – Economic Interpretation

- Bank lending channel: Half a standard deviation increase in interest rates (i.e., 172 bps) reduces the likelihood of loan granting by between 0.5 and 1.3 percentage points (cols 1-3).

- Symmetry test: *During this period*, the extensive margin of loan supply responded to monetary policy tightening, but not to the loosening (col 4).
  - ▶ Due to larger NPLs, banks may have focused on loan recovery rather than new loan extensions ▸ NPLs
  - ▶ Expansion was slower and longer (than contraction), leading banks to be more cautious in extending new loans

Intensive margin (1)

Lending equation at the district-industry-quarter level (291 pairs):

$$ln(LOAN\ AMOUNT_{jbt}) = \psi_b + \phi_j + \alpha_1 \Delta_2 IR_t + \beta_1 \Delta_2 GDP_t + \gamma_1 \Delta_2 CPI_t +$$
$$+ \delta_1 LIQUIDITY_{b,t-2} + \delta_2 CAPITAL_{b,t-2} +$$
$$+ \alpha_2 \Delta_2 IR_t \times LIQUIDITY_{b,t-2} + \alpha_3 \Delta_2 IR_t \times CAPITAL_{b,t-2} +$$
$$+ \beta_2 \Delta_2 GDP_t \times LIQUIDITY_{b,t-2} + \beta_3 \Delta_2 GDP_t \times CAPITAL_{b,t-2} +$$
$$+ \gamma_2 \Delta_2 CPI_t \times LIQUIDITY_{b,t-2} + \gamma_3 \Delta_2 CPI_t \times CAPITAL_{b,t-2} + \epsilon_{jbt}$$

- Dependent variable is the total volume of loans granted to firms in district-industry j by bank b in quarter t.
- District-industry fixed effects (ϕ_j) assume that credit demand shocks are **time-invariant** and common to all firms in a district-industry pair.
- Change in the interest rate ($\Delta_2 IR_t$) is cumulated over 2 quarters to allow monetary policy to influence credit supply with a lag.

Intensive margin (2)

- To control for credit demand, we add district-industry-quarter fixed effects ($\phi_j \times \tau_t$), which allow for a **time-varying** common demand shock to all firms in a district-industry pair:

$$ln(LOAN\ AMOUNT_{jbt}) = \psi_b + \phi_j \times \tau_t + \delta_1 LIQUIDITY_{b,t-2} + \delta_2 CAPITAL_{b,t-2} +$$
$$+ \alpha_2 \Delta_2 IR_t \times LIQUIDITY_{b,t-2} + \alpha_3 \Delta_2 IR_t \times CAPITAL_{b,t-2} +$$
$$+ \beta_2 \Delta_2 GDP_t \times LIQUIDITY_{b,t-2} + \beta_3 \Delta_2 GDP_t \times CAPITAL_{b,t-2} +$$
$$+ \gamma_2 \Delta_2 CPI_t \times LIQUIDITY_{b,t-2} + \gamma_3 \Delta_2 CPI_t \times CAPITAL_{b,t-2} + \epsilon_{jbt}$$

- All macro variables drop out, allowing us to estimate only coefficients on interaction terms (i.e., the bank balance sheet channel).
- We also splice the macro variables in the contraction/expansion periods to test for symmetry.

Intensive margin – Results

Dep. Var.: $ln(LOAN\ AMOUNT_{jbt})$	(1)	(2)	(3)	(4)
$\Delta_2 IR_t$	-0.0167***	-0.0298***	-0.0201**	
	(0.005)	(0.006)	(0.008)	
$\Delta_2 GDP_t$		0.0847***	0.0702***	
		(0.019)	(0.017)	
$\Delta_2 CPI_t$		0.0134	0.0126	
		(0.012)	(0.011)	
$LIQUIDITY_{b,t-2}$			0.0180***	0.0171***
			(0.003)	(0.004)
$CAPITAL_{b,t-2}$			0.0525***	0.0530***
			(0.012)	(0.015)
$\Delta_2 IR_t \times contraction$				-0.0509**
				(0.020)
$\Delta_2 IR_t \times expansion$				-0.0147***
				(0.005)
$\Delta_2 GDP_t \times contraction$				0.0713***
				(0.025)
$\Delta_2 GDP_t \times expansion$				0.0444
				(0.050)
$\Delta_2 CPI_t \times contraction$				0.0296
				(0.020)
$\Delta_2 CPI_t \times expansion$				0.0034
				(0.035)
Observations	3,537	3,537	3,537	3,537
R^2	0.406	0.411	0.420	0.421
Sector-district FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Quarter FE	No	No	No	No

Intensive margin – Economic Interpretation

- Bank lending channel: Half a standard deviation increase in interest rates over two quarters (i.e., 309 bps) reduces the supply of loans by between 5.2 and 9.2 percent (cols 1-3).

- Symmetry test: *During this period*, the intensive margin of loan supply responded to both tightening and loosening, but more strongly to the former (col 4).

Interest rate pass-through

Lending equation at the district-industry-quarter level (291 pairs) similar to the quantity equation for the intensive margin:

$$\Delta(LENDING\ RATE_{jbt}) = \psi_b + \phi_j + \alpha_1\Delta IR_t + \beta_1\Delta GDP_t + \gamma_1\Delta CPI_t +$$
$$+ \delta_1 LIQUIDITY_{b,t-1} + \delta_2 CAPITAL_{b,t-1} +$$
$$+ \alpha_2\Delta IR_t \times LIQUIDITY_{b,t-1} + \alpha_3\Delta IR_t \times CAPITAL_{b,t-1} +$$
$$+ \beta_2\Delta GDP_t \times LIQUIDITY_{b,t-1} + \beta_3\Delta GDP_t \times CAPITAL_{b,t-1} +$$
$$+ \gamma_2\Delta CPI_t \times LIQUIDITY_{b,t-1} + \gamma_3\Delta CPI_t \times CAPITAL_{b,t-1} + \epsilon_{jbt}$$

- Dependent variable is the change in interest rates on loans granted to firms in district-industry j by bank b in quarter t.
- Control for demand with district-industry fixed effects (ϕ_j).

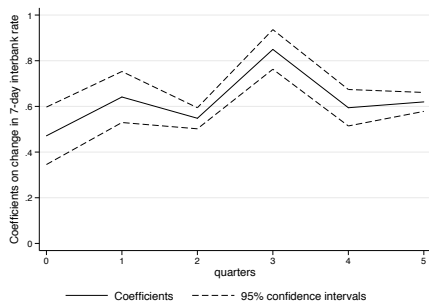## Interest rate pass-through – Results

Dep. Var.: $\Delta LENDING\ RATE_{jbt}$	(1)	(2)	(3)	(4)
ΔIR_t	0.3389*** (0.051)	0.4879*** (0.065)	0.4712*** (0.064)	
ΔGDP_t		-0.4691*** (0.096)	-0.4037*** (0.108)	
ΔCPI_t		-0.1817*** (0.052)	-0.2273*** (0.065)	
$LIQUIDITY_{b,t-1}$			-0.0890*** (0.022)	-0.0885*** (0.023)
$CAPITAL_{b,t-1}$			-0.0089 (0.059)	-0.0223 (0.081)
$\Delta IR_t \times contraction$				0.4717*** (0.124)
$\Delta IR_t \times expansion$				0.5428*** (0.097)
$\Delta GDP_t \times contraction$				-0.3382*** (0.096)
$\Delta GDP_t \times expansion$				-0.4197 (0.248)
$\Delta CPI_t \times contraction$				-0.2670*** (0.057)
$\Delta CPI_t \times expansion$				-0.1188 (0.086)
Observations	1,499	1,499	1,499	1,499
R^2	0.084	0.100	0.106	0.107
District-industry FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Quarter FE	No	No	No	No

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Impulse response functions
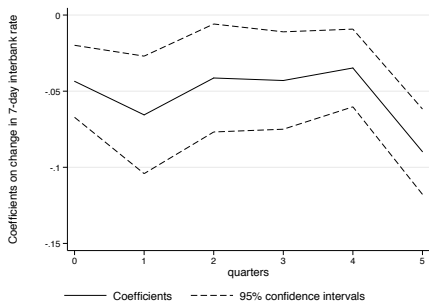
Intensive margin adjustment

Interest rate pass-through

Bank balance sheet channel – Results

	LOAN GRANTED$_{ibt}$ z = 1		LOAN AMOUNT$_{jbt}$ z = 2		ΔLENDING RATE$_{jbt}$ z = 1	
	(1)	(2)	(3)	(4)	(5)	(6)
$LIQUIDITY_{b,t-z}$	0.0027***	0.0037***	0.0051	0.0023	-0.0560**	-0.0829***
	(0.001)	(0.001)	(0.007)	(0.010)	(0.027)	(0.025)
$CAPITAL_{b,t-z}$	0.0082***	0.0053***	0.0560**	0.0421	-0.0338	0.0610
	(0.001)	(0.001)	(0.024)	(0.038)	(0.076)	(0.062)
$\Delta_z IR_t \times LIQUIDITY_{b,t-z}$	-0.0001	-0.0003**	-0.0009	-0.0023***	0.0204***	0.0247***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.006)	(0.005)
$\Delta_z IR_t \times CAPITAL_{b,t-z}$	0.0009***	0.0008***	0.0024***	0.0037**	-0.0136	-0.0335***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.010)	(0.009)
$\Delta_z GDP_t \times LIQUIDITY_{b,t-z}$	0.0002	-0.0001	0.0013	0.0013	-0.0195**	-0.0103*
	(0.000)	(0.000)	(0.001)	(0.001)	(0.009)	(0.005)
$\Delta_z GDP_t \times CAPITAL_{b,t-z}$	-0.0022***	-0.0022***	-0.0025	-0.0006	0.0173	0.0448***
	(0.000)	(0.000)	(0.002)	(0.003)	(0.016)	(0.009)
$\Delta_z CPI_t \times LIQUIDITY_{b,t-z}$	0.0006***	0.0004***	0.0015**	0.0025***	-0.0083	-0.0055
	(0.000)	(0.000)	(0.001)	(0.001)	(0.006)	(0.009)
$\Delta_z CPI_t \times CAPITAL_{b,t-z}$	-0.0001	0.0004	-0.0016	-0.0018	0.0027	0.0013
	(0.000)	(0.000)	(0.002)	(0.002)	(0.010)	(0.012)
Observations	14,199	16,078	3,537	2,637	1,499	1,064
R^2	0.428	0.288	0.425	0.525	0.108	0.202
Individual FE	Yes	No	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	No	Yes	No
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual $\times$ Quarter FE	No	Yes	No	Yes	No	Yes

Bank balance sheet channel – Economic Interpretation

- Half a standard deviation increase in interest rates (over one quarter for extensive margin and two quarters for intensive margin, respectively) leads to the following differential effects for low capitalized banks (10th pct, 15%) compared to high capitalized banks (90th pct, 34%):

    - lower probability of loan granting by 3.1%;
    - lower volumes of granted loans by 21.3%;
    - higher interest rate charged on granted loans by almost 200 bps

- These results hold up to controlling for bank age, size, and density of branch and ATM network.
- Currently exploring the link between capital and cost of funds.

Robustness

- All results are robust to:
  - alternative interest rates;
  - clustering standard errors at different levels;
  - presence of outliers. ▸ Outliers

- Results on the intensive margin:
  - are driven by disbursed loans rather than credit lines;
  - are robust to adding more bank characteristics;
  - are robust to an alternative identification strategy. ▸ Khwaja & Mian

- Extensive margin results indicate that the probability of loan granting is higher for larger loan applications, suggesting a role for borrower size. ▸ Loan size

Conclusions

1. When short-term interest rates increase in Uganda:

   - Bank loan supply adjusts on both the extensive and intensive margins
   - For the intensive margin, they adjust on both quantity and price
   - There are differential effects for banks with high vs. low capital (bank capital channel)
   - Estimated elasticities are statistically significant and economically meaningful

2. Magnitudes for the overall and differential effects of interest rates on loan supply are **smaller** than for advanced economies (e.g., Spain).

Next steps

Explore the impact of changes in short-term interest rates on:

1. **The real economy** (in progress):
   - geocoded real activity based on satellite nightlights ▸ maps
   - firm-level investment, asset and employment growth
   - district-level labor market outcomes
   - district-level patrol/gas sales, transportation intensity
   - district-level tax receipts, firm registrations

2. **Foreign currency loans** (in progress):
   Preliminary evidence suggests transmission of changes in short-term interest rates to the supply of bank loans in USD.

Macro developments in Uganda, 2009-2014
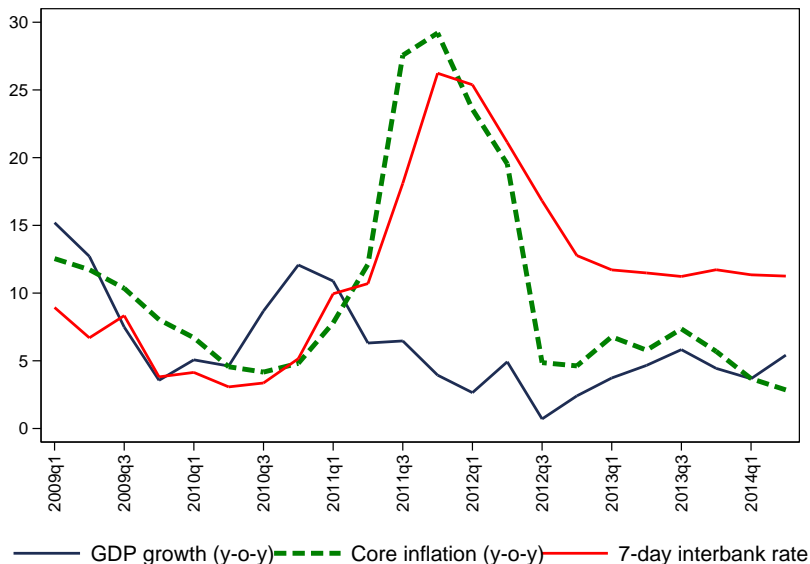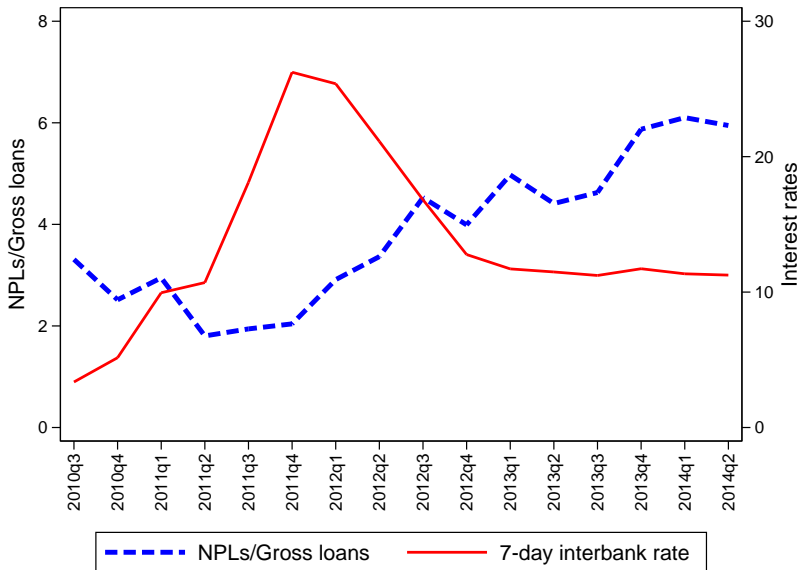
Balance sheet structure of Ugandan banks, 2010-2014
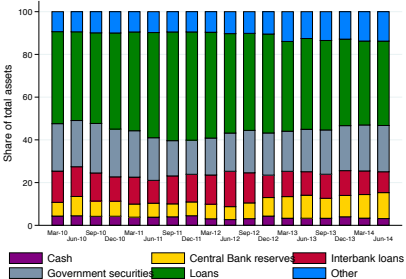
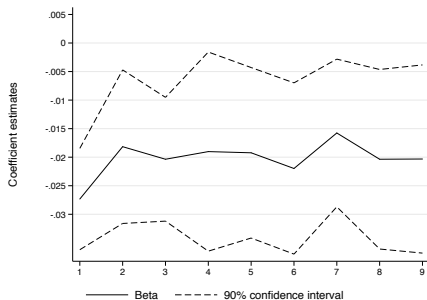Assets
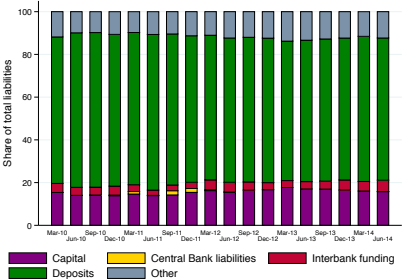
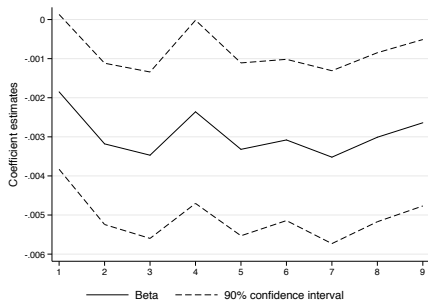Liabilities and capital

Bank NPLs, 2010-2014

Estimated coefficient on ΔIR, jackknife samples

Intensive and extensive margins   ‹ Back

Intensive margin

Extensive margin

Notes: The charts show the estimated coefficients on ΔIR and the 90% confidence intervals estimated on 9 different samples, each excluding one borrowing industry.

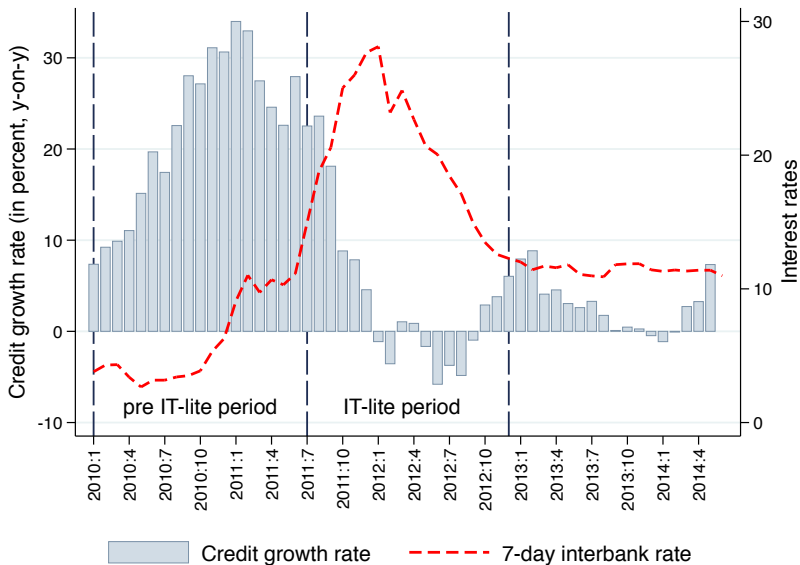# Intensive margin: alternative identification strategy

For each borrower we compare the change in bank credit *before* and *after* the beginning of the monetary tightening for banks with different *exposure* to the liquidity shock (Khwaja & Mian 2008):

- Compare bank lending in the 6 quarters before and after the introduction of the **IT-lite framework** in Jul 2011;
- Focus on borrowers (**district-industry pairs**) that obtained loans from at least two banks before and after;
- Measure banks' exposure to the liquidity shock with reliance on **interbank funding** (interbank liabilities/total deposits).

$$\Delta ln(LOAN\ AMOUNT_{jb}) = \alpha_1 INTERBANK_b + \delta_1 LIQUIDITY_b + \delta_2 CAPITAL_b +$$

$$+ \sum_{i=1}^{4} \beta^i BANK\ CHARACTERISTICS_b^i +$$

$$+ \alpha_2 INTERBANK_b \times LIQUIDITY_b +$$

$$+ \alpha_3 INTERBANK_b \times CAPITAL_b + \phi_j + \epsilon_{ibt}$$

All variables are measured as of 2011:Q2 (that is, the *pre* IT-lite period).

# Before and after the 'IT-lite'

Intensive margin – Results

Alternative identification strategy   ◄ Back

Dep. Var.: ΔLOAN AMOUNT	(1)	(2)	(3)	(4)
INTERBANK EXPOSURE	-0.276***	-0.256***	-0.488***	-0.759***
	(0.042)	(0.066)	(0.089)	(0.162)
FOREIGN BANK	3.203***	2.409***	3.197***	2.672***
	(0.382)	(0.535)	(0.340)	(0.296)
SIZE	1.055***	0.830**	1.067***	1.198***
	(0.202)	(0.355)	(0.204)	(0.231)
RISK PROFILE	0.109***	0.046	0.119***	0.076***
	(0.022)	(0.027)	(0.021)	(0.020)
NPL	0.143*	0.183***	0.155**	0.227***
	(0.074)	(0.044)	(0.067)	(0.064)
LIQUIDITY	0.062***		0.051***	
	(0.017)		(0.014)	
CAPITAL		0.017		0.021*
		(0.018)		(0.010)
LIQUIDITY × INTERBANK EXPOSURE			0.008**	
			(0.003)	
CAPITAL × INTERBANK EXPOSURE				0.029***
				(0.009)
Observations	246	246	246	246
R^2	0.441	0.414	0.446	0.436
Industry-district FE	Yes	Yes	Yes	Yes

Extensive margin – Size of the loan application
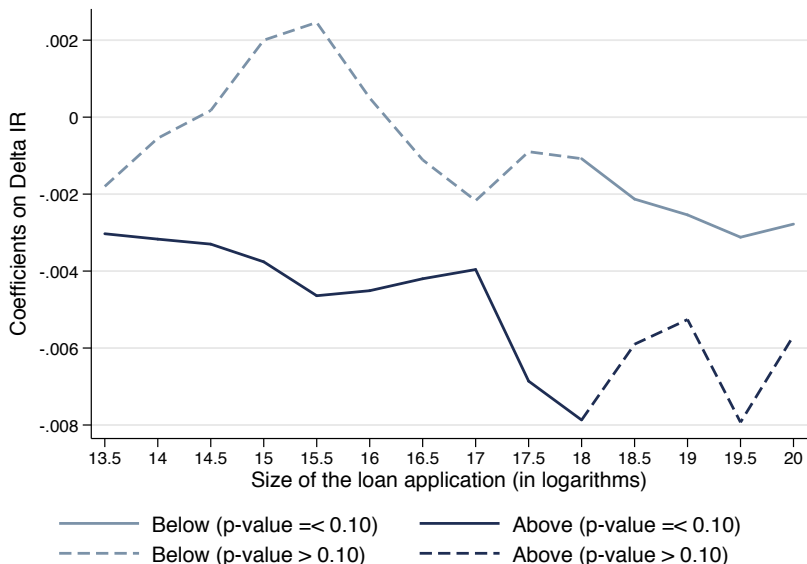
Real economic activity from nightlights

2010   2011   2012