WP/15/270

IMF Working Paper

Monetary Policy in a Developing Country: Loan Applications and Real Effects

by Charles Abuka, Ronnie K. Alinda, Camelia Minoiu, José-Luis Peydró, and Andrea F. Presbitero

INTERNATIONAL MONETARY FUND

 WP/15/270

IMF Working Paper

Institute for Capacity Development, Research Department, and Strategy, Policy, and Review Department

Monetary Policy in a Developing Country: Loan Applications and Real Effects[*]

Prepared by Charles Abuka, Ronnie K. Alinda, Camelia Minoiu, Jose-Luis Peydro, and Andrea F. Presbitero

Authorized for distribution by Andrew Berg, Prakash Loungani, and Catherine Pattillo

December 2015

Abstract

The transmission of monetary policy to credit aggregates and the real economy can be impaired by weaknesses in the contracting environment, shallow financial markets, and a concentrated banking system. We empirically assess the bank lending channel in Uganda during 2010–2014 using a supervisory dataset of loan applications and granted loans. Our analysis focuses on a short period during which the policy rate rose by 1,000 basis points and then came down by 1,200 basis points. We find that an increase in interest rates reduces the supply of bank credit both on the extensive and intensive margins, and there is significant pass-through to retail lending rates. We document a strong bank balance sheet channel, as the lending behavior of banks with high capital and liquidity is different from that of banks with low capital and liquidity. Finally, we show the impact of monetary policy on real activity across districts depends on banking sector conditions. Overall, our results indicate significant real effects of the bank lending channel in developing countries.

JEL Classification Numbers: E42; E44; E52; E58

Keywords: Monetary policy transmission; Bank lending channel; Bank balance sheet channel; Developing countries

Authors' E-Mail Addresses: cabuka@bou.or.ug; ralinda@bou.or.ug; cminoiu@imf.org; jose.peydro@upf.edu; apresbitero@imf.org.

[*] We thank the Bank of Uganda, Compuscan Uganda CRB Ltd., and the Uganda Bureau of Statistics, for providing the data used in this study and assisting us with queries and advice. We thank Andrew Berg and Catherine Pattillo for support at all stages of this project, and Olivier Blanchard, Rupa Duttagupta, Hideaki Hirata, Tommaso Mancini-Griffoli, Stelios Michalopoulos, Peter Montiel, Steven Ongena, Mahvash Qureshi, Marta Reynal Querol, Neeltje Van Horen, Tomasz Wieladek, Ling Zhu, staff at the Financial Stability, Research, and Statistics Departments at the Bank of Uganda, participants at the Conference on Banking in Emerging Economies (Rio de Janeiro), 2015 Conference of the Georgetown Center for Economic Research (Washington, DC), CSAE 2015 (Oxford), RIETI-MoFiR-Hitotsubashi-JFC International Workshop on Banking and Financial Research (Tokyo), and at seminars at the IMF, Cerdi (Clermont-Ferrand), Bank of Uganda, and Makerere University School of Economics for useful comments and discussions. We thank Nicola Babarcich, Jeffrey Dickinson, and Manzoor Gill for outstanding research assistance. Additional material is available in an Online Appendix available for download on: https://sites.google.com/site/presbitero/homepage/wp. This paper is part of a research project on macroeconomic policy in low-income countries supported by the U.K.'s Department for International Development (DFID).

Contents

List of figures

List of tables

1 Introduction

A key question for policymakers is to what extent monetary policy can effectively influence real economic activity through its impact on credit aggregates. A large literature argues that the transmission of monetary policy to the real economy—the so-called monetary transmission mechanism (MTM)—can be hampered by several factors. These include small and shallow financial markets, oligopolistic banking systems, excess bank liquidity, monetary policy frameworks with limited ability to anchor inflation expectations, and poor institutional and legal environments that raise the costs of lending. These features are most frequently found in developing and emerging market economies. The quantitative evidence on the strength of the MTM, in particular the bank lending channel, in these economies remains mixed, questioning the effectiveness of monetary policy in emerging versus advanced economies where structural impediments are less likely to be present.

To shed light on this question, we analyze the bank lending channel in Uganda, a fast-growing East African economy. With a bank-dependent economy and a recent transition to a new monetary policy framework—inflation targeting lite (IT-lite),—Uganda serves as an ideal representation of developing countries. In addition, the Bank of Uganda's monetary policy stance changed significantly during the period of analysis, ranging from highly contractionary after the introduction of the new framework to highly expansionary subsequently. In mid-2011 the Bank of Uganda raised the policy rate by a cumulative 1,000 basis points (bps) over the course of five months and reduced it by a total of 1,100 bps in the following eleven months. The relatively short period over which these changes occurred reduces the likelihood that structural transformation of the economy might confound an analysis of the effectiveness of monetary policy.

We face two main empirical challenges in assessing the transmission of interest rate changes to credit aggregates and the real economy. The first challenge stems from the fact that monetary policy is determined by economic conditions. This problem is difficult to resolve as instances of truly exogenous monetary policy are extremely rare and high-frequency identification is not feasible in the absence of deep financial markets. In our case, we argue that there is an exogenous element in the extent of interest rate variation observed during the tightening period, which is unusually large. When estimating the effect of short-term interest rate changes on loan supply, we control for macroeconomic variables such as real GDP growth rate and inflation to account for macroeconomic conditions to which monetary policy responds. Furthermore, we identify differential loan supply effects for banks with different balance sheet characteristics (and respectively differential real effects in districts with varying banking sector conditions) while controlling for time fixed effects, which account for all macroeconomic factors that may change simultaneously with interest rates.

The second challenge comes from the fact that aggregate shocks affect equilibrium bank credit through both the bank lending (supply) and the firm borrowing (demand) channels. Since supply and demand shocks often occur simultaneously, we need to differentiate changes in loan supply from changes in loan demand. We use granular data that are well suited for this task. We exploit a unique supervisory dataset provided by the credit reference bureau (CRB) in Uganda (Compuscan Uganda CRB Ltd.) The dataset has information on individual loan applications (with acceptance/rejection decision) and loans granted to non-financial firms by the 15 largest Ugandan banks during 2010:Q3–2014:Q2. These banks account for 95 percent of total banking sector assets. We focus on local currency loans (in Ugandan shillings) which represent almost 90 percent of loan applications during the period of analysis.

There are three main ingredients to our analysis. First, we test the standard bank lending channel (Bernanke and Gertler, 1989, 1995; Bernanke and Blinder, 1988) which predicts that higher short-term interest rates reduce the probability of loan granting (extensive margin) and, for loans granted, their volume (intensive margin). Second, we estimate the pass-through of short-term interest rates to retail lending rates charged on new loans. These two dimensions inform how credit aggregates change, both in terms of quantity and price, in response to monetary policy. Third, we look beyond credit aggregates and test for transmission of changes in the monetary policy to the real economy.

For all outcome variables—quantity of credit, price of credit, and real outcomes—we look for evidence that the strength of the bank lending channel depends on banking sector conditions; that is, that a bank balance sheet channel is at work. This channel predicts that weaker banks, for instance those with lower levels of capital and liquidity, are more "effective" at transmitting changes in interest rates to the broader economy. This effect could be due to the external finance premium for banks, according to which healthier banks benefit from better access to external funds, and hence are less sensitive to changes in monetary conditions (Bernanke, 2007).[1] An important question in the context of a developing country is whether a higher stock of liquid assets is an indicator of bank health. Banking systems in developing countries are generally seen as "too liquid" as banks invest in safe government securities at the expense of risky lending, so high levels of public sector borrowing crowd out lending to

[1]The bank capital channel is influenced also by how close banks are to the regulatory capital requirement. For instance, banks for which the capital requirement is binding are more likely to pass up current profitable lending opportunities to avoid future losses and reduce the probability of being undercapitalized in the future (Van den Heuvel, 2012). This mechanism, however, is less relevant for our analysis, as banks in Uganda have capital ratios that are well in excess of the regulatory minimum, see Section 2.2.

the private sector (Hauner, 2009). Thus, we conjecture that higher bank liquidity in the case of Uganda may in fact amplify the bank lending channel, as higher interest rates would lead highly liquid banks to invest according to their preferred preference for government securities at the expense of new lending.

We find evidence of significant loan supply adjustment for both the quantity and price of bank credit. For the extensive margin we show that an increase in interest rates by half a standard deviation raises the probability of loan granting in the same quarter by 0.7-1.4 percentage points. For the intensive margin, we estimate that an increase in interest rates by half a standard deviation over two quarters reduces loan supply by 4.9-9.7 percent. About half of the variation in market interest rates translates into changes in retail lending rates, indicating an economically significant pass-through. The results for the bank balance sheet channel show that high-capital banks transmit changes in the monetary policy stance significantly less than do low-capital banks, while highly liquid banks pass through these changes more than do other banks. We also show that real activity—captured by the intensity of night lights across districts and over time—is less affected by a monetary policy tightening in districts where banks are better capitalized and less liquid.

The novelty of our dataset allows us to expand the empirical literature on monetary policy by being the first to study the real effects of the bank lending channel in a developing country using loan-level data. The availability of credit register data for Uganda makes it possible to control for changes in loan demand at a higher level of granularity than in previous studies for developing countries, and hence more convincingly isolate supply from demand effects. Since we observe pricing information for each loan in the dataset, a feature that is rare in credit registers, we are also able to precisely estimate the pass-through to the marginal bank lending rate. In addition, credit register data allows us to control for a wide range of unobserved lender and borrower heterogeneity through bank, borrower, and borrower×time fixed effects.

Our study adds to a recent literature that employs credit register data to examine the bank lending channel in advanced and emerging market economies. Jiménez *et al.* (2012) show that a 100 bps increase in the short-term interest rate by the European Central Bank (ECB) reduces the probability of loan granting to Spanish firms by 1.4 percentage points, which is larger than our baseline estimates. Jiménez *et al.* (2014) show that accommodative monetary policy in the Eurozone leads weakly capitalized banks to grant loans to riskier firms, and these loans are larger and longer-term, suggesting a risk-taking channel. In addition to an international bank lending channel that operates through foreign banks, Ongena *et al.* (2015) and Bernardo *et al.* (2015) identify a domestic monetary policy channel in Hungary and Mexico. By looking at the district-level effects of monetary policy on economic activity, we also contribute to recent studies documenting the real effects of credit contractions (Cingano *et al.*, 2013; Acharya *et al.*, 2014; Bottero *et al.*, 2015). Studies such as Jiménez *et al.* (2012) provide a useful reference point for our coefficient estimates. Though our empirical strategy is similar, our goal is to assess the strength of the bank lending channel in a far less studied *developing* country where monetary policy transmission may suffer from structural impediments. The magnitudes of our estimated coefficients suggest weaker monetary policy transmission than that experienced by advanced economies.

We also contribute to the literature on monetary policy transmission in developing countries that finds mixed evidence of policy rate transmission to credit aggregates and bank lending rates (see Mishra and Montiel (2013) and Davoodi *et al.* (2013) for reviews). Mishra and Montiel (2013) argue that this is not merely the result of methodological limitations. In a sample of countries at varying levels of development, Mishra *et al.* (2014) find that the relationship between policy rates and retail lending rates is stronger for countries with better institutions, deeper financial markets, and less concentrated banking systems. Saxegaard (2009) shows that banks in sub-Saharan Africa hold reserves in excess of the level consistent with a precautionary savings motive, and argues that excess liquidity in the banking system weakens the MTM. Bulir and Vlcek (forthcoming) find a strong link from short-term policy and interbank rates to longer-term bond yields for emerging market and low-income countries. Berg *et al.* (2013) use a "narrative" approach to document several channels of monetary policy transmission in East African economies during 2010-2012, including through market and lending rates, bank credit, and the exchange rate. In our study we focus on the bank lending channel in Uganda and employ micro data to control for concurrent credit demand shifts and to examine real effects. Furthermore, we extend the period of analysis to mid-2014 to capture not only the tightening but also the subsequent expansionary policy phase, which was of equally dramatic magnitude. Observing periods of both tight and loose monetary policy further allows us to test for asymmetric transmission.

Uganda provides an ideal setting for examining the bank lending channel given its representative features of a developing economy that can weaken the transmission of monetary policy, including illiquid financial markets, a concentrated banking industry, and a young and untested monetary policy framework (Berg *et al.*, 2013). In addition, the weak institutional framework increases the cost of lending, prompting banks to invest primarily in government securities and hold excess reserves (Mishra *et al.*, 2012). As central banks in many developing countries are in the process of adopting forward-looking monetary policy frameworks to enhance their credibility and effectiveness (Kasekende and Brownbridge, 2011; Khan, 2011), Uganda's experience with this transition starting in 2011, coupled with a short period of large interest rate swings, provides for a highly informative case study.

2 Institutional background

Uganda is an East African developing country with a flexible exchange rate regime and a moderate level of dollarization.[2] Like many other economies in sub-Saharan Africa, it relies heavily on commodity exports and foreign aid, has a large microfinance sector, and has significant agricultural employment. With a large share of food items in the CPI basket (27 percent), price volatility is primarily driven by external food and fuel price shocks and domestic supply shocks (especially weather-related) (Berg *et al.*, 2013; Mugume, 2010).

Like other sub-Saharan African central banks, including those in East Africa, the Bank of Uganda followed a *de jure* monetary aggregate targeting framework prior to 2011. This type of framework has historically proven ineffective at anchoring inflation expectations and has led to excess interest rate volatility (International Monetary Fund, 2008). In July 2011, the Bank of Uganda moved to an IT-lite monetary policy framework and introduced a policy rate to signal the monetary policy stance. The explicit inflation target was set at 5 percent (see Berg *et al.* (2013) for a detailed account of the regime change and a comparison of monetary policy regimes in East Africa).

2.1 The tightening and expansionary phases

The 2010-2014 period was marked by a change of monetary policy regime and large swings in interest rates. What explains these developments? A negative commodity price shock unfolded during 2010-2011, with food and fuel prices rising substantially. Coupled with strong credit growth, a weakening currency and low real interest rates, the shock led to soaring inflation (Figure 1). This phenomenon occurred to various degrees in four countries of the East African Community (ECA)—Kenya, Rwanda, Tanzania, and Uganda. In the second half of 2011 the four central banks decided to tighten monetary policy in a coordinated effort to fight inflation.

The tightening phase began in July 2011, when the Bank of Uganda simultaneously switched to an IT-lite monetary policy framework, introduced a policy rate, and stepped up its communication efforts to enhance the credibility of the new framework. During July-November 2011

[2] In 2013, the share of foreign currency assets in Uganda was 31.6 percent, a value lower than in most East European countries (Brown and De Haas, 2012) but higher than the average for 16 selected African countries covered by a Bank of International Settlements Survey (Christiensen, 2014).

the policy rate was raised by a cumulative 1,000 bps: 300 bps between July and September and an additional 700 bps between September and November. These developments are illustrated in Figure 2, which shows year-on-year credit growth soaring to more than 30 percent in early 2011, and market rates moving in tandem with the policy rate after the regime change. Following the tightening, credit growth collapsed to negative levels by the second half of 2012.

While monetary policy clearly responded to economic conditions, we argue that the magnitude, and to some extent the timing of the tightening, were largely unanticipated by economic agents. There are several reasons for this. First, the Bank of Uganda had reacted little to an earlier commodity price shock, during 2007-2008, which had also sent inflation soaring. Second, the Bank's long-term track record suggests a dovish attitude, even during the occurrence of a similar acceleration of real credit growth in 2008 – when real interest rate was negative –, and hence little reason for economic agents to anticipate the dramatic consecutive rate hike (Figure **??**). Third, pre-tightening communication had emphasized the need for the monetary authority to *support* strong economic activity rather than to address inflationary concerns. Fourth, the tightening phase occurred at the same time as the transition to an entirely new monetary policy framework, leaving economic agents little time to form expectations about future central bank actions in line with its new inflation targeting mandate. As of October 2011, the Bank of Uganda had not yet published a well-articulated intermediate inflation trajectory (International Monetary Fund, 2011, 2012).

The expansionary phase began in January 2012. By that time, credit aggregates had collapsed and economic growth was taking a hit (Figure 1). Given that close to 60 percent of loans in Uganda have flexible interest rates, loan quality deteriorated and banks' non-performing loans rose (from 1.8 percent in 2011:Q2 to 4.9 percent of total loans in 2013:Q1, see Figure A3). Starting in January 2012 the policy rate was gradually reduced over the following three quarters from 23 percent to 11 percent. In tandem with the policy and short-term market interest rates, the average marginal lending rate on local currency loans increased during the tightening period from close to 15 percent to almost 25 percent and subsequently returned to about 20 percent (Figure 4).

There are two important sets of factors that may confound the credit and real effects of monetary policy, both of which we argue are unlikely to affect our results. First, there may have been coincidental monetary or macroprudential policy changes during our period of analysis. However, the Bank of Uganda does not use cash reserve requirements as an active tool of monetary policy. Reserve requirements have been relatively flat over time, with the latest reduction in March 2011 by 1.5 percentage points to 8 percent of total deposits. If this reduction had any real impact, it would work towards dampening any estimated effects of the interest rate hikes that occurred in the second half of 2011. There were no other changes in macroprudential policies during 2010-2014. A second set of factors refers to foreign monetary policy which may be correlated with domestic monetary policy and influence banks' access to funds. As we argue in the next section, foreign banks in Uganda fund their operations primarily with local deposits, which insulates them from the global monetary cycle and limits the transmission of core country monetary policy to Uganda.

2.2 The banking system in Uganda

Uganda has experienced financial deepening in the last decade, with bank credit to the private sector more than doubling to 15 percent (of GDP) during 2001-2013 (International Monetary Fund, 2015). Financial depth remains nonetheless low by international standards. There is also a large informal financial sector. According to the Finscope and World Bank Enterprise Surveys, 74 percent of the Ugandan adult population used the financial services of an informal lender in 2013 and 15 percent used the services of both a formal and informal lender (Finscope, 2013).

The banking system in Uganda comprises 25 (mostly foreign- and privately-owned) banks during the period of analysis. Total banking sector assets represent 19 percent of GDP and the largest 5 banks account for 73 percent of total banking system assets (GFDD, 2011).[3] Banks are highly capitalized, with average Tier 1 capital ratios of 20 percent and average total regulatory capital ratios of 24 percent. The typical bank funds its assets with 66 percent in deposits, 30 percent shareholders' equity, 11 percent market-based funding (from banks in Uganda and abroad), and 6 percent other sources. The average bank holds 52 percent loans, 21 percent securities (mostly government bonds), 10 percent reserves at the central bank, and 4 percent cash. As a result, Ugandan banks are highly liquid, with an average liquid-to-total assets ratio of 27 percent.[4]

Figure 5 shows the evolution of the cross-sectional distributions of regulatory capital and liquidity, our key variables for assessing the bank balance sheet channel. We exploit heterogeneity in bank balance sheet characteristics—capital and liquidity—to formally test for a bank balance sheet channel. Furthermore, we compute district-level bank capital and liquidity, weighted by banks' market shares in each district, to examine real effects of the bank lending channel.

[3] Estimates are for 2011.
[4] See Section A-I in the Online Appendix for more details on the banking system in Uganda.

3 The Ugandan credit register

Uganda is one of the few developing countries with a fully functional and comprehensive credit register. Other countries in sub-Saharan Africa (including Ghana, Kenya, and Malawi) have also set up credit registers in recent years, but mainly collect loan default information. The Ugandan credit register was set up in 2008 and collects data on loan applications and granted loans, on a monthly basis, from all commercial banks, microfinance deposit-taking institutions, and other credit institutions. Its coverage has continuously improved over time and it stabilized by mid-2010. We use credit register data for the largest 15 banks, which account for 95 percent of total banking assets.

The Ugandan CRB collects comprehensive information on both loan applications *and* originations (credit lines and disbursed loans) granted by banks to non-financial firms, with no restriction on the minimum size of the loan. For each individual loan application and granted loan, we know the date and all terms of the loan, including interest rate, maturity, currency, a description of collateral and its resale value, and borrower performance information. Importantly, banks make separate data submissions on loan applications and granted loans (i.e., there is an "applications dataset" and a "loans dataset"). For this reason, there is limited overlap between the two datasets, and not all granted loans can be traced back as successful applications in the applications dataset.[5] Therefore, we analyze loan applications and granted loans separately. After cleaning the data and keeping local currency loans, we arrive at a sample of 26,363 loan applications and 25,948 granted loans during the 2010:Q3–2014:Q2 period.

Firms are identified by a unique numerical code which allows tracking their activity over time and across banks. We observe applications from 8,679 firms and loans granted to 8,718 firms. For each borrower we also have information on their location (across 66 districts) and sector of activity (across 9 industries). However, we have no information on firm balance sheets. The distribution of loan applications and granted loans by industry is shown in Table 1.

Most firms have a lending relationship with just one bank. During the period of analysis, 83 percent of firms apply for a loan to only one bank, although they can do so multiple times. Thirteen percent of firms apply to two banks, and the rest to 3 banks or more. In the granted loans dataset, 87 percent of firms borrow from one bank and 10 percent from two banks. The prevalence of single firm-bank relationships has important implications for the identification strategy, as discussed further below.

[5] This limitation prevents us from estimating the effect of interest rates on loan supply using a two-stage selection model.

The micro-data are merged with bank balance sheet variables and macroeconomic time series (interest rates, GDP growth, inflation) on a monthly and quarterly basis. To examine real effects, we employ satellite data on night lights, available for Uganda on a monthly basis, which we aggregate at the district-quarter level. Variable definitions, sources, and descriptive statistics are shown in Tables 2 and 3.

4 Empirical strategy

A key challenge in identifying the bank lending channel is to disentangle credit demand from credit supply effects. In this section we discuss empirical strategies for doing so.

4.1 Extensive margin

Each month, banks report the status of loan applications received during the prior month. For each loan application, we know whether it was accepted (53.4 percent), rejected (10.2 percent), pending at the time of submission (36.2 percent), or cancelled by the borrower (0.2 percent). We analyze only the applications that were either accepted or rejected and define an indicator for applications submitted by firm i to bank b at time t that were accepted ($LOAN\ GRANTED_{ibt}$). The average acceptance rate during 2010-2014 is 84.6 percent.

To examine the link between monetary policy and the probability of loan granting—the extensive margin—we estimate a linear model that broadly follows Jiménez *et al.* (2012):

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

where $LOAN\ GRANTED_{ibt}$ takes value 1 if a loan application by firm i to bank b in quarter t was successful. In all baseline regressions we use the 7-day interbank rate as the short-term interest rate (IR_t). To account for the fact that macroeconomic conditions may drive short-term interest rates, we also add real GDP growth (ΔGDP_t) and inflation (ΔCPI_t) as controls.[6] In a first set of regressions, time-invariant firm and bank heterogeneity are captured by firm (η_i) and bank (ψ_b) fixed effects.

Then, we allow heterogeneity in bank balance sheets to influence the probability of loan granting by including the ratio of liquid assets to total deposits as a measure of bank liquidity

[6] In the Robustness section we show all results are robust to additionally controlling for the nominal exchange rate.

($LIQUIDITY_{b,t-1}$) and the ratio of total regulatory capital to risk-weighted assets as a measure of bank capital ($CAPITAL_{b,t-1}$). Each measure is lagged one quarter. Then, we allow for the effect of interest rates on the probability of loan granting to vary in the contractionary and expansionary phases by interacting the macro variables with indicators for the 2010:Q3-2011:Q4 and the 2012:Q1-2014:Q2 periods. In a last specification, we test for the possibility that the bank lending channel is stronger for worse capitalized and less liquid banks—that is, we test for a "bank balance sheet channel"—by interacting ΔIR_t with bank capital and liquidity, while controlling for similar interactions with GDP growth and inflation. When testing the bank balance sheet channel we can also add industry-district×year-quarter fixed effects to capture time-varying demand shocks that are common to all firms operating in the same industry and district. In that case, macroeconomic variables drop out but we can still estimate the coefficients on the interaction terms. In line with theory, we expect better capitalized banks to weaken the bank lending channel (Bernanke, 2007). Contrary to the case of advanced economies, in a developing country high holdings of liquid assets can indicate a preference for government securities over lending activities; therefore, we expect more liquid banks to strengthen the bank lending channel by cutting loans (and increasing securities holdings) more than do other banks—a "crowding-out effect" (Hauner, 2009).

We estimate Equation 1 with Ordinary Least Squares (OLS) and cluster the standard errors at the district level to allow for serial correlation within districts.[7]

4.2 Intensive margin and interest rate pass-through

For each granted loan we have information on volume, interest rate (level and type), maturity, and collateral. To separate demand from supply effects, we need to control for unobserved borrower×time heterogeneity where the borrower and time units are as granular as possible.[8] We run the intensive margin analysis at a higher level of aggregation than individual firms—namely, our borrowers are district-specific industries (loan volumes are added up across firms within each district-industry pair for a total of 290 pairs and the time unit is quarters). This assumes that demand shocks each quarter are common to all firms in a district-industry cluster.[9] We have two reasons for aggregating the data at the district-industry level: first, to include firm×quarter fixed effects we need to see multiple loans granted to the same firm within a

[7] One advantage of a linear probability model compared to a probit model is that the latter is unidentified if we include a large set of bank and firm fixed effects. Another advantage is the ease of interpretation of the interaction terms (Ai and Norton, 2003).

[8] For instance, borrowers are firms and the time unit are months in Jiménez *et al.* (2014) and Ongena *et al.* (2015).

[9] Acharya *et al.* (2014), De Haas and Van Horen (2013), and Kapan and Minoiu (2013) use a similar strategy to identify changes in the supply of international syndicated loans during the global financial crisis and the European sovereign crisis. Credit rationing at the individual firm level creates intensive margin adjustment at higher levels of aggregation, for instance the country-industry level.

quarter. However in our data almost half of the firms borrow only once per quarter, so adding firm×quarter fixed effects would significantly reduce sample size. Second, we notice that during the contractionary period, firms were more likely to be credit rationed than to receive smaller loans. Comparing the total number of borrowers and average loan size in the six quarters before and after July 2011, we find that the latter fell by 23 percent (from 244 to 187 million Ugandan shilling) while the former fell by 46 percent (from 4,602 to 2,502 firms).

To examine the link between the monetary policy stance and the volume of new credit—the intensive margin—we estimate the following specification:

$$\begin{aligned} ln(LOAN\ AMOUNT_{jbt}) = \psi_b + \phi_j + \alpha_1 \Delta IR_{t,t-z} + \beta_1 \Delta GDP_t + \gamma_1 \Delta CPI_t + \\ + \delta_1 LIQUIDITY_{b,t-1} + \delta_2 CAPITAL_{b,t-1} + \\ + \alpha_2 \Delta IR_{t,t-z} \times LIQUIDITY_{b,t-1} + \alpha_3 \Delta IR_{t,t-z} \times CAPITAL_{b,t-1} + \\ + \beta_2 \Delta GDP_t \times LIQUIDITY_{b,t-1} + \beta_3 \Delta GDP_t \times CAPITAL_{b,t-1} + \\ + \gamma_2 \Delta CPI_t \times LIQUIDITY_{b,t-1} + \gamma_3 \Delta CPI_t \times CAPITAL_{b,t-1} + \epsilon_{ibt} \end{aligned} \tag{2}$$

where $LOAN\ AMOUNT_{jbt}$ is the volume of credit granted to firms in district-industry j by bank b in quarter t. The main variable of interest is the change in the 7-day interbank rate ($\Delta IR_{t,t-z}$) over different time horizons ($z = 1,2$ quarters) which allow changes in short-term interest rates to affect bank credit with a lag. The coefficient α_1 is the interest rate elasticity of loan volume supplied by individual banks to firms within the same district-industry cluster.

To separate supply from demand effects, we include district-industry fixed effects ϕ_j, which assume that credit demand shocks are common to firms in each district-industry pair, but constant over time. We also include bank fixed effects (ψ_b). Then we augment the specification with macroeconomic and bank-level variables defined as in Equation 1. Finally, we interact $\Delta IR_{t,t-z}$ with bank capital and liquidity to test for the bank balance sheet channel. We examine differential effects (i.e., the coefficients of interest are α_2 and α_3) by adding industry-district×year-quarter fixed effects. In this last specification, identification of a credit supply effect hinges on the assumption that firms operating in the same district-industry cluster experience a common demand shock every quarter.

To examine the pass-through of the 7-day interbank rate to interest rates charged by banks on new loans, we estimate the specifications in Equation 2 but change the dependent variable to the average lending rate at the district-industry level. All regressions are estimated with OLS and standard errors are clustered at the district level.

4.3 Real effects

We test for real effects of the bank lending channel in Uganda using satellite data on night lights from the NOOA National Geophysical Data Center, which has been shown to predict well economic growth across countries (Henderson *et al.*, 2012) and regions (Hodler and Raschky, 2014). Elvidge *et al.* (2014) document that for Uganda night lights are positively and strongly correlated with population and GDP. The data are aggregated at the district-quarter level. We examine how monetary policy influences real activity depending on banking sector characteristics such as capital and liquidity. These measures are computed at the district level as averages of bank capital and liquidity across banks weighted by their market power. Market power is given by the share of local currency loans extended to firms in each district during the period of analysis.[10] We estimate a reduced-form specification as follows:

$$\begin{aligned} LIGHTS_{dt} = \psi_d + \tau_t + \delta_1 LIQUIDITY_{d,t-1} + \delta_2 CAPITAL_{d,t-1} + \\ + \alpha_2 IR_{t,t-z} \times LIQUIDITY_{d,t-1} + \alpha_3 IR_{t,t-z} \times CAPITAL_{d,t-1} + \\ + \beta_2 \Delta GDP_{t,t-z} \times LIQUIDITY_{b,t-1} + \beta_3 \Delta GDP_{t,t-z} \times CAPITAL_{b,t-1} + \\ + \gamma_2 \Delta CPI_{t,t-z} \times LIQUIDITY_{b,t-1} + \gamma_3 \Delta CPI_{t,t-z} \times CAPITAL_{b,t-1} + \epsilon_{dt} \end{aligned} \tag{3}$$

where $LIGHTS_{dt}$ is night-time luminosity in district d in quarter t and we allow monetary policy to have an effect on real economic activity after up to 4 quarters ($z = 1, 2, 3, 4$). The interest rate $IR_{t,t-z}$ enters the specification as the cumulative change in the interest rate over the past z quarters. For each district, the bank balance sheet variables are lagged one quarter, and their interactions with lagged GDP growth and inflation are included to avoid confounding effects. By adding district fixed effects in all specifications, we examine how the change in night lights within a district varies depending on monetary and banking sector conditions in that district. Similar to the loan supply equations, we expect $\alpha_2 < 0$ and $\alpha_3 > 0$, i.e., that the bank lending channel is stronger in districts with highly liquid banks and weaker in districts with well capitalized banks.

5 Results

5.1 Extensive margin

Table 4 reports the results for the extensive margin. We start with simple specifications that include bank and firm fixed effects. The coefficient estimates on ΔIR indicate that half a standard deviation increase in the 7-day interbank rate over a quarter (182 bps) reduces the probability

[10] The results are similar if we measure market power based on the number of bank branches located in each district.

of loan granting by between 0.7 and 1.4 percentage points (columns 1-3). These estimates are lower than those for advanced economies. For instance, Jiménez *et al.* (2012) show that a 100 basis point increase in the Spanish 3-month interbank rate (representing almost one standard deviation) raises the rejection rate on loan applications by 1.4 percentage points. Given the large differences in economic cycle amplitude between advanced and developing countries (Male, 2011), a significantly larger increase in interest rates is required in Uganda to achieve the same impact on loan rejection rates as in Spain.

In column 4 we test for an asymmetric effect by splicing the interest rate variable during the contraction and expansion periods. Higher interest rates are associated with higher loan rejection rates during the monetary contraction (i.e., before 2012:Q1) but the monetary expansion does not have a statistically significant effect on loan granting. This is consistent with studies of the asymmetric effects of monetary policy on US investment and output (Morgan, 1993). We believe two factors weighed down on loan origination during the expansionary period—high policy uncertainty surrounding the tightening episode and large non-performing bank loans (Figure A3).

In column 5 of Table 4 we include interaction terms of capital and liquidity with ΔIR to test the bank balance sheet channel. We find that the differential effect of a rise in the interbank rate by half a standard deviation (182 bps) over a quarter between a highly and a poorly capitalized bank (90th vs. 10th percentile) is 3.5 percentage points.[11] In other words, banks with high levels of capital pass on increases in interest rates to the supply of credit less than other banks. This result highlights an important role for capital in monetary policy transmission, consistent with the presence of an *external finance premium* for banks. By contrast, we observe that more liquid banks *amplify* the effect of interest rates ($\alpha_2 < 0$). Since a high liquidity ratio could indicate a bank's preference for investing in government bonds, an increase in interest rates raises the bank's demand for safe, high-return government assets, thus crowding out private sector lending.

5.2 Intensive margin

In Tables 5 and 6 we focus on the intensive margin of credit supply. We start by estimating Equation 2 and regress loan volumes on $\Delta IR_{t,t-z}$ where $z = 1, 2$ quarters. The results show that the 7-day interbank rate affects the quantity of loans both instantaneously and with a lag, but the estimates are more precisely estimated when we allow for a deeper lag ($z = 2$). Depending on the specification, the coefficient on ΔIR_{t-2} in Table 6 indicates that half a standard deviation

[11] The 90th and 10th percentiles of the capital ratio distribution are 34 and 15 percent, therefore the differential effect is computed as $182 \times (34 - 15) \times 0.0010 = 3.5$.

increase in the interest rate over 2 quarters (i.e., 322 bps) reduces bank credit by between 5.1 and 10.1 percent (columns 1-3). In column 4 we allow for distinct effects during the contractionary and expansionary periods, and find negative and statistically significant coefficients for both subperiods, but of larger magnitude in the contractionary period (p-value=0.017).

In addition, our results lend support to a strong bank balance sheet channel. This channel is identified in a specification with a comprehensive set of industry-district×quarter fixed effects, which allows all firms within the same industry-district cluster to receive a time-varying credit demand shock (Table 6, column 5). Similar to the extensive margin regressions, the estimates here suggest higher capital dampens the transmission of interest rates changes to credit supply and higher liquidity enhances it. Half a standard deviation increase in interest rates over two quarters (322 bps) leads high-capital banks (at the 90th percentile) to reduce the volume of new loans by 23.8 percent more than do low-capital banks (at the 10th percentile).[12]

5.3 Lending rates

Next we quantify the pass-through of changes in the monetary policy stance to lending rates on new loans. We estimate the same set of specifications as in the previous section, but we replace the dependent variable with average interest rates across loans to firms in a given district-specific industry. The results for $z = 1, 2$ lags are shown in Tables 7 and 8. In Table 7, the coefficient estimates on ΔIR_t indicate that a 100 bps increase in the 7-day interbank rate is associated with an increase in the lending rate of between 33 and 49 bps (columns 1-3). The latter coefficient is not statistically different from 50 bps, indicating a pass-through of almost 50 percent. Differential effects of short-term interest rate changes on lending rates for high/low capital and liquidity banks are present in all specifications. For instance, the coefficient magnitudes indicate that high-capital banks charge 82 bps less than do low-capital banks (at the 90th vs. 10th percentile of the capital distribution) for an increase of half a standard deviation in interest rates over one quarter (Table 7, column 5).[13] By contrast, more liquid banks pass through the increase in 7-day interbank rate less than do banks with lower liquidity ratios.

These results provide new evidence on the transmission of monetary policy to retail lending rates in developing countries. Mishra *et al.* (2014) employ structural vector panel autoregressive (VAR) techniques in a sample of 132 countries during 1978-2013 and find that there is significant heterogeneity in interest rate pass-through of monetary policy innovations to lending rates. This heterogeneity can be explained by country characteristics such as contractual enforcement, concentration of the banking system, and development of financial markets.

[12] $322 \times (34 - 15) \times 0.0039 = 23.8$.
[13] $182 \times (34 - 15) \times 0.0239 = 82.6$.

The correlation between policy rates and lending rates in the long run is 0.29 for developing countries compared to 0.35 for advanced economies. In a large sample of countries over 2003-2008 Saborowski and Weber (2013) find an average interest rate elasticity of 0.52. Advanced and G20 economies exhibit almost full pass-through, followed by South American and East Asian countries with 50 percent, and Eastern Europe, Middle East and North Africa, and sub-Saharan Africa with 40 percent. An important distinction from earlier studies is that our lending rate is calculated directly from micro data on loan originations. Thus, we work with the marginal lending rate, whereas previous work uses the average lending rate on existing loan *claims* (from the International Financial Statistics), which adjusts more slowly to changes in monetary conditions.

5.4 Real effects

Our results so far provide evidence for a bank lending channel in Uganda. To further examine the potency of this channel, we analyze whether in addition to the quantity and price of bank credit, monetary policy also affects real economic outcomes. Doing so is challenging given that we do not have balance sheet information for individual borrowers in the credit register files, and due to confidentiality concerns, it is not possible to match them to existing firm-level surveys. To overcome this limitation, we conduct the analysis at a lower granularity level—the district rather than the firm—and therefore need a district-level measure of economic activity. A key requirement is for the measure to be a good proxy for GDP growth. As shown by Henderson *et al.* (2012), satellite night lights track well short-term fluctuations in growth and have the advantage of capturing informal economic activity which often eschews formal GDP measurement. We use geo-coded satellite data on night lights for Uganda on a monthly basis, which we average at the quarterly level to remove short-term fluctuations that may be influenced by weather patterns and other sources of measurement error.

Figure 6 depicts differences in luminosity across districts in 2010 (while credit was booming and the economy was showing signs of overheating), 2011 (when the monetary contraction took place), and 2012 (when the monetary expansion set in). These maps confirm our priors that the monetary tightening was effective at reducing economic activity, and that the loosening had a (limited) boosting effect. In the regression analysis, we exploit variation in bank capital and liquidity across districts to examine differential effects of interest rate changes on night lights depending on banking sector conditions in those districts. The results from estimating the reduced-form Equation 3 for a panel of 66 districts are reported in Table 9. As a robustness check, in the last four specifications we exclude from the sample Kampala, the main commercial and manufacturing hub. We allow for real effects to be statistically discernible after 1-4 quarters.

The results in Table 9 consistently support the presence of a bank balance sheet channel with a lag of about 3-4 quarters. Higher interest rates affect economic activity less in high-capital districts and do so more in high-liquidity districts (columns 3-4, 7-8). The coefficients are more precisely estimated when Kampala is excluded from the sample (columns 5-8). The coefficient estimates in column 7 indicate that for an increase of half a standard deviation in the interest rate over three quarters (about 400 bps) is associated with night lights in high-capital districts (90th percentile) that are higher by 0.142 units than in low-capital districts (10th percentile). This coefficient represents almost one tenth of a standard deviation of the lights distribution.

6 Robustness tests

We subject our baseline results to a number of robustness tests. Specifically, we replicate our baseline results: 1) using three alternative interest rates: the policy rate introduced in July 2011, the 91-day T-bill rate, and the discount rate at which banks access emergency funds from the Bank of Uganda; 2) making different assumptions about the correlation structure of the errors, allowing for clustering at the industry, quarter, and respectively the industry-district level; and 3) controlling for changes in the nominal exchange rate. Our results are robust to all sensitivity tests (see regression tables in the Online Appendix).

7 Conclusions

The question of how monetary policy influences credit aggregates and the real economy is of central concern to policymakers, especially in countries where the transmission of monetary policy may be impaired by structural factors. The literature suggests that the bank lending channel is weaker in developing economies than in advanced economies, but there is some debate on precisely by how much. In this paper, we bring to the debate the first piece of systematic evidence based on micro-data, drawing on a unique loan-level dataset from Uganda. We examine the 2010-2014 period, when the introduction of a new monetary policy framework was followed by large swings in interest rates. We supplement our rich loan-level data with satellite data on night lights, a granular measure of economic activity at the district level. The resulting dataset allows us to identify the loan supply *and* real effects of the domestic bank lending channel in a developing African economy.

We document economically meaningful adjustment on both the extensive and intensive margins of credit supply, and on retail lending rates, following changes in monetary policy. As expected, the bank lending channel is weaker (by about 50 percent) than it is in advanced economies. The data also reveal a strong bank balance sheet channel, as high-capital banks transmit interest rate changes less than do other banks to the probability of loan granting, to new loan volumes, and to retail lending rates. The reverse is true for bank liquidity: highly-liquid banks pass through interest rates changes to the quantity and price of credit more than low-liquidity banks, so high liquidity has a crowding out effect on loans. The same differential effects are present at the district level, where we find that, for a given increase in interest rates, nighttime luminosity is higher in high-capital and low-liquidity districts than elsewhere.

Our results are a first step toward better understanding the transmission of monetary policy to credit aggregates and real economic growth in developing countries using micro-data. As credit registers are established in more countries, they offer a unique opportunity to move away from aggregate time-series analyses of monetary policy, for which identification remains a major challenge, and to shed light on the effectiveness of macroeconomic policies in these countries.

References

Acharya, V. V., Esiert, T., Eufinger, C. and Hirsch, C. W. (2014). *Real effects of the sovereign debt crisis in Europe: Evidence from syndicated loans*. Discussion Paper 10108, CEPR.

Ai, C. and Norton, E. C. (2003). Interaction terms in logit and probit models. *Economics Letters*, **80** (1), 123–129.

Berg, A., Charry, L., Portillo, R. and Vlcek, J. (2013). *The monetary transmission mechanism in the tropics: A narrative approach*. IMF Working Paper 13/197, International Monetary Fund, Washington, DC.

Bernanke, B. (2007). The financial accelerator and the credit channel. Speech delivered at the Board of Governors of the US Federal System, Washington DC, June 15.

— and Blinder, A. (1988). Money, credit, and aggregate demand. *American Economic Review*, **82**, 901–921.

— and Gertler, M. (1989). Inside the black box: The credit channel of monetary policy transmission. *American Economic Review*, **79** (1), 14–31.

— and — (1995). Agency costs, net worth, and business fluctuations. *Journal of Economic Perspectives*, **9** (4), 27–48.

Bernardo, M., Peydro, J. and Ruiz, C. (2015). The international bank lending channel of monetary policy rates and QE: Credit supply, reach-for-yield, and real effects, FRB International Finance Discussion Paper No. 1137.

BOTTERO, M., LENZU, S. and MEZZANOTTI, F. (2015). *Sovereign debt exposure and the bank lending channel: Impact on credit supply and the real economy*. Working Papers 1032, Bank of Italy, Rome.

BROWN, M. and DE HAAS, R. (2012). Foreign banks and foreign currency lending in emerging europe. *Economic Policy*, **27** (69), 57–98.

BULIR, A. and VLCEK, J. (forthcoming). *Monetary transmission: Are emerging market and low-income countries different?* IMF Working Paper 15/XX, Washington, DC: International Monetary Fund.

CHRISTIENSEN, B. V. (2014). *Financial integration in Africa: Implications for monetary policy and financial stability*. BIS Papers 76, Bank of International Settlements.

CINGANO, F., MANARESI, F. and SETTE, E. (2013). *Does credit crunch investments down? New evidence on the real effects of the bank-lending channel*. MoFiR Working Paper No. 91 91, MoFiR.

DAVOODI, H., DIXIT, S. and PINTER, G. (2013). *Monetary transmission mechanism in the East African Community: An empirical investigation*. IMF Working Paper 13/39, Washington, DC: International Monetary Fund.

DE HAAS, R. and VAN HOREN, N. (2013). Running for the Exit? International Bank Lending During a Financial Crisis. *Review of Financial Studies*, **26** (1), 244–285.

ELVIDGE, C. D., HSU, F.-C., BAUGH, K. E. and GHOSH, T. (2014). National Trends in Satellite-Observed Lighting: 1992-2012. In Q. Weng (ed.), *Global Urban Monitoring and Assessment through Earth Observation*, *6*, CRC Press, pp. 97–120.

FINSCOPE (2013). *Uganda 2013 FinScope III Survey Report Findings*. Unlocking barriers to financial inclusion, Washington, DC: International Monetary Fund.

GFDD (2011). *Global Financial Development Database*. Available on: http://data.worldbank.org/data-catalog/global-financial-development, Washington, DC: The World Bank Group.

HAUNER, D. (2009). Public debt and financial development. *Journal of Development Economics*, **88** (1), 171–183.

HENDERSON, J. V., STOREYGARD, A. and WEIL, D. N. (2012). Measuring economic growth from outer space. *American Economic Review*, **102** (2), 994–1028.

HODLER, R. and RASCHKY, P. A. (2014). Regional favoritism. *Quarterly Journal of Economics*, **129** (2), 995–1033.

INTERNATIONAL MONETARY FUND (2008). *Regional Economic Outlook: Sub-Saharan Africa*.

Chapter II, Monetary and Exchange Rate Policies in Sub-Saharan Africa, International Monetary Fund, Washington, DC.

INTERNATIONAL MONETARY FUND (2011). *Uganda: Second Review Under the Policy Support Instrument and Request for Waiver of Assessment Criteria—Staff Report*. IMF Country Report 11/308, International Monetary Fund, Washington, DC.

INTERNATIONAL MONETARY FUND (2012). *Uganda: Third Review Under the Policy Support Instrument, Request for Waiver of Nonobservance of an Assessment Criterion, and Request for Modification of Assessment Criteria—Staff Report*. IMF Country Report 12/125, International Monetary Fund, Washington, DC.

INTERNATIONAL MONETARY FUND (2015). *Uganda: Staff Report for the 2015 Article IV Consultation and the Fourth Review Under the Policy Support Instrument*. IMF Country Report 15/175, International Monetary Fund, Washington, DC.

JIMÉNEZ, G., ONGENA, S., PEYDRÓ, J. and SAURINA, J. (2012). Credit supply and monetary policy: Identifying the bank-balance sheet channel with loan applications. *American Economic Review*, **102** (5), 2121–2165.

—, —, — and SAURINA, J. (2014). Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk? *Econometrica*, **2** (82), 463–505.

KAPAN, T. and MINOIU, C. (2013). *Bank balance sheet strength and bank lending during the global financial crisis*. IMF Working Paper 13/102, International Monetary Fund, Washington DC.

KASEKENDE, L. and BROWNBRIDGE, M. (2011). Post-crisis Monetary Policy Frameworks in sub-Saharan Africa. *African Development Review*, **23** (2), 190–201.

KHAN, M. S. (2011). The Design and Effects of Monetary Policy in Sub-Saharan Africa. *Journal of African Economies*, **20** (AERC Supplement 2), ii16–ii35.

MALE, R. (2011). Developing country business cycles: Characterizing the cycle. *Emerging Markets Finance and Trade*, **47** (sup2), 20–39.

MISHRA, P. and MONTIEL, P. (2013). How Effective Is Monetary Transmission in Developing Countries? A Survey of the Empirical Evidence. *Economic Systems*, **37** (2), 187–216.

—, —, PEDRONI, P. and SPILIMBERGO, A. (2014). Monetary policy and bank lending rates in low-income countries: Heterogenous panel estimates. *Journal of Development Economics*, **111**, 117–131.

—, — and SPILIMBERGO, A. (2012). Monetary transmission in low-income countries: Effectiveness and policy implications. *IMF Economic Review*, **60**, 270–302.

MORGAN, D. P. (1993). Asymmetric effects of monetary policy. *Economic Review-Federal Reserve*

Bank of Kansas City, **78**, 21–21.

MUGUME, A. (2010). Commodity price volatility, commodity exports and Uganda's growth. *Bank of Uganda Journal*, **4** (1), 109–143.

ONGENA, S., SCHINDELE, I. and VONNAK, D. (2015). *In Lands of Foreign Currency Credit, Bank Lending Channels Run Through?* CFS Working Paper 474, Center for Financial Studies.

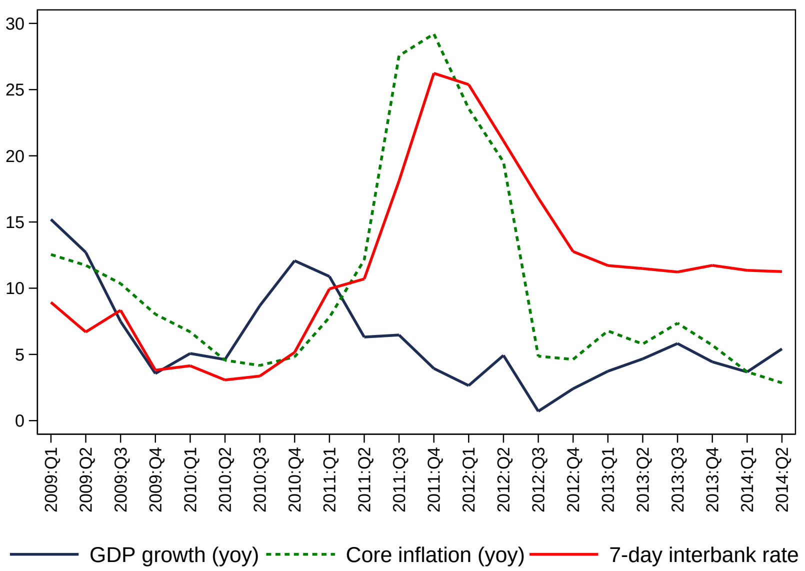
SABOROWSKI, C. and WEBER, S. (2013). *Assessing the Determinants of Interest Rate Transmission Through Conditional Impulse Response Functions*. IMF Working Paper 13/23, International Monetary Fund, Washington, DC.

SAXEGAARD, M. (2009). *Excess Liquidity and Effectiveness of Monetary Policy: Evidence from Sub-Saharan Africa*. IMF Working Paper 06/115, Washington, DC: International Monetary Fund.

VAN DEN HEUVEL, S. (2012). Banking conditions and the effects of monetary policy: Evidence from US states. *B.E. Journal of Macroeconomics (Advances)*, **12** (2), Article 5.

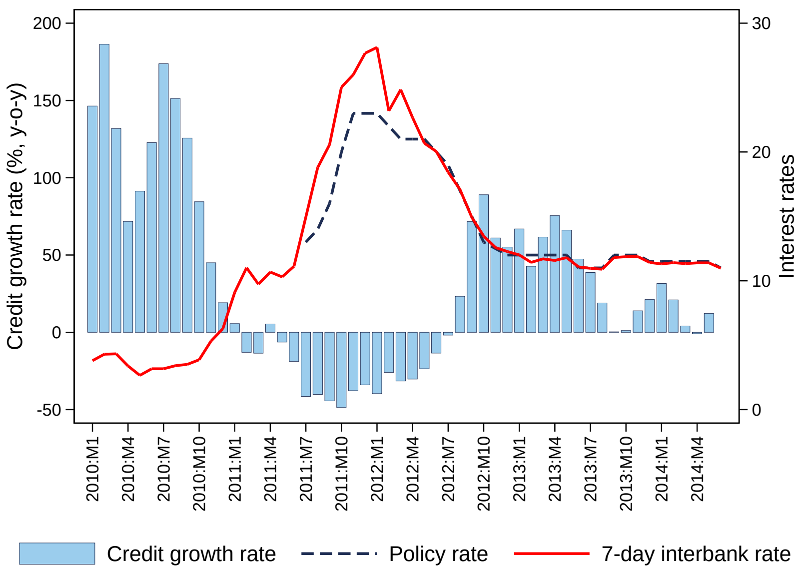
Figures and tables

Figure 1: Macroeconomic developments in Uganda: 2009-2014



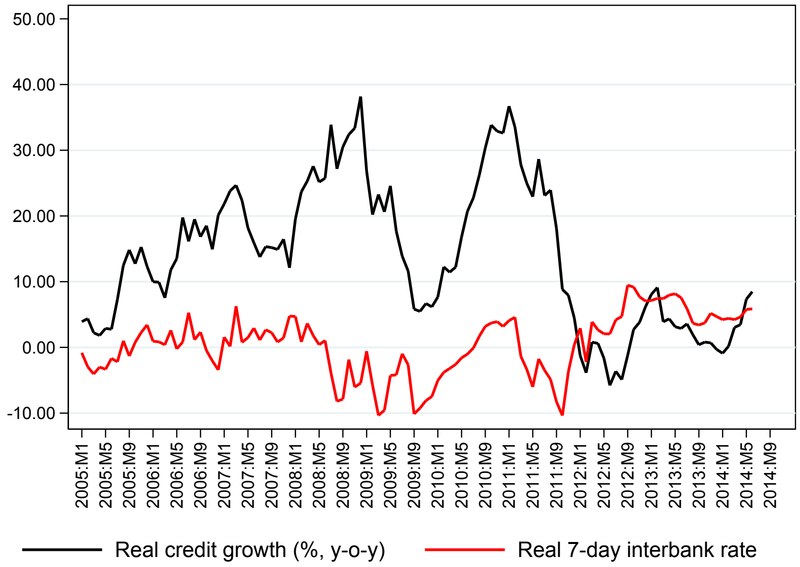
Data sources: Bank of Uganda and Uganda Bureau of Statistics.

Figure 2: Monetary conditions and credit growth: 2010-2014



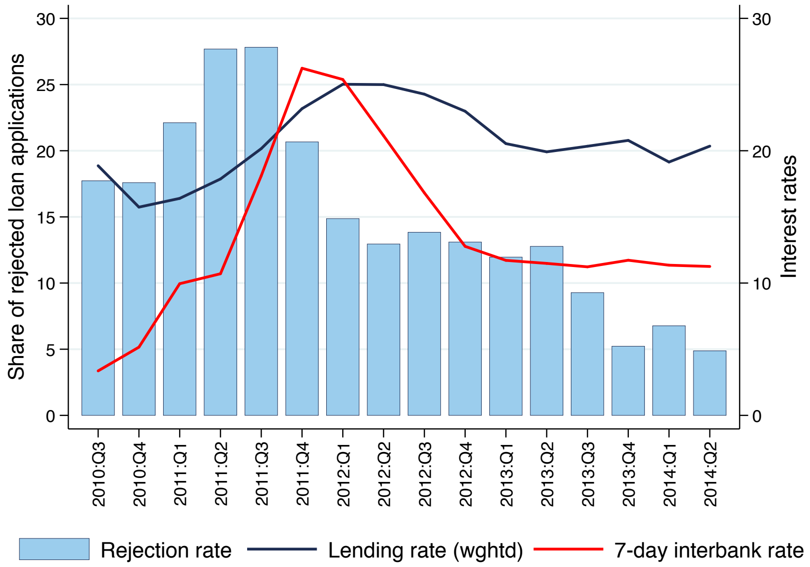
Data sources: Bank of Uganda and International Financial Statistics (IFS).

Figure 3: Real credit growth and monetary policy stance, 2005-2014



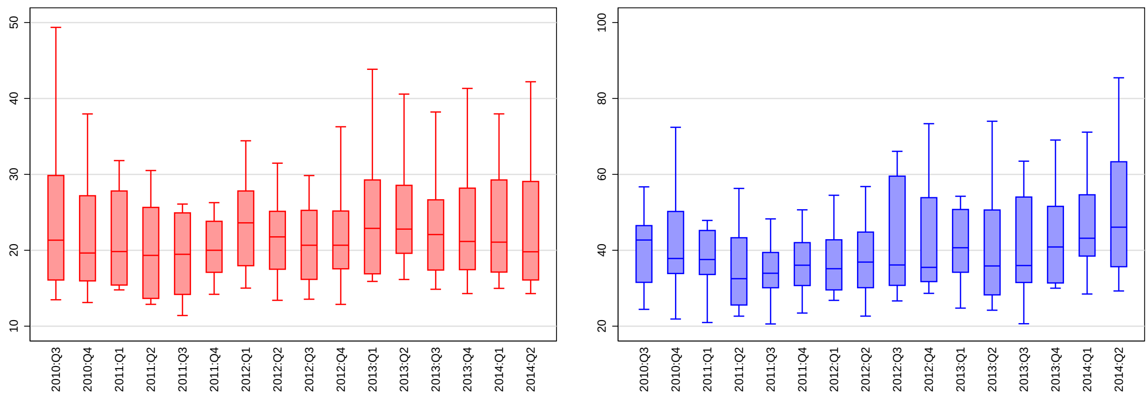
Data sources: Bank of Uganda and International Monetary Fund.

Figure 4: Monetary conditions, loan rejection rate, and lending rate: 2010-2014



Data sources: Bank of Uganda and Compuscan Uganda CRB Ltd.

Figure 5: Bank capital and liquidity: 2010-2014

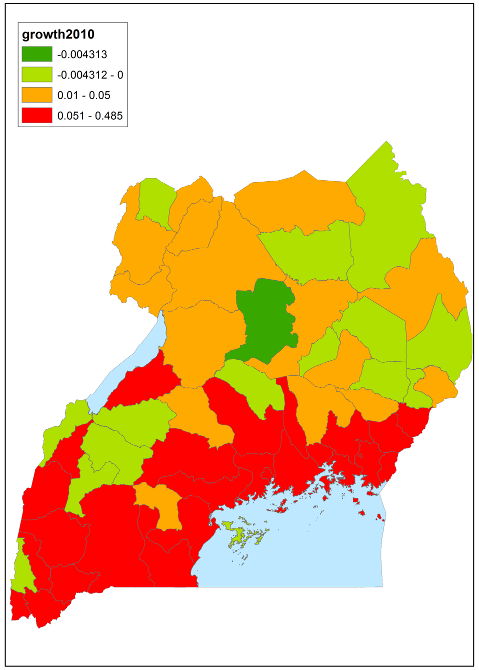


(a) Bank capital

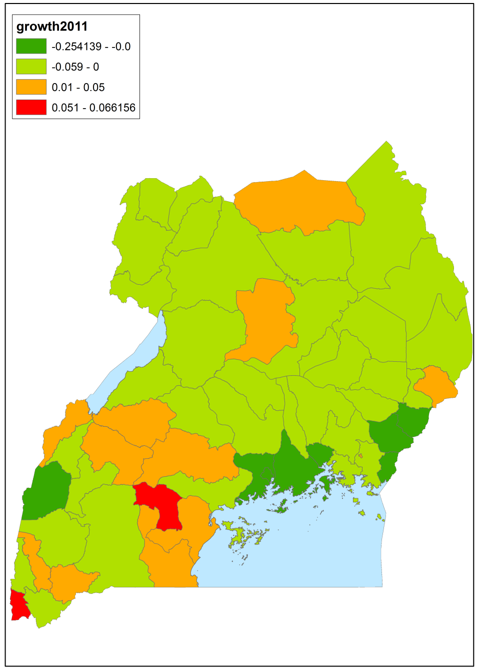
(b) Bank liquidity

Notes: Bank capital is the ratio of total regulatory capital (Tier 1 + Tier 2) to total risk-weighted assets. Bank liquidity is the ratio of liquid assets to total deposits. The data refer to the sample of 15 banks. *Data sources*: Bank of Uganda.

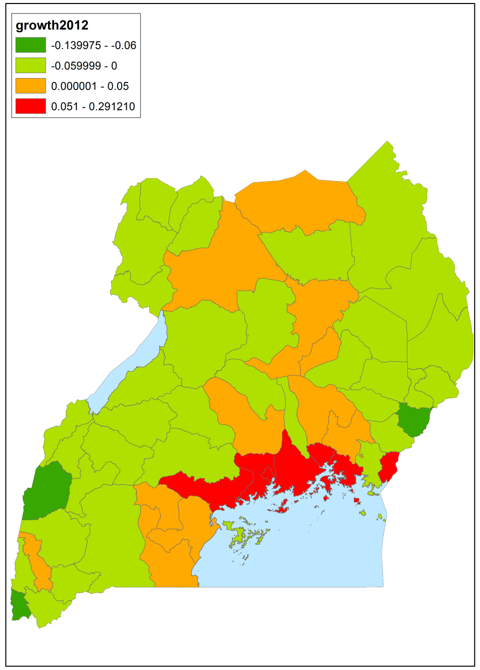
Figure 6: Maps of district-level nightlights intensity



(a) 2010



(b) 2011



(c) 2012

Notes: The figure depicts satellite data on nigh lights, yearly, during 2010-2012. Color coding ranges between red (highest luminosity) and green (lowest luminosity). *Data sources*: NOOA National Geophysical Data Center.

Table 1: Industry composition of borrowers

Panel A: Distribution of loans by borrower industry

	Loan applications		Granted loans	
Industry	#	%	#	%
Agriculture	2,560	9.71	3,340	12.87
Mining and Quarrying	354	1.34	270	1.04
Manufacturing	1,344	5.1	2,713	10.46
Trade	4,595	17.43	4,779	18.42
Transport and Communication	3,142	11.92	1,965	7.57
Electricity and Water	86	0	133	0.51
Building, Construction and Real Estate	2,660	10.09	3,443	13.27
Community, Social and Other Services	3,573	13.55	1,859	7.16
Central and Local Government	1,029	3.9	312	1.2
Other	7,020	26.63	7,134	27.49
Total	26,363	100	25,948	100

Panel B: Distribution of borrowers by industry

	Applicant firms		Borrowing firms	
Industry	#	%	#	%
Agriculture	697	8.03	917	10.52
Mining and Quarrying	101	1.16	46	0.53
Manufacturing	354	4.08	454	5.21
Trade	1,320	15.21	1,177	13.5
Transport and Communication	1,157	13.33	568	6.52
Electricity and Water	32	0.37	35	0.4
Building, Construction and Real Estate	790	9.10	645	7.4
Community, Social and Other Services	1,029	11.86	608	6.97
Central and Local Government	385	4.44	136	1.56
Other	2,814	32.42	4,132	47.4
Total	8,679	100	8,718	100

Data sources: Compuscan Uganda CRB Ltd.

Table 2: Variables: definitions and sources

Variable	Description	Source
Macroeconomic data		
IR (7-day interbank rate)	Interest rate on interbank market with maturity of 7 days	Bank of Uganda
91-day T-bill rate	Interest rate on government securities with a maturity of 91 days.	Bank of Uganda
Discount rate	Rate at which banks can borrow from the Bank of Uganda against eligible collateral.	International Finance Statistics (IFS)
Overnight interbank rate	Rate at which banks borrow and lend in the overnight interbank market	International Finance Statistics (IFS)
Policy rate	Bank of Uganda policy rate (central bank rate or CBR) introduced in July 2011 together with an inflation targeting lite framework.	International Finance Statistics (IFS)
ΔGDP_t	Real GDP growth (q-o-q)	Bank of Uganda
ΔCPI_t	CPI growth (q-o-q)	Bank of Uganda
LIGHTS	Night time luminosity or night lights intensity calculated from satellite images on a monthly basis. Images are taken in the evenings, for a global grid in 30 arc seconds resolution; this grid cell size is approximately a square kilometer at the equator. Nighttime lights are measured on a 0-63 scale.	National Geophysical Data Center at the National Oceanic and Atmospheric Administration
BANK BRANCHES	Number of bank branches by district.	Author's calculations based on Bank of Uganda data
contraction	Dummy variable equal to 1 for the period 2010:Q3-2011:Q4, and 0 otherwise.	Author's calculations
expansion	Dummy variable equal to 1 for the period 2012:Q1-2014:Q2, and 0 otherwise.	Author's calculations
Bank balance sheet data		
LIQUIDITY	Liquid assets to total deposits	Bank of Uganda
CAPITAL	Total regulatory capital divided by risk weighted assets	Bank of Uganda
Credit register data		
LOAN GRANTED	Dummy variable that takes value 1 for loan applications that have been accepted and zero if the application have been rejected. Loan application status can be: accepted, rejected, pending, and cancelled by borrower. Pending and canceled applications are not considered.	Compuscan Uganda CRB Ltd.
LOAN AMOUNT	Total loan amount for granted loans	Compuscan Uganda CRB Ltd.
LENDING RATE	Average interest rate on loans granted	Compuscan Uganda CRB Ltd.
BORROWER DISTRICT	Borrower district of location. There are 66 districts.	Compuscan Uganda CRB Ltd.
BORROWER INDUSTRY	Borrower sector of activity. There are 9 sectors: Agriculture, Mining and Quarrying, Manufacturing, Trade, Transport & communication, Electricity and Water, Building, Construction and Real Estate, Community, Social, and Other Services; and Institutional Sector.	Compuscan Uganda CRB Ltd.

Table 3: Descriptive statistics

Variable	Obs.	Mean	S.D.	Min	p25	p50	p75	Max
Macroeconomic data								
IR_t (7-day interbank rate)	16	13.65	6.39	3.36	10.96	11.6	17.46	26.23
ΔIR_t	16	0.51	3.64	-4.31	-0.95	-0.16	1.27	8.13
$\Delta^2 IR_t$	16	0.96	6.44	-8.57	-3.19	-0.17	6.07	15.53
Policy rate	12	14.85	4.37	11.33	11.58	12.25	18.83	22
91-day T-bill rate	16	11.06	4.11	4.6	8.99	9.45	13.89	19.49
Discount rate	16	17.54	5.54	8.68	15.07	15.75	20.5	28
ΔGDP_t	16	1.32	1.62	-1.74	0.3	1.12	2.28	4.4
$\Delta^2 GDP_t$	16	2.62	2.21	-0.65	0.81	2.54	3.62	7.01
ΔCPI_t	16	2.55	3.31	-0.94	1.02	1.36	3.23	12.29
$\Delta^2 CPI_t$	16	5.25	5.05	0.49	1.65	3.57	7.95	16.98
$LIGHTS$ (including Kampala)	1122	5.01	5.53	0.30	3.72	4.20	4.71	55.33
$LIGHTS$ (excluding Kampala)	1105	4.36	1.61	0.30	3.72	4.19	4.69	15.69
Bank balance sheet data								
$LIQUIDITY$	772	42.13	26.46	0.00	29.21	40.41	57.19	129.71
$CAPITAL$	772	24.88	11.23	11.67	17.04	22.06	28.67	78.00
Credit register data								
$LOAN\ GRANTED$	19063	0.84	0.37	0	1	1	1	1
$LOAN\ AMOUNT$ (all loans)	25268	0.2	0.87	0	0.01	0.03	0.10	29.89
$LOAN\ AMOUNT$ (by district-industry, log)	3633	18.5	2.35	6.06	16.95	18.4	20.07	25.09
$LENDING\ RATE$ (all loans)	18944	25.2	7.57	1	21.00	24.00	29.00	255
$LENDING\ RATE$ (by district-industry)	3401	24.77	6.43	1	21.00	24.00	28.00	98
$\Delta LENDING\ RATE$ (by district-industry)	1545	-0.08	6.85	-81	-2	0	2.03	73.33

Notes: The period of analysis is 2010:Q3–2014:Q2. Macroeconomic and bank balance sheet data are measured on a quarterly basis. Loans amount ($LOAN\ AMOUNT$) is expressed in real terms using the Uganda CPI (January 2010=100). See Table 2 for variable definitions.

Table 4: Extensive margin of credit supply and monetary conditions

Dep. Var.: $LOAN\ GRANTED_{ibt}$	(1)	(2)	(3)	(4)	(5)
ΔIR_t	-0.0076***	-0.0060***	-0.0041***		
	(0.001)	(0.001)	(0.001)		
ΔGDP_t		0.0097***	0.0084***		
		(0.002)	(0.002)		
ΔCPI_t		-0.0051***	-0.0026**		
		(0.002)	(0.001)		
$LIQUIDITY_{b,t-1}$			0.0036***	0.0036***	0.0041***
			(0.001)	(0.001)	(0.000)
$CAPITAL_{b,t-1}$			0.0077***	0.0070***	0.0045***
			(0.002)	(0.002)	(0.001)
$\Delta IR_t \times contraction$				-0.0041**	
				(0.002)	
$\Delta IR_t \times expansion$				-0.0015	
				(0.001)	
$\Delta GDP_t \times contraction$				0.0103***	
				(0.003)	
$\Delta GDP_t \times expansion$				0.0062*	
				(0.004)	
$\Delta CPI_t \times contraction$				-0.0039**	
				(0.002)	
$\Delta CPI_t \times expansion$				0.0029*	
				(0.002)	
$\Delta IR_t \times LIQUIDITY_{b,t-1}$					-0.0003***
					(0.000)
$\Delta IR_t \times CAPITAL_{b,t-1}$					0.0010***
					(0.000)
$\Delta GDP_t \times LIQUIDITY_{b,t-1}$					-0.0003
					(0.000)
$\Delta GDP_t \times CAPITAL_{b,t-1}$					-0.0021***
					(0.000)
$\Delta CPI_t \times LIQUIDITY_{b,t-1}$					0.0003***
					(0.000)
$\Delta CPI_t \times CAPITAL_{b,t-1}$					0.0004
					(0.000)
Observations	13,826	13,826	13,826	13,826	15,763
R^2	0.403	0.405	0.410	0.411	0.274
Firm FE	Yes	Yes	Yes	Yes	No
Bank FE	Yes	Yes	Yes	Yes	Yes
Industry-district × year-quarter FE	No	No	No	No	Yes

Notes: The dependent variable is an indicator for successful loan applications of firm i at bank b at time t. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Intensive margin of credit supply and monetary conditions, contemporaneous effect

Dep. Var.: $LOAN\ AMOUNT_{jbt}$	(1)	(2)	(3)	(4)	(5)
ΔIR_t	-0.0072	-0.0209**	-0.0120		
	(0.006)	(0.010)	(0.009)		
ΔGDP_t		0.1152***	0.1054***		
		(0.024)	(0.022)		
ΔCPI_t		0.0064	0.0159		
		(0.013)	(0.014)		
$LIQUIDITY_{b,t-1}$			0.0157***	0.0162***	0.0246***
			(0.004)	(0.004)	(0.008)
$CAPITAL_{b,t-1}$			0.0354***	0.0345**	0.0092
			(0.013)	(0.014)	(0.020)
$\Delta IR_t \times contraction$				-0.0387**	
				(0.016)	
$\Delta IR_t \times expansion$				0.0080	
				(0.014)	
$\Delta GDP_t \times contraction$				0.1111***	
				(0.019)	
$\Delta GDP_t \times expansion$				0.0484	
				(0.052)	
$\Delta CPI_t \times contraction$				0.0218	
				(0.016)	
$\Delta CPI_t \times expansion$				-0.0031	
				(0.018)	
$\Delta IR_t \times LIQUIDITY_{b,t-1}$					0.0011
					(0.001)
$\Delta IR_t \times CAPITAL_{b,t-1}$					0.0051**
					(0.002)
$\Delta GDP_t \times LIQUIDITY_{b,t-1}$					-0.0052**
					(0.002)
$\Delta GDP_t \times CAPITAL_{b,t-1}$					0.0014
					(0.002)
$\Delta CPI_t \times LIQUIDITY_{b,t-1}$					-0.0015
					(0.002)
$\Delta CPI_t \times CAPITAL_{b,t-1}$					-0.0003
					(0.001)
Observations	3,563	3,563	3,563	3,563	2,652
R^2	0.417	0.422	0.428	0.429	0.527
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	No
Industry-district × year-quarter FE	No	No	No	No	Yes

Notes: The dependent variable is the total loan amount granted to borrowers in district-specific industry j by bank b at time (quarter) t. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Intensive margin of credit supply and monetary conditions, lagged effect

Dep. Var.: $LOAN\ AMOUNT_{jbt}$	(1)	(2)	(3)	(4)	(5)
$\Delta^2 IR_t$	-0.0158***	-0.0314***	-0.0223***		
	(0.003)	(0.006)	(0.008)		
$\Delta^2 GDP_t$		0.0821***	0.0684***		
		(0.021)	(0.020)		
$\Delta^2 CPI_t$		0.0180*	0.0167**		
		(0.009)	(0.008)		
$LIQUIDITY_{b,t-2}$			0.0174***	0.0162***	0.0015
			(0.004)	(0.005)	(0.008)
$CAPITAL_{b,t-2}$			0.0473***	0.0477***	0.0268
			(0.010)	(0.013)	(0.031)
$\Delta^2 IR_t \times contraction$				-0.0598***	
				(0.018)	
$\Delta^2 IR_t \times expansion$				-0.0162***	
				(0.006)	
$\Delta^2 GDP_t \times contraction$				0.0696**	
				(0.027)	
$\Delta^2 GDP_t \times expansion$				0.0381	
				(0.055)	
$\Delta^2 CPI_t \times contraction$				0.0376**	
				(0.016)	
$\Delta^2 CPI_t \times expansion$				0.0049	
				(0.033)	
$\Delta^2 IR_t \times LIQUIDITY_{b,t-2}$					-0.0022***
					(0.001)
$\Delta^2 IR_t \times CAPITAL_{b,t-2}$					0.0039***
					(0.001)
$\Delta^2 GDP_t \times LIQUIDITY_{b,t-2}$					0.0004
					(0.001)
$\Delta^2 GDP_t \times CAPITAL_{b,t-2}$					0.0015
					(0.002)
$\Delta^2 CPI_t \times LIQUIDITY_{b,t-2}$					0.0027***
					(0.001)
$\Delta^2 CPI_t \times CAPITAL_{b,t-2}$					-0.0022
					(0.002)
Observations	3,563	3,563	3,563	3,563	2,652
R-squared	0.418	0.423	0.431	0.433	0.529
Bank FE	Yes	Yes	Yes	Yes	Yes
Sector-district FE	Yes	Yes	Yes	Yes	No
Industry-district × year-quarter FE	No	No	No	No	Yes

Notes: The dependent variable is the total loan amount granted to borrowers in district-specific industry j by bank b at time (quarter) t. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Interest rate pass-through, contemporaneous effect

Dep. Var.: $\Delta LENDING\ RATE_{jbt}$	(1)	(2)	(3)	(4)	(5)
ΔIR_t	0.3343***	0.4877***	0.4722***		
	(0.035)	(0.039)	(0.039)		
ΔGDP_t		-0.4024***	-0.3401***		
		(0.103)	(0.113)		
ΔCPI_t		-0.2059***	-0.2477***		
		(0.055)	(0.065)		
$LIQUIDITY_{b,t-1}$			-0.0845***	-0.0843***	-0.1057***
			(0.018)	(0.019)	(0.017)
$CAPITAL_{b,t-1}$			-0.0117	-0.0228	0.0380
			(0.044)	(0.064)	(0.055)
$\Delta IR_t \times contraction$				0.5037***	
				(0.082)	
$\Delta IR_t \times expansion$				0.5250***	
				(0.105)	
$\Delta GDP_t \times contraction$				-0.3268***	
				(0.104)	
$\Delta GDP_t \times expansion$				-0.2744	
				(0.288)	
$\Delta CPI_t \times contraction$				-0.2793***	
				(0.047)	
$\Delta CPI_t \times expansion$				-0.1138	
				(0.092)	
$\Delta IR_t \times LIQUIDITY_{b,t-1}$					0.0239***
					(0.005)
$\Delta IR_t \times CAPITAL_{b,t-1}$					-0.0343***
					(0.008)
$\Delta GDP_t \times LIQUIDITY_{b,t-1}$					-0.0001
					(0.006)
$\Delta GDP_t \times CAPITAL_{b,t-1}$					0.0421***
					(0.008)
$\Delta CPI_t \times LIQUIDITY_{b,t-1}$					-0.0003
					(0.008)
$\Delta CPI_t \times CAPITAL_{b,t-1}$					-0.0009
					(0.010)
Observations	1,516	1,516	1,516	1,516	1,066
R^2	0.089	0.103	0.109	0.110	0.196
Firm FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	No
Industry-district × year-quarter FE	No	No	No	No	Yes

Notes: The dependent variable is the change in average interest rates on loans granted to firms in district-industry j by bank b at time (quarter) t. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8: Interest rate pass-through, lagged effect

Dep. Var.: $\Delta LENDING\ RATE_{jbt}$	(1)	(2)	(3)	(4)	(5)
$\Delta^2 IR_t$	0.2267***	0.2787***	0.2718***		
	(0.013)	(0.028)	(0.027)		
$\Delta^2 GDP_t$		-0.0076	-0.0021		
		(0.070)	(0.073)		
$\Delta^2 CPI_t$		-0.0873**	-0.0849*		
		(0.042)	(0.044)		
$LIQUIDITY_{b,t-2}$			-0.0341***	-0.0264*	-0.0821
			(0.012)	(0.014)	(0.053)
$CAPITAL_{b,t-2}$			-0.0025	0.0047	0.0485
			(0.039)	(0.040)	(0.031)
$\Delta^2 IR_t \times contraction$				0.3116***	
				(0.037)	
$\Delta^2 IR_t \times expansion$				0.2257***	
				(0.064)	
$\Delta^2 GDP_t \times contraction$				0.0156	
				(0.093)	
$\Delta^2 GDP_t \times expansion$				-0.0027	
				(0.336)	
$\Delta^2 CPI_t \times contraction$				-0.2074***	
				(0.044)	
$\Delta^2 CPI_t \times expansion$				-0.1176	
				(0.085)	
$\Delta^2 IR_t \times LIQUIDITY_{b,t-2}$					-0.0021
					(0.005)
$\Delta^2 IR_t \times CAPITAL_{b,t-2}$					-0.0181***
					(0.005)
$\Delta^2 GDP_t \times LIQUIDITY_{b,t-2}$					0.0032
					(0.007)
$\Delta^2 GDP_t \times CAPITAL_{b,t-2}$					0.0157***
					(0.005)
$\Delta^2 CPI_t \times LIQUIDITY_{b,t-2}$					0.0065
					(0.005)
$\Delta^2 CPI_t \times CAPITAL_{b,t-2}$					0.0042
					(0.004)
Observations	1,516	1,516	1,516	1,516	1,066
R^2	0.100	0.101	0.102	0.107	0.188
Bank FE	Yes	Yes	Yes	Yes	Yes
Sector-district FE	Yes	Yes	Yes	Yes	No
Industry-district × year-quarter FE	No	No	No	No	Yes

Notes: The dependent variable is the change in average interest rates on loans granted to firms in district-industry j by bank b at time (quarter) t. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9: Real effects of monetary policy: Nightlights

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Including Kampala				Excluding Kampala			
	z=1	z=2	z=3	z=4	z=1	z=2	z=3	z=4
$CAPITAL_{d,t-1}$	-0.0097	0.0234	-0.0357	-0.0021	0.0074	0.0382	-0.0064	0.0094
	(0.022)	(0.027)	(0.033)	(0.036)	(0.013)	(0.024)	(0.016)	(0.038)
$CAPITAL_{d,t-1} \times IR_{t-z}$	-0.0011	0.0005	0.0024**	0.0025**	-0.0009	0.0011	0.0028***	0.0028***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$CAPITAL_{d,t-1} \times \Delta GDP_{t-z}$	0.0018	-0.0112**	0.0058	0.0099***	0.0001	-0.0088**	0.0039	0.0103***
	(0.004)	(0.005)	(0.005)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)
$CAPITAL_{d,t-1} \times \Delta CPI_{t-z}$	0.0030	-0.0092**	-0.0009	-0.0019	0.0041***	-0.0087**	-0.0006	-0.0023
	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)
$LIQUID_{d,t-1}$	-0.0129	-0.0186	0.0107	0.0250*	-0.0045	-0.0064	0.0223*	0.0295**
	(0.011)	(0.016)	(0.016)	(0.015)	(0.008)	(0.010)	(0.011)	(0.014)
$LIQUID_{d,t-1} \times IR_{t-z}$	0.0008	-0.0002	-0.0010	-0.0016**	0.0003	-0.0009**	-0.0017***	-0.0020***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
$LIQUID_{d,t-1} \times \Delta GDP_{t-z}$	0.0005	0.0040	-0.0018	-0.0055**	0.0003	0.0026	-0.0023	-0.0054**
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$LIQUID_{d,t-1} \times \Delta CPI_{t-z}$	-0.0025*	0.0034	-0.0000	0.0015	-0.0018	0.0043*	0.0006	0.0017
	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Observations	1,254	1,188	1,122	1,056	1,235	1,170	1,105	1,040
R^2	0.390	0.378	0.348	0.275	0.447	0.434	0.403	0.300
Number of districts	66	66	66	66	65	65	65	65
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the average night-time luminosity in district d in quarter t. $CAPITAL$ and $LIQUIDITY$ are computed as weighted averages of bank capital and liquidity at the district level, where the weights are given by banks' market power in each district (measured as the share of local currency loans extended during the period of analysis). Given that the monthly night lights series for Uganda was discontinued in 2014, the regression period is 2010Q1:2013Q4. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.