Financial Development and Monetary Policy: Loan Applications, Rates, and Real Effects *

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Abstract

The finance-growth literature argues that institutional constraints in developing countries impede financial intermediation and monetary policy transmission. Recent studies using aggregate data document a weak bank lending channel. For identification, we instead exploit Uganda's supervisory credit register, with loan applications and rates, and unanticipated variation in monetary policy. A monetary tightening strongly reduces credit supply—increasing loan application rejections and tightening volume and rates—especially for banks with more leverage and sovereign debt exposure (even within the same borrower-period). There are spillovers on inflation and economic activity, especially in more financially-developed areas, including on commercial building, trade, and social unrest.

JEL Codes: E42; E44; E52; E58; G21; G28.

Keywords: Financial development; Bank credit; Bank lending channel; Monetary policy; Real effects; Developing countries.

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1 Introduction

The finance-growth literature argues that institutional constraints in developing countries hamper financial intermediation and public policy effectiveness (Beck, Levine and Loayza, 2000; Levine, Loayza and Beck, 2000). For instance, monetary policy transmission is hindered by weaknesses in the legal environment, underdeveloped financial markets, and uncompetitive banking systems. Stanley Fischer, the Federal Reserve's Vice Chairman, points out that in developing countries "interbank markets are still underdeveloped, and, even though some central banks use policy rates, changes to these policy rates have only limited effect on other interest rates and on the economy more generally" (Fischer, 2015). Olivier Blanchard, IMF Chief Economist, argues that "the macroeconomics of low-income and of advanced economies are incredibly different [...]. The role of banking—both its existence and governance—seems so essential to understanding how for example monetary policy is transmitted to the economy" (Blanchard, 2014). The existing literature documents a weak or nonexistent traditional bank lending channel, but is confronted with data and methodological challenges.

In this paper we test the bank lending channel of monetary policy in developing countries using Uganda as a laboratory for identification. Uganda is a fast-growing, bank-dependent African economy which shares many characteristics with countries at the same level of development. Financial intermediation is relatively low by international standards, but it has been growing steadily over the last decade.[1] Financial development gaps are a common feature throughout Africa and low bank presence is a key factor behind this gap (Allen, Carletti, Cull, Senbet and Valenzuela, 2014). As in other developing countries, banks are the main source of external finance for firms and bank financing is a key driver of entrepreneurship and firm growth (Banerjee and Duflo, 2014; Giannetti, 2003; Rajan and Zingales, 1998b). Continuous financial development—reflected in the expansion of banks and financial services—and increased exposure to global capital markets, led Uganda, among other low and lower-middle income countries, to gradually adopt a more forward-looking monetary policy framework (IMF, 2015). Analyses of monetary policy effectiveness are therefore crucial for understanding how developing economies function as they pursue price and financial stability objectives through modern macroeconomic policies. In addition, the bank lending channel of monetary policy is important to analyze not only as a public

[1] In Uganda, the domestic private credit-to-GDP ratio, a measure of financial development, increased from 7.5 percent in 2006 to 16 percent in 2016, compared to 25 percent in low-income countries, 63 percent in lower-middle income countries, 123 percent in middle-income countries, and 200 percent in high-income countries (data from the World Bank's World Development Indicators).

policy issue, but also as an opportunity to learn how banks react to significant variation in financial conditions.

We are able to undertake the current analysis because Uganda has an extensive credit register with loan applications and rates and has had largely unanticipated variations in monetary policy. Therefore, for the first time in the context of a developing economy, the analysis employs microdata on the lending activities of commercial banks (both loan applications and rates) coupled with extensive information on local economic activity between 2010 and 2014.

During the period of analysis, monetary conditions range from highly contractionary to highly expansionary. In the second half of 2011, the Bank of Uganda raised the policy rate by a cumulative 1,000 basis points (bps). This monetary tightening followed inflationary pressures from a large commodity price shock. After the tightening of monetary policy, the economy slowed down and the Bank of Uganda gradually cut the policy rate by a total of 1,100 bps. As a result, changes in money market interest rates during the period of analysis are unusually large by historical standards, falling in the top 5% of interest rate changes for developing economies since 1980. Using a narrative approach to identifying monetary policy shocks, Berg, Charry, Portillo and Vlcek (2013) argue that the timing and the extent of the tightening episode in mid-2011 were partly unexpected by economic agents. The reason is the track record of monetary policy in Uganda of remaining accommodative in the face of sizeable commodity price shocks, casting doubt on whether a tightening would occur during this period at all, and if it did, about its timing and magnitude. These arguments impart a degree of exogeneity in the monetary policy stance in Uganda, which helps with identification. Moreover, we control in an exhaustive way for economic activity and prices in addition to changes in interest rates.

A key challenge for testing the bank lending channel is to isolate changes in loan supply from changes in loan demand, given that aggregate macroeconomic shocks affect bank credit through both the bank lending and the firm borrowing channels. To overcome this challenge, we use a supervisory loan-level credit register which covers all corporate loans extended by banks in Uganda, including loan applications and rates which are absent in most credit registers around the world, even in almost all developed countries. Specifically, the credit register has information on individual loan applications by non-financial firms, with acceptance/rejection decisions, and the terms of loans granted by banks to firms, including the loan interest rate. We match the loan-level data to bank balance sheets on a quarterly basis.

Using these data and additional aggregate statistics, we estimate specifications with macroe-

conomic controls, bank balance-sheet interactions, and a multitude of fixed effects. In lending specifications we separate the effects of monetary policy proxied by changes in short-term rates from those of macroeconomic conditions by controlling for real GDP growth and inflation as in previous studies. Following Kashyap and Stein (2000) and Jiménez, Ongena, Peydró and Saurina (2012), we allow the effects of monetary policy to vary with bank balance-sheet strength (capital and liquidity), while controlling for time fixed effects, which account for all macroeconomic factors that change simultaneously with monetary policy rates, and also for bank and firm fixed effects, which control for bank and firm unobserved characteristics. In addition, we use multiplicative time-varying borrower fixed effects in specifications involving bank balance-sheet interactions to precisely control for credit demand shocks (Khwaja and Mian, 2008). We do not have sufficient variation in the data to include firm×year-quarter fixed effects, therefore we compare loans to firms in narrowly defined clusters (same industry and district) borrowing *in the same quarter* from different banks. However, we have enough variation to alternatively include firm×year fixed effects and hence compare loans to the same firm borrowing *in the same year* from different banks (Khwaja and Mian, 2008; Jimenez, Mian, Peydró and Saurina, 2015). Our results are quantitatively similar across these alternate sets of fixed effects.[2]

The microdata on corporate loans, coupled with extensive regional statistics, allows us not only to conduct an analysis of banks' lending decisions but also to examine the impact of the bank lending channel on the real economy and prices. To gauge the impact on local economic activity, we use information on the exact location of the lending bank branch and the borrowing firm. This information allows us to match the loan-level data with measures of real economic activity at different frequencies (monthly, quarterly, and yearly). Outcome variables include (non-food, utilities and transport) inflation, commercial construction, volume of exports, night-time luminosity, and public demonstrations as a broad indicator of the quality of economic and living conditions.

The analysis is organized in two parts. First, we test the bank lending channel (Bernanke and Blinder, 1988, 1992; Kashyap and Stein, 2000) which predicts that higher monetary policy rates reduce the probability of loan granting (extensive margin) and, for loans granted, their volume (intensive margin). We also estimate the pass-through of monetary policy rates to lending rates on new loans. Moreover, we test whether the strength of the bank lending channel depends on bank

[2]In addition, our results are robust to controlling not only for GDP growth and inflation, capturing local economic conditions, but also to external factors such as the terms of trade and the exchange rate, both in levels and interactions, and different sets of fixed effects.

capital and liquidity. This effect could be due to the external finance premium for banks, according to which banks with stronger balance sheets benefit from better access to external funds, and hence are less sensitive to changes in monetary conditions (Kashyap and Stein, 2000; Bernanke, 2007; Jiménez, Ongena, Peydró and Saurina, 2012). Second, we test for transmission to different sets of consumer prices and real economic activity, including overall economic conditions proxied by night-time luminosity, or real effects in some specific markets such as building permits or trade. We also examine whether a tightening of monetary policy leads to public demonstrations by dampening economic activity via a reduction in credit supply. In addition, we test for differences in the strength of monetary policy transmission as a function of financial development, measured by bank presence at the district level.

Our results document a strong bank lending channel of monetary policy, with sizeable subsequent effects on real activity and prices. An increase in short-term interest rates by one standard deviation reduces the likelihood of loan granting in the same quarter by 1.2-2.8 percentage points, depending on model specification, which given the rejection rate, implies a semi-elasticity of 7.4-17.2%. An increase in short-term rates by one standard deviation reduces granted loan volumes by 10.2-20.3%. About half of the variation in market interest rates translates into changes in loan rates, indicating an economically significant pass-through.[3] Additionally, we show that better-capitalized banks transmit changes in monetary policy significantly less than thinly-capitalized banks. These results are directionally similar to the bank lending channel in advanced economies (although there is no paper on the bank lending channel of monetary policy in high-income countries using both loan applications and rates). However, contrary to advanced economies, we find that banks with higher liquidity (mainly reflecting greater exposure to sovereign debt) react more (not less) in credit supply to monetary policy changes. The evidence that highly liquid banks amplify the bank lending channel suggests that a monetary tightening leads those banks to further invest in government securities at the expense of new lending to firms—a "crowding out" effect.

The impact of the bank lending channel on inflation and the real economy is consistent with the results on loan supply. In particular, we find that inflation and real outcomes are less affected by a monetary policy tightening in districts where banks have more capital and lower exposure to sovereign debt. To gauge the impact of monetary policy on trade, we control for external export demand with product×destination×time fixed effects; this is important as in loan-level data we

[3] In addition, we find no evidence of substitution to the foreign currency loan market when domestic monetary conditions tighten.

can control for unobserved time-varying firm fundamentals as a proxy for loan demand, but it is difficult to control for demand in firm-level real effects regressions. We also document effects on public demonstrations which go beyond what is typically analyzed in monetary policy studies. Nevertheless, this is a relevant outcome as tight money and credit may lead to social unrest and populist movements.[4] Finally, in line with the idea that less developed credit markets act as a constraint to monetary policy transmission, we show the bank lending channel is stronger in districts with greater financial development. These findings emphasize the role of financial development in shaping the impact of public policies on the economy, supporting the notion of finance as a crucial input to economic growth (Beck, Levine and Loayza, 2000; Levine and Zervos, 1998; King and Levine, 1993).

Our study contributes to two strands of literature. First, the analysis emphasizes the importance of banks in developing countries for the effective implementation of macroeconomic policies. An extensive cross-country cross-industry literature argues that financial development is a key driver of economic growth, through total factor productivity growth and capital accumulation (Beck, Levine and Loayza, 2000; Beck and Levine, 2002; Levine, Loayza and Beck, 2000; Rajan and Zingales, 1998a). Our results shed light on some of the mechanisms behind the finance-growth nexus by showing that the impact of monetary policy on inflation and economic activity, as proxied by commercial building and night-time luminosity, is stronger in more financially-developed areas, consistent with the notion that less developed credit markets are a constraint on the transmission of monetary policy. Several studies explicitly identify financial underdevelopment as a constraint on growth in African economies, emphasizing the heavy exposure of banks to government securities and limited financial intermediation (Allen, Carletti, Cull, Senbet and Valenzuela, 2014; Easterly and Levine, 1997). We contribute by showing that banks with greater holdings of sovereign debt are more sensitive to monetary conditions, a result which echos the private credit "crowding out" effect of public debt in developing countries (Allen, Otchere and Senbet, 2011; Hauner, 2009). Additionally, consistent with Friedman and Schwartz (1963), who argue that monetary policy may affect social stability through its impact on credit dynamics, our results reveal interesting effects of the bank lending channel on public demonstrations, which go beyond the typical modern study of monetary policy.

Second, it contributes to the literature on the bank lending channel in several ways. Blanchard

[4] A number of studies examine the effects of economic shocks on social stability, see, among others, Acemoglu and Robinson (2000); Besley and Persson (2011); Braggion, Manconi and Zhu (2017) and Mian, Sufi and Trebbi (2014).

(2014) and Fischer (2015), among others, argue that banks are key to understanding how monetary policy impacts the economy in developing countries. In surveying the literature, Mishra and Montiel (2013) argue that the lack of evidence of strong monetary transmission in developing countries is mainly the result of structural impediments,[5] but also point out methodological deficiencies, in particular the heavy use of vector autoregressions on aggregate time-series data. We bring to this literature an analysis that is for the first time based entirely on microdata. The loan-level data from the credit register makes it possible to control for changes in loan demand at a more granular level than in previous studies and hence to isolate credit supply from demand in a more convincing way. In addition, we observe the interest rate of each granted loan, so we are also able to precisely estimate the pass-through to the lending rate on new loans, rather than that on the existing stock of loans that is captured in aggregate lending rate statistics.

Our paper additionally contributes to the literature on the bank lending channel by documenting important differences in monetary policy transmission between developing and advanced economies. These differences are driven by structural characteristics—developing countries have smaller banking sectors, financial markets are less liquid, and the banking landscape is less competitive. Our results suggest the notion of a "strong" bank balance sheet is also different. Banks in developing countries hold large amounts of liquidity through government securities, primarily treasury bills. Coupled with weak institutions that raise the cost of financial intermediation, banks often prefer safe government debt over risky lending. As a result, bank holdings of liquid assets are high and may "crowd out" private sector debt (Diamond, 1965). Contrary to evidence from Europe and the U.S., (e.g., Jiménez, Ongena, Peydró and Saurina, 2012; Kashyap and Stein, 2000) that monetary policy transmission is *weaker* for more liquid banks, we find a *stronger* bank lending channel and real impacts for more liquid banks (with greater sovereign debt holdings). This is because during periods of expansionary monetary policy, public debt is relatively less attractive compared to lending, and banks with greater government bondholdings therefore lend more to firms. The opposite occurs during monetary contractions, increasing the crowding-out effect.

We further contribute by analyzing the impact of the bank lending channel not only on output but also on inflation, a crucial outcome for central banks. We analyze both loan applications and rates, which are key for separating credit demand from supply and have not been examined in the

[5]This literature emphasizes the macroeconomic characteristics that weaken the bank lending channel in developing countries. For instance, Mishra, Montiel, Pedroni and Spilimbergo (2014) show that the link between policy rates and bank-level lending rates is stronger in countries with better institutions, deeper financial markets, and more competitive banking systems.

monetary policy literature.[6]

The paper is organized as follows. In Section 2 we describe the institutional context, macroeconomic conditions, and banking system in Uganda. In Section 3 we describe our data. Sections 4 and 5 outline the empirical approach and present the results for the loan supply and real effects of the bank lending channel. We conclude in Section 6.

2 Institutional background

Uganda is an East African developing country with a flexible exchange rate regime and a moderate level of dollarization.[7] Historically, the Bank of Uganda followed a monetary aggregate targeting framework, which was ineffective at anchoring inflation expectations and led to significant interest rate volatility (IMF, 2008). In July 2011, the Bank of Uganda moved to an inflation targeting (IT) monetary policy framework and introduced a policy rate to signal the monetary policy stance.[8]

To place our analysis in context, we briefly describe monetary and macroeconomic developments in the years prior and during our period of analysis 2010-2014. Then we describe the main characteristics of the banking sector.

2.1 Macroeconomic context

Uganda faced two major external shocks around the period of analysis. First, before the 2008-2009 financial crisis a major food and fuel price shock generated inflationary pressures in most developing countries. However, as the financial crisis become global, inflationary pressures declined and inflation returned to single digits in 2009. A second commodity price shock hit the Ugandan economy in 2010-2011, sending inflation back into two-digit territory, and affecting several East African countries. While the first shock waned due to external forces and in the absence of a strong monetary response, central banks in the region (Kenya, Rwanda, Tanzania, and Uganda) addressed the second shock with a significant monetary tightening. During July-November 2011

[6] Among advanced economies, Italy is the only country that has a credit register with loan applications and rates. Unlike the Ugandan credit register, the Italian one does not collect information on loan rejections. In addition, there is no paper on the Italian economy using loan applications and rates as endogenous outcomes of monetary policy. Therefore, to the best of our knowledge, this is the first paper to exploit loan applications and rates, both of which are needed to identify the bank lending channel.

[7] In 2013, the share of foreign currency assets was 31.6%, lower than in most East European countries (Brown and De Haas, 2012) but higher than the average for African countries (Christiensen, 2014). In Section 5.1 we discuss the possibility of substitution between the local and the foreign currency loan market during a monetary tightening.

[8] The policy rate is a benchmark rate aimed at guiding short-term interbank rates. The Bank of Uganda undertakes open market operations (overnight and 7-day repos on the secondary government securities market) to bring the 7-day interbank rate as close as possible to the benchmark rate.

the Bank of Uganda raised the policy rate by a total of 1,000 bps: 300 bps between July and September and an additional 700 bps between September and November. Following the collapse of credit aggregates and economic growth, an expansionary phase began in January 2012. The policy rate was gradually reduced during the first three quarters of 2012 from 23% to 11%. Our period of analysis from 2010 until 2014 thus captures a full economic cycle. Macroeconomic conditions and credit dynamics during this period are illustrated in Figures 1 and 2.

Based on a narrative approach *à* la Romer and Romer (1989), Berg, Charry, Portillo and Vlcek (2013) argue that the "clean-cut nature of the [tightening] event allows us to consider it a *natural experiment* from which significant inferences can be drawn" (p. 5). This conclusion rests on the following arguments. First, the Bank of Uganda had a dovish track record, with monetary policy remaining highly accommodative during earlier episodes of high credit growth and inflation. For instance, the Bank of Uganda had reacted little to the previous 2007-2008 commodity price shock despite soaring inflation, casting doubt it would tighten in 2011 at all, and if so, when and by how much. Second, before the mid-2011 tightening, the Bank of Uganda communicated through its monthly Economic and Financial Indicators report a need for the monetary authority to *support* strong economic activity rather than to address inflationary concerns. For instance, in April 2011 it considered the possibility that "at very fast growth rates, prices may have to rise to funnel resources to those areas where demand and output are rising particularly rapidly" but argued it "should not be too worried about this, particularly if growth is broad-based" (Bank of Uganda, 2011a). In the June 2011 report it further ruled out a tightening by remarking that "Given that inflation was largely caused by supply-side shocks, it was neither desirable nor feasible for BOU to bring inflation back to the targeted levels in the short run" (Bank of Uganda, 2011b). Based on these communications, economic agents had little reason to anticipate the dramatic and consecutive interest rate hikes that ensued. Third, the tightening phase starting in June 2011 occurred at the same time with the introduction of a new monetary policy framework that centered on targeting inflation rather than money supply. However, the Bank of Uganda did not publish an intermediate inflation trajectory until several months later in October 2011 (IMF, 2011, 2012), offering economic agents few ingredients to form expectations about future central bank actions throughout this period.

Overall, these arguments point to a certain degree of unrelatedness between the monetary policy stance and economic conditions, which helps with the identification of bank lending decisions in the subsequent analysis.

We can also rule out other central bank policies (such as minimum reserve requirements or macroprudential tools) that may have occurred during the period of analysis. In particular, the Bank of Uganda does not use cash reserve requirements as an active tool of monetary policy. The most recent change was a loosening in March 2011 (by 1.5 percentage points to 8 percent of total deposits). To the extent this change had an impact on the economy, it would dampen the effects of the monetary tightening that occurred in the second half of 2011. Moreover, there were no changes in macroprudential policies during the period of interest.[9]

2.2 Banking system

Uganda experienced significant financial development during the 2000s, with bank credit to the private sector reaching 16.4% of GDP by 2016. This ratio remains nonetheless low by international standards—as common in most African economies (Allen, Carletti, Cull, Senbet and Valenzuela, 2014; Allen, Otchere and Senbet, 2011)—and there is a large informal financial sector. Financial deepening in Uganda is reflected in the expansion of banking services, as the number of commercial banks increased from 15 in 2006 to 25 in 2016 (the same as in Nigeria), and the the number of loan accounts doubled from 18 to 36 for 1,000 adults between 2010 and 2015, a value higher than Malawi, Nigeria and Tanzania, and similar to Rwanda (data from the IMF's Financial Access Survey). The banking system comprises 25 (mostly foreign- and privately-owned) banks at the time of analysis, it is highly concentrated—with the largest 5 banks accounting for almost 75% of banking system assets (GFDD, 2011)—and single bank-firm relationships are prevalent.

Banks are well capitalized and highly-liquid, with an average regulatory capital ratio of 23% and average liquid-to-total deposits ratio of 41%. The typical bank funds its assets with 68% in deposits, 15% shareholders' equity, 4% market funding (primarily domestic interbank funding), and 12% other sources. The average bank holds 45% loans, 20% government securities, 4% cash, 12% interbank assets (domestic and foreign), and 8% reserves at the central bank.[10]

The average loan portfolio is comprised of 64% private sector loans, 35% loans to individuals, and 1% loans to public sector enterprises.

[9] We can also note that the relatively short period of analysis, 2010-2014, reduces the likelihood that structural transformation of the economy affects our analysis. Furthermore, in small open economies foreign monetary policy may act as an additional impulse on the local economy and may affect our results insofar as it is correlated with domestic monetary policy and it influences bank's access to funds. As argued in the next section, both domestic and foreign banks in Uganda mainly fund their operations with local deposits and hence are largely insulated from the global financial cycle.

[10] Figure A2 shows the cross-sectional distributions of regulatory capital and liquidity—the two financial ratios we use to identify the bank balance sheet channel.

3 Data

3.1 Credit register

Our study requires detailed data on the commercial lending activities of banks and the economic performance of the private sector. Uganda has a fully functional and comprehensive credit register that is maintained by the private credit bureau Compuscan Uganda CRB Ltd. under the supervision of the Bank of Uganda. The credit register was set up in 2008 and collects data on loan applications and granted loans based on monthly reports from all commercial banks, microfinance deposit-taking institutions, and other credit institutions. Its coverage continuously improved over time and the data became representative by mid-2010.[11] Therefore, our period of analysis runs from 2010:Q3 until 2014:Q2. We use data for the largest 15 banks, which account for 95% of total banking assets.

The credit register collects information on both loan applications (with acceptance/rejection decision) and loan originations (credit lines and term loans) to non-financial firms, with no restriction on the minimum size of the loan. We focus on local currency loans (in Ugandan shillings) which represent the majority of loan applications and more than half of outstanding private credit. For each individual loan application and granted loan, we know the date and the terms of the loan such as interest rate, maturity, and currency. We limit our sample to applications that were approved or rejected and exclude any records with pending or withdrawn status. Note that banks make separate data submissions on loan applications and granted loans (i.e., there are "loan application reports" and "granted loan reports" that feed into different supervisory datasets). 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. Therefore, we analyze loan applications and granted loans separately.[12] The final sample has 26,363 loan applications and 25,948 granted loans between 2010:Q3 and 2014:Q2.

Firms are identified by a unique numerical code which allows tracking their activity over time and across banks. We observe loan applications from 8,679 firms and loans granted to 8,718 firms. For each borrowing firm we also have information on its location (in one of 66 districts) and sector of activity (9 industries), but there is no information on individual firm balance sheets.[13] Looking at loan applications, over the full sample period 83% of firms apply for a loan to only one bank,

[11] See Section A-II in the Appendix for details on the representativeness of the credit register (Figures A3 and A4).
[12] Hence, we are unable to estimate a two-stage selection model.
[13] See Figures A3 and A4 on the the sample composition by industry and region.

13% to two banks, and the rest to 3 or more banks. Looking at granted loans, 87% of firms borrow from one bank and 10% from two banks. In addition, only about one third of firms submit multiple loan applications in any given quarter. The prevalence of single firm-bank relationships and the limited number of repeated loan applications has important implications for the identification strategy, as discussed in Section 4.1.2.

We merge the loan-level data with bank balance sheet variables and macroeconomic time series (interest rates, GDP growth, inflation) from the Bank of Uganda on a monthly and quarterly basis.

3.2 Real economic activity

To examine real effects we employ several measures of economic activity and living conditions *at the district level* (for up to 66 districts).[14] These include building permits, night-time luminosity, export volume, public demonstrations, and non-food inflation and its main components. We briefly describe each economic indicator in turn.

Quarterly data on commercial building permits is available from the Uganda Bureau of Statistics. We have information on the number of applications for permits for all districts. Growth in commercial building permits is highly correlated with income growth across US states and is a valuable indicator of local economic activity (Calomiris and Mason, 2003).

Yearly data on export volume is available, from the Uganda Bureau of Statistics, for 20 districts where exports are recorded at customs offices, for 96 product categories that are exported to 105 destination countries. Therefore the data is at the district-product-destination-year level.

Monthly data on night-time luminosity comes from satellite images and were obtained from the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. We average these data by quarter to minimize the impact of short-term fluctuations due to weather patterns and measurement error. Night-time luminosity data has been used to evaluate and improve national accounts measures of economic wellbeing (Pinkovskiy and Sala-i Martin, 2016), and have a high correlation with regional growth and with measures of public goods within and across countries (Michalopoulos and Papaioannous, 2014; Hodler and Raschky, 2014; Henderson, Storeygard and Weil, 2012). The data have the advantage that they capture informal economic activity which eschews official estimates of GDP and industrial production.[15] The maps in Figure 4 show the distribution of average night-time luminosity across districts; they reveal

[14] There are no regional statistics on industrial production.

[15] In addition, Elvidge, Hsu, Baugh and Ghosh (2014) show that luminosity data for Uganda are a strong predictor of population density and GDP growth in the time series.

strong economic activity and fast credit growth during the boom phase in 2010, an economic contraction in 2011 when monetary policy tightened, and a modest rebound in 2012 when monetary conditions loosened.

Data on public protests comes from the Armed Conflict Location and Event Data Project (ACLED) database, which records information on violence and conflict in developing countries. The variable of interest records the total number of events defined as "riots and protests" and refer to organized or spontaneous demonstrations against a public or private institution, which may involve targeting property and businesses, as well as clashes with security institutions. We compute the quarterly number of protests from daily data.

Lastly, monthly data on non-food CPI is available from the Bank of Uganda for 8 districts. Non-food expenditure accounts for almost 70% of the consumption basket. The main components of non-food expenditure are utilities (housing, water, electricity, gas and other fuels) and transportation (each with a share of more than 15%). Smaller expenditure items, with weights of less than 10%, include clothing and footware, health, communications, education, recreation, and other goods and services. We focus the analysis on the overall non-food CPI and its two major components—utilities and transportation.

Detailed variable definitions and sources are shown in Table 1. Descriptive statistics for the variables in the regression sample are reported in Table 2.

4 Monetary policy and bank credit

4.1 Empirical strategy and hypotheses

In this section we discuss the empirical approach for examining the extensive and intensive margins of credit supply adjustment followed by impact on loan rates. We focus on the identification of credit supply effects using a rich set of controls and fixed effects. To our knowledge this is the first study of the bank lending channel in a developing economy that aims to isolate loan supply from loan demand effects using both data on loan applications and borrower$\times$period fixed effects.

4.1.1 Extensive margin

To examine the link between monetary policy and the likelihood of loan granting—the extensive margin of lending—we estimate the following linear probability model:

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

where $LOAN\ APPLICATION\ GRANTED_{ibt}$ takes value 1 if a loan application by firm i to bank b in quarter t was accepted.[16] Our measure of monetary policy is the 7-day interbank rate (IR).[17] We also add real GDP growth (ΔGDP) and inflation (ΔCPI) to control for macroeconomic conditions that may drive monetary policy rates. We allow differences in bank financial strength to influence the likelihood of loan granting by including the ratio of liquid assets to total deposits as a measure of bank liquidity ($LIQUIDITY$) and the ratio of total regulatory capital to risk-weighted assets as a measure of bank capital ($CAPITAL$). Bank characteristics are lagged one quarter relative to the quarter of the application date.[18]

In a first set of regressions, unobserved time-invariant firm and bank heterogeneity are captured by firm (η_i) and bank (ψ_b) fixed effects. To better account for shifts in credit demand, we would like control for unobserved time-varying firm heterogeneity at a level as granular as possible. Ideally, we would like to control for firm$\times$quarter (or month) fixed effects which require us to observe multiple loan applications by the same firm in a given quarter (month). However, in our data less than one third of firms request multiple loans in any given quarter—a common feature

[16] The rejection rate during 2010-2014 is 16.3%.

[17] This choice is motivated by the lack of a policy rate for the full sample period. In Figure A1 we can see that there is significant co-movement among our measure of monetary policy, the policy rate introduced in July 2011, and two other market rates, namely the 91-day T-bill rate, and the discount rate at which banks access emergency funds from the central bank. Subsequent to the introduction of a monetary policy rate in July 2011, this co-movement suggests a fair degree of pass-through from the policy rate to market rates. As a robustness check, we re-run the baseline regressions replacing the 7-day interbank rates with these alternative interest rates (Figure A1), which leaves our results unchanged (Table A2).

[18] As a robustness test, we augment our baseline with additional macro controls, namely the nominal exchange rate and the change in the terms of trade to take into account external factors that may affect monetary policy transmission (Table A3). We also make sure our results for bank capital and liquidity are not driven by other bank characteristics such as bank age, size, and foreign ownership (Table A4). These additional variables enter the specifications both in levels and in interaction with bank capital and liquidity. All estimated coefficients on ΔIR, $CAPITAL \times \Delta IR$ and $LIQUIDITY \times \Delta IR$ remain statistically significant and of similar magnitude to the baseline.

of bank-firm relationships in developing countries (Rajan and Zingales, 1998b). The following approach addresses this issue without running into sample-size problems. We include time-varying fixed effects at the firm-cluster level, where a cluster includes the firms in the same district and industry, or we can extend the period from a quarter to a year, and include firm$\times$year fixed effects. The first set of fixed effects capture time-varying demand shocks that are common to all firms in the same industry and district. By contrast, firm$\times$year fixed effects exploit multiple firm-bank relationships within a year to control for time-varying unobserved shifts in credit demand at the firm level.

Interactions of bank capital and liquidity with ΔIR allow the bank lending channel to depend on banks' financial positions. We are guided by several theoretical arguments in favor of a bank balance sheet channel. For a given increase in short-term interest rates, banks with ex-ante higher levels of capital should be in a better position to support growth in their loan books because they have more loanable funds (Kashyap and Stein, 1994). Banks with stronger balance sheets (less leverage) should be able to access market funds on better terms than other banks (Bernanke, 2007; Gambacorta and Shin, 2016). The degree to which banks are capital-constrained from a regulatory standpoint may also matter, as banks for which the capital requirement is binding are more likely to pass up current profitable lending opportunities to avoid future losses (Van den Heuvel, 2012). Therefore, we expect high capital to dampen the effects of a monetary contraction ($\alpha_2 > 0$). This argument is reversed for liquidity, as high exposure to sovereign debt can indicate a bank's preference for holding government securities over extending risky loans. We expect relatively more liquid banks to respond to a monetary tightening by cutting loans more aggressively than other banks ($\alpha_3 < 0$).

Following earlier studies on loan approvals (Jiménez, Ongena, Peydró and Saurina, 2012; Puri, Rocholl and Steffen, 2011), we estimate Equation 1 with Ordinary Least Squares (OLS). We choose a linear probability model because non-linear models can be unidentified in the case of many fixed effects and short panels can produce inconsistent estimates of interactions terms (Ai and Norton, 2003). We cluster the standard errors at the district level to allow for serial correlation within districts.

4.1.2 Intensive margin and lending rates

For each granted loan we have information on volume, interest rate (level and type) and maturity. In the granted loans dataset there are few multiple-bank relationships—only 6% of firms

borrow from multiple banks in a given quarter. Given this limitation variation, we cannot include firm×quarter fixed effects, but we can undertake the analysis at a higher level of aggregation while controlling for credit demand as precisely as feasible. We start by setting up the data at the bank-cluster-quarter level where a cluster includes all firms in a district-industry pair (for a total of 287 district-industry pairs). Then we compute average loan volumes for each bank-cluster-quarter combination. This set-up allows us to include district-industry×year-quarter fixed effects which control for credit demand under the assumption that all firms in a given cluster receive a common quarterly demand shock.[19] Alternatively, we set up the data at the bank-firm-year level by averaging loan volumes extended by each bank to each firm within the year, and adding firm×year fixed effects.

We estimate the following specification:

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

where $LOAN\ AMOUNT_{jbt}$ is the volume of credit granted to firms in district-industry j by bank b in quarter t (or to firm j by bank b in year t in the alternative data structure). The main variable of interest is the change in the short-term interest rate ($\Delta IR_{t,t-z}$) over different time horizons which allow short-term rates to affect loan volumes with a lag. We find the most consistent and precisely estimated effects at a lag of 2 quarters, on which we settle for the baseline specifications. The coefficient α_1 is the interest rate elasticity of loan volume supplied by individual banks to firms in the same district-industry cluster. We expect $\alpha_1 < 0$. We estimate specifications that include district-industry fixed effects ϕ_j and bank fixed effects (ψ_b), followed by macroeconomic and bank-level controls, and finally interactions of ΔIR with bank capital and liquidity. In the specifications with balance sheet interactions we control for time-varying loan demand with district-industry×year-quarter fixed effects or firm×year fixed effects. We expect $\alpha_2 > 0$ and $\alpha_3 < 0$.

[19] This data set-up is similar to, e.g., Acharya, Eisert, Eufinger and Hirsch (2016), Auer and Ongena (2016), and De Haas and Van Horen (2013) who examine banks' supply of corporate loans following financial shocks and control for demand shifts at a level of aggregation that is higher than the individual firm. This choice is driven by two motivations: credit rationing at the individual firm level creates intensive margin adjustment at the firm-cluster level, and firms mainly form relationships with a single bank.

Finally, we examine the pass-through of the 7-day interbank rate to interest rates charged by banks on new loans in a specification akin to Equation 2. The main difference is that the dependent variable is the average lending rate on granted loans and is defined separately for each data structure.[20] For instance, in the bank-firm-year panel, the average lending rate is computed across loans granted by a given bank to a given firm each year. Similar to the extensive margin regressions, all regressors are lagged one quarter. We expect $\alpha_2 < 0$ and $\alpha_3 > 0$. Regressions are estimated with OLS and standard errors are clustered at the district level.[21]

4.2 Results

4.2.1 Extensive and intensive margins

Table 3 reports the results for the extensive margin of lending. We start with simple specifications that include bank and firm fixed effects (columns 1-3). The coefficient estimates on ΔIR indicate that a standard deviation (SD) increase in the 7-day interbank rate over a quarter (359 bps) reduces the probability of loan granting by between 1.2 and 2.8 percentage points.[22] Given a loan application rejection rate of 16.3%, these estimates imply a semi-elasticity of 7.4-17.2% decline in the likelihood of loan granting.

In column 4 we include interaction terms of short-term rates with bank capital and liquidity. We find that the differential effect of a rise in the interbank rate by a SD over a quarter between a highly and a thinly-capitalized bank (90th vs. 10th percentile) is 4.9 percentage points (and semi-elasticity of 30.6%).[23] Put differently, banks with higher levels of capital pass on a monetary tightening to the supply of credit less than do banks with lower levels of capital. By contrast, we observe that more liquid banks amplify the negative effect of an interest rate rise. Given that 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 securities, crowding out private sector lending.

[20] The results we report are for the unweighted average interest rate, but they are similar if we use the loan volume-weighted average interest rate.

[21] The specifications for loan volumes and rates are robust to the same sensitivity tests discussed in relation loan applications, see footnotes 17 and 18.

[22] It is informative to compare our estimates with those for advanced economies. Jiménez, Ongena, Peydró and Saurina (2012) show that a 100 bps increase in the Spanish 3-month interbank rate (almost one SD) raises the rejection rate on loan applications by 1.4 percentage points. We can see that a much larger interest rates increase is required in Uganda to achieve the same impact on loan rejection rates as in Spain, consistent with the large difference in the amplitude of economic cycles between advanced and developing countries (Claessens, Kose and Terrones, 2012).

[23] The 90th and 10th percentiles of the capital ratio distribution are 34 and 15 percent, therefore the differential effect is given by $359 \times (34 - 15) \times 0.0721/100 = 4.9$.

Column 5 shows the specification with balance-sheet interactions where we add more demanding controls for credit demand in the form of firm×year fixed effects. Despite a sharp reduction in the sample size, the coefficients on the interaction terms between ΔIR and capital and liquidity remain statistically significant at conventional levels and become slightly larger in absolute terms.

Table 4 reports the intensive margin results. Across specifications (columns 1-3), we find that a monetary tightening is associated with lower loan volumes, controlling for macroeconomic conditions and bank balance sheet characteristics. The coefficient estimates on ΔIR indicate that a SD increase in the short-term interest rate over 2 quarters (644 bps) reduces bank credit by between 10.2 and 20.3%. In column 4 we add district-industry×year-quarter fixed effects and find that higher capital dampens the transmission of interest rates changes to credit supply and higher liquidity amplifies it. One SD increase in interest rates over two quarters leads high-capital banks (at the 90th percentile) to reduce the volume of new loans by 47.7% more than low-capital banks (at the 10th percentile).[24] When we saturate the specification with firm×year fixed effects (column 5), the coefficient estimates on the balance sheet interaction terms retain their statistical significance.

4.2.2 Lending rates

Next we quantify the pass-through of changes in short-term interest rates to bank lending rates on newly granted loans. Table 5 reports the results for specifications that are similar to the previous section. The coefficient estimates on ΔIR in columns 1-3 show 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. The latter coefficient is not statistically different from 50 bps, indicating a pass-through of almost 50%.

The results also indicate differential effects depending on bank capital and liquidity. As seen in column 4 of Table 5, high-capital banks charge 234 bps less than do low-capital banks (at the 90th vs. 10th percentile of the capital distribution) for an increase of one SD in interest rates over one quarter.[25] By contrast, more liquid banks pass through the increase in the short-term rate more than less liquid banks. Notice, however, that the differential effect across bank capital is no longer statistically significant when we include more demanding sets of fixed effects, even though the point estimate does not vary much (column 5).

[24] $644 \times (34 - 15) \times 0.0039 = 47.7$.
[25] $359 \times (34 - 15) \times 0.0343 = 233.9$.

5 Monetary policy, real economic activity, and inflation

In this section we further assess the strength of the bank lending channel in Uganda by exploring the link between monetary policy and real economic outcomes. Doing so is challenging given that we cannot complement our bank-firm loan-level data with information on firm-level outcomes.[26] To overcome this limitation, we conduct an analysis of economic performance at the district rather than the firm level. For this purpose, we collect data on multiple measures of economic activity across districts, as described in Section 3.2.

The bank lending channel of monetary policy is effective if short-term rates affect not only credit aggregates but also the real sector. This is expected to occur if firms are bank-dependent and cannot easily switch to alternative forms of financing such as corporate bonds, cross-border loans, or informal lenders. Each of these possibilities is discussed below. The bank balance sheet channel predicts that the impact of short-term rates on real sector outcomes varies with local financial conditions. Moreover, given our previous results on credit, a monetary tightening would affect economic activity relatively more in districts where the banking system is less well capitalized and more inclined to hold government securities, as a result of the fact that those districts experience a greater credit contraction.

5.1 Empirical strategy

The unit of observation in most real effects regressions is a district-quarter. (In the inflation regressions it is district-month and in the exports regressions it is district-product-destination-year.) We start by constructing time-varying measures of banking conditions at the district level. Specifically, we compute weighted averages of bank capital and liquidity across banks, where the weights are given by the bank's market shares within each district. The market shares are based on the total loan volume granted by each bank per district over the full sample period. Then we estimate a reduced-form specification as follows:

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

where $REAL\,OUTCOME_{dt}$ is a set of measures of economic activity. When these measures are the

[26] Due to confidentiality reasons, firm-level loan outcomes cannot be matched to existing firm investment data.

number of commercial building permits, night-time luminosity, or the number of public demonstrations in district d in quarter t, we allow monetary policy to have an effect on real economic activity with a transmission lag of up to 4 quarters ($z = 1, 2, 3, 4$). The interest rate IR_{t-z} enters the specification in level and is lagged by z quarters.[27] The bank balance sheet variables are lagged one quarter and their interactions with GDP growth and inflation are included to avoid confounding effects for our interactions of interest with the short-term rate. All specifications include district and year-quarter fixed effects.[28] Similar to the credit supply equations, we expect more pronounced effects in districts with low-capital and highly liquid banks, i.e., $\alpha_2 > 0$ and $\alpha_3 < 0$. When the measure of economic activity is trade, we estimate a similar model, where the dependent variable is the log-transformed volume of exports. Given that the unit of observation is the district-product-destination-year, we are able to precisely control for export demand by saturating the specifications with product×destination×year fixed effects (as in Paravisini, Rappoport, Schnabl and Wolfenzon, 2015). Finally, when we look at the transmission of monetary policy to prices, since for inflation we have monthly data for a small set of districts, we estimate a slightly modified Equation 3 where we control solely for balance-sheet characteristics and their interactions with GDP growth, with district and year-month fixed effects.

Our reduced-form empirical strategy hinges on the assumption that firms do not have access to diversified sources of external financing, such as foreign currency loans, corporate bonds, cross-border loans, or informal lenders, which could help neutralize fluctuations in bank credit. We review each form of external funding in turn. Almost half of total credit from commercial banks is extended in foreign currencies, notably the U.S. dollar. Foreign currency loans are granted primarily to firms in the manufacturing, trade, and agricultural sectors by a small number of banks. Macroprudential rules require that foreign currency borrowers earn revenues in foreign currencies, which effectively restricts the borrower pool to large manufacturers or exporting firms. We find that bank credit in USD responds to changes of local monetary policy rates on both the extensive and intensive margins (Table A1), casting doubt on the foreign currency loan market acting as a substitute for local currency loans.

Furthermore, the bond market for non-financial firms in Uganda, like in other developing economies, is underdeveloped, and firms have limited access to cross-border loans.[29] But access

[27] The interest rate enters the real effects regressions in level because it delivers more consistent results than in first-difference, likely because real-effects data are less persistent than loan data (Kashyap and Stein, 1994).

[28] The results are also robust to including district×quarter fixed effects, for the four quarters of the year, to account for systematic seasonal shifts in economic activity.

[29] According to data from Dealogic Loan Analytics, during 2010-2014 only eight loans were extended to firms in

to informal credit is widespread: in developing countries, firms commonly borrow from both formal and informal lenders (Jain, 1999). There are two reasons we believe access to the informal credit sector cannot neutralize the monetary transmission channel. To start with, informal credit incurs sizeable interest rates and transaction costs (Giné, 2011). Therefore, switching to informal lenders would raise firms' cost of external finance, which in turn could hinder profitability and output. In addition, informal lenders tend to be small and capital-constrained (Conning and Udry, 2007), which makes it difficult to substitute banks as providers of credit to firms.

5.2 Results

Tables 6-8 report our findings. The estimates consistently indicate that a rise in monetary policy rates reduces economic activity and non-food prices relatively more in districts where banks are less well capitalized and, albeit less consistently, more liquid.

Table 6 shows the effect of monetary policy on economic activity measured by the number of applications for commercial construction permits is statistically significant after one quarter and persists in outer quarters. Across specifications, the coefficient estimates on the interaction terms of the short-term rate with bank capital are significant at conventional levels while those for bank liquidity are statistically insignificant. Comparing low- and high-capital districts as above (90th vs. 10th percentile), a rise of the interest rate by one SD (604 bps) reduces the number of applications for new commercial buildings in the following quarter by between 30 and 44% more in low-capital districts than it does in high-capital districts (columns 1-4).[30]

Turning to the impact of monetary policy on trade, the results in columns 5-6 of Table 6 consistently show that export volumes react more to changes in the policy rate in districts with low capital banks. By including product×destination×year fixed effects, we compare the exports of the same product that are shipped to the same destination country and in the same year, of firms from districts with high vs. low bank capital and liquidity. The coefficient magnitudes indicate a differential impact of an increase in short-term rates by one SD on export volumes of more than 9% in high vs. low capital districts. The results are robust to excluding exports of raw materials which may be more responsive to global commodity prices and financing conditions than to domestic monetary policy.

The specifications in columns 1-4 of Table 7 suggest monetary policy affects real economic activity with a lag of 3 to 4 quarters. Higher interest rates reduce economic activity measured by

Uganda (out of 667 loans granted to firms in developing countries over the same period).

[30] For column 1: $604 \times (34 - 15) \times 0.0038 = 43.6$.

night-time luminosity relatively less in high-capital districts and relatively more in high-liquidity districts. The estimates in columns 1-4 indicate that a hike of the short-term rate of one SD reduces night-time luminosity in high-capital districts (at the 90th percentile) by 0.3 units less than in low-capital districts (at the 10th percentile) after three quarters, or 6% of the mean of the lights distribution.

Then, we explore the impact of monetary policy on social unrest using data on public demonstrations. We consider this outcome because most corporate loans in Uganda have variable rates so a change in the policy rate directly affects interest costs and borrowers' debt burden. In addition, there is anecdotal evidence of public protests against high interest rates and tight economic conditions during the monetary contraction period; and previous literature shows that tight credit can lead to social instability. As expected, in columns 5-8 of Table 7 we find that for a given increase in interest rates, the number of protests and riots is relatively higher in districts with banks where banks have lower capital and higher liquidity. These effects are statistically significant at a lag of 3 and 4 quarters. The coefficient estimates in column 3 indicate that an increase in short-term interest rates by one SD increases the number of demonstrations by 1.42 (per quarter) three quarters later, or 12% of the mean number of demonstrations.

Finally, Table 8 reports the estimated effects of monetary policy on non-food inflation and its components with a lag of up to 12 months. For brevity we only report the coefficients for the interaction coefficients of interest. The results show statistically significant coefficients and suggest that the effect of short-term rates on inflation is stronger in lower capital districts. To gauge the economic magnitude of the effect of bank characteristics, we once again compare low- and high-capital districts (i.e., 10th and 90th percentiles). Looking at the coefficients in column 6, we obtain that an increase by one SD in the short-term rate (664 bps in the monthly data) reduces non-food inflation 6 months later by almost 3 percentage points (or 32% of the mean) more in low-capital districts than in high-capital ones. The coefficients are statistically significant for utilities and transportation, the two main components of the non-food CPI. They are negative but imprecisely estimated for bank liquidity.

5.3 Role of financial development

To shed light on a potential mechanism through which financial sector development can promote capital accumulation and growth, we examine if the potency of the bank lending channel varies with financial sector development at the district level. The cross-country literature shows that

financial development and an efficient legal system boost capital formation and economic growth (Beck and Levine, 2002). Focusing on a single country allows us to control for the quality of the legal environment—which is arguably the same across districts—and zoom in on the role of financial development. For this purpose we exploit differences in bank presence across districts, which we measure with the number of bank branches normalized by district-level population. The measure allows us to split districts into high vs. low financial development (above/below the 90th percentile of the bank presence distribution). We estimate our baseline specifications by further interacting the main coefficients of interest ($CAPITAL \times IR$) and ($LIQUIDITY \times IR$) with indicators for high and low financial development ($FINDEV$), measured by the number of branches per capita at the district level, and controlling for all double-interactions and control variables as before. In line with the notion that financial development enhances monetary policy transmission, we expect the bank balance sheet channel to be stronger in districts with greater bank presence.

The analysis focuses on three outcomes: building permits, night-time luminosity, and public demonstrations.[31] The results are shown in Table 9. We also report p-values for one-sided tests of the hypotheses that the balance-sheet interactions yield larger coefficients for more financially-developed districts. The tests largely support these hypotheses. Across specifications, the coefficients on the triple interaction terms for districts with strong bank presence, for both capital and liquidity, have the expected sign and are statistically significant, while those for other districts are either statistically significant and smaller or insignificant. These results suggest an important role for financial development in monetary policy effectiveness (Mishra, Montiel, Pedroni and Spilimbergo, 2014) and ultimately, capital accumulation and economic growth (Beck, Levine and Loayza, 2000; Levine, Loayza and Beck, 2000; Beck and Levine, 2002; Rajan and Zingales, 1998a).

6 Conclusions

Research on monetary policy using aggregate data documents a weak or nonexistent bank lending channel in developing countries. We revisit this question using Uganda as a laboratory for identification, as it allows us to exploit a supervisory loan-level credit register with loan applications and rates and largely unanticipated variation in monetary policy during the period 2010-2014.

We find that a tightening of monetary policy reduces the supply of bank credit to firms and

[31] Unfortunately, we cannot undertake the same exercise for trade and inflation, due to insufficient variation in financial development across districts (20 districts for trade and 8 districts for inflation.)

dampens economic activity. We document a significant and sizeable effect of monetary policy on the quantity and price of credit, with adjustments in credit supply on both the extensive and intensive margins. The analysis reveals a strong bank balance sheet channel. The tightening of credit conditions—through higher rejection of loan applications, reduced granted loan volume, and higher loan rates—is stronger for banks with less capital and greater exposure to sovereign debt, even when comparing loans to identical firms borrowing at the same time from different banks (within borrower-period). Our credit supply results also imply binding effects of monetary policy on prices and economic activity, including commercial building, trade, and even public demonstrations. The impacts on the real economy are stronger in more financially-developed areas.

Overall, our results show that monetary policy can be an effective macroeconomic tool in developing countries. We argue that there are reasons to believe that the experience of Uganda can be representative of other developing countries at a similar level of financial development and in a transition towards forward-looking monetary regimes. However, further study of developing countries, especially based on microdata, is needed to understand how banks and financial development affect the transmission of monetary policy to credit aggregates and the real economy.

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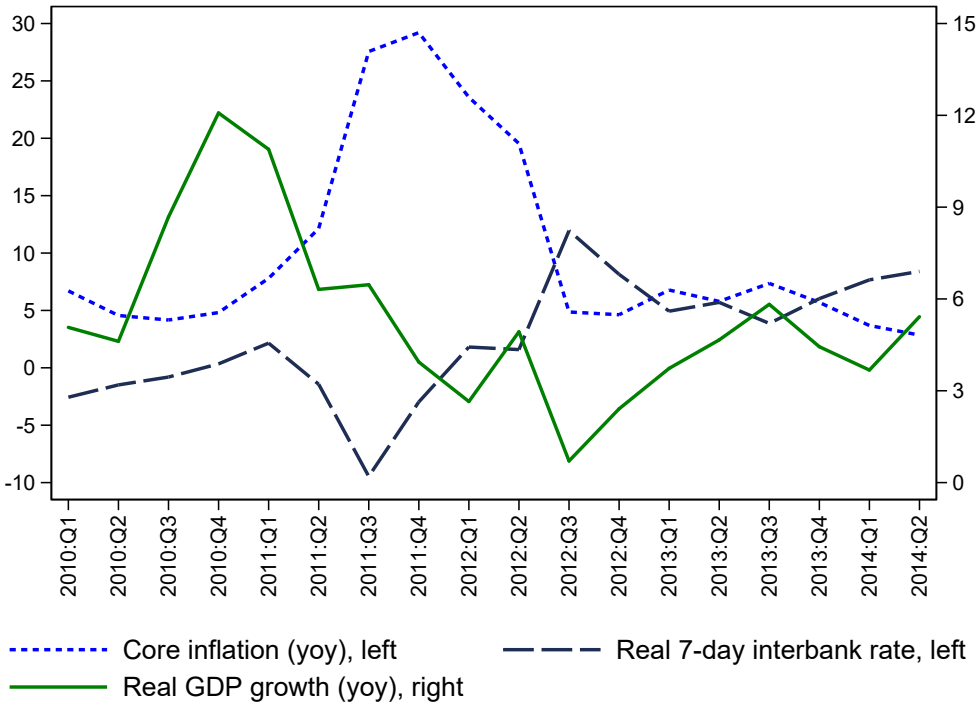
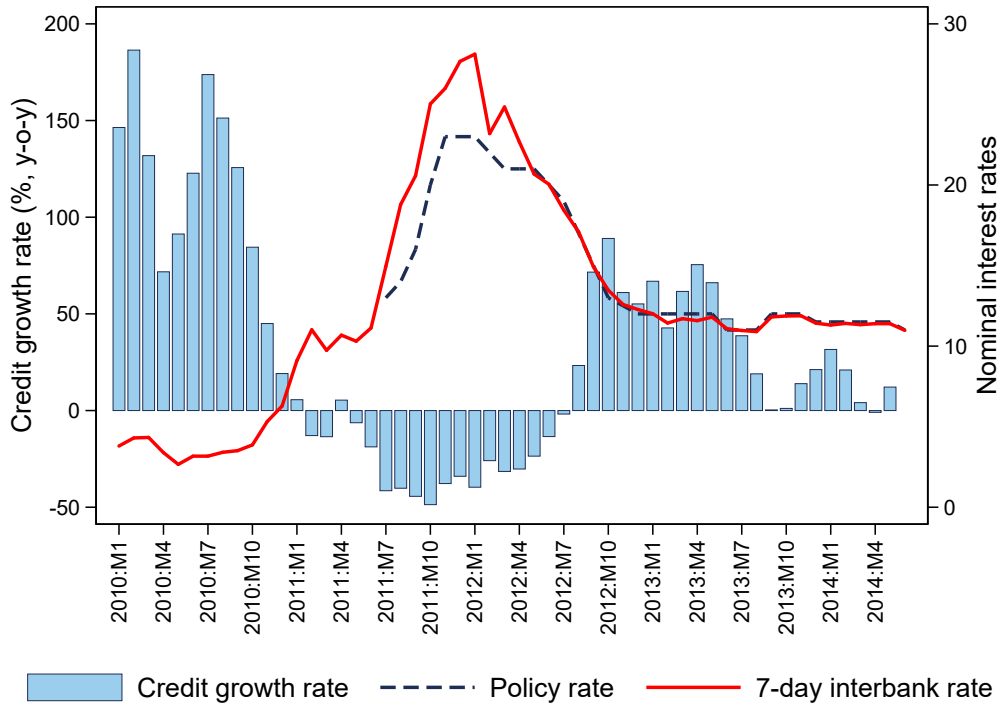
Figures and tables

Figure 1: Monetary conditions, real GDP growth, and inflation



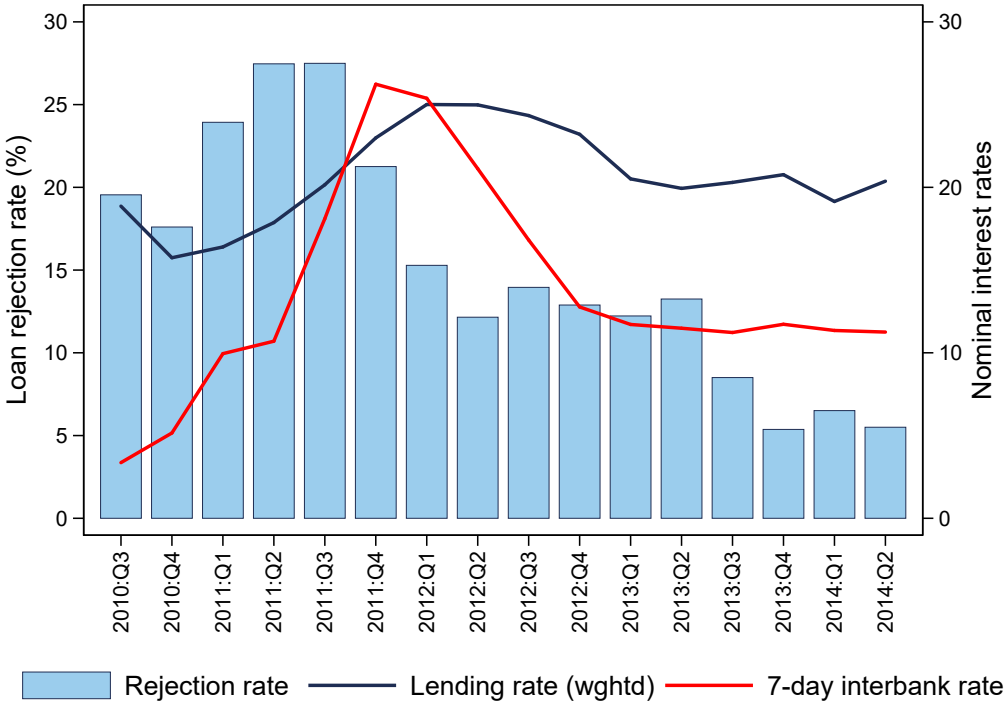
Data sources: Bank of Uganda and Uganda Bureau of Statistics.

Figure 2: Monetary conditions and credit



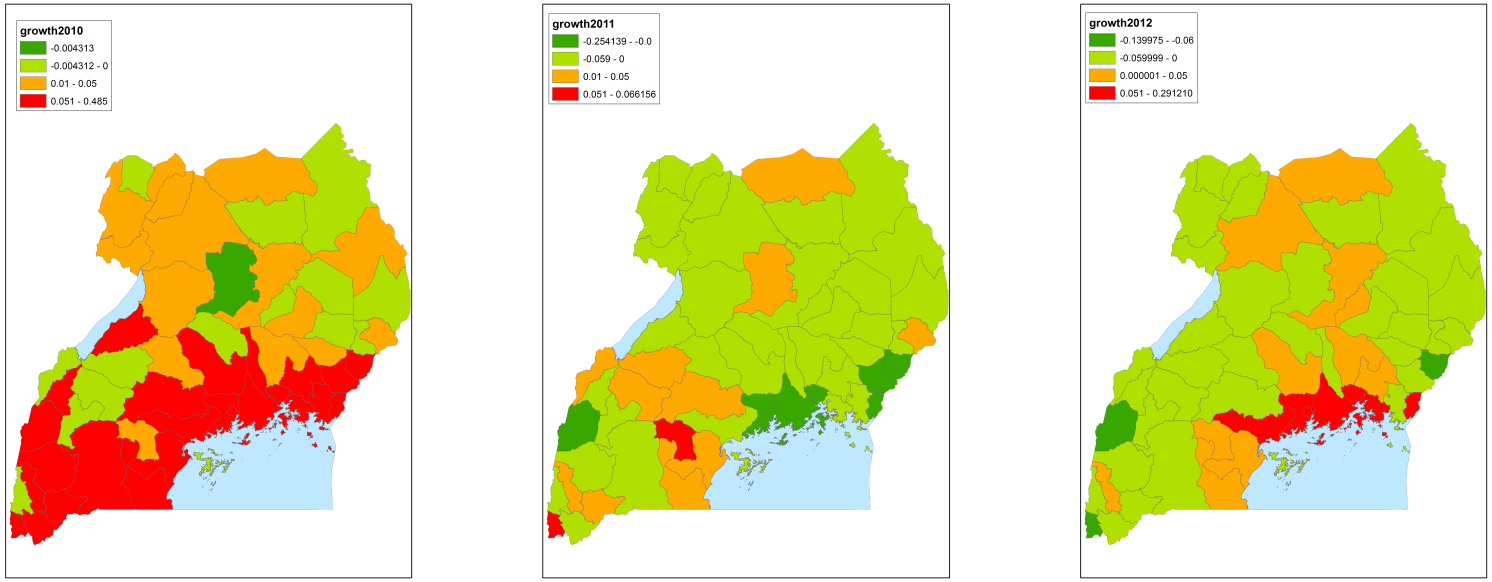
Data sources: Bank of Uganda and International Financial Statistics (IFS).

Figure 3: Monetary conditions, loan rejection rate, and average loan rate



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

Figure 4: District-level night-time luminosity



(a) 2010 (b) 2011 (c) 2012

Notes: The figure depicts satellite data on nigh-light luminosity during 2010-2012. Color coding ranges between red (highest luminosity) and green (lowest luminosity). *Data sources*: National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce.

Table 1: Variable definitions and sources

Variable	Description	Source
Credit Register Data		
LOAN APPLICATION GRANTED	Dummy variable that takes value 1 for loan applications that are accepted, 0 otherwise. To make coefficients more readable this variable is multiplied by 100	Compuscan Uganda CRB Ltd.
LOAN AMOUNT (ln)	Loan amount for granted loans (UGX billion). Expressed in real terms using the Uganda CPI (Jan 2010=100)	Compuscan Uganda CRB Ltd.
LOAN RATE	Interest rate on granted loans	Compuscan Uganda CRB Ltd.
DISTRICT	District (location) of the borrower. There are 66 districts	Compuscan Uganda CRB Ltd.
INDUSTRY	Sector of activity (industry) of the borrower. There are 9 industries: 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.
Macroeconomic Data		
IR (7-day interbank rate)	Interest rate on interbank market with maturity of 7 days	Bank of Uganda
Policy rate	Bank of Uganda policy rate (central bank rate) introduced in July 2011.	International Finance Statistics (IFS)
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)
ΔGDP	Real GDP growth (q-o-q)	Bank of Uganda
ΔCPI	CPI growth (q-o-q)	Bank of Uganda
NER	Nominal exchange rate (UGX/USD)	International Finance Statistics (IFS)
TOT	Terms of trade index.	International Finance Statistics (IFS)
$\Delta CPI, NONFOOD$	Non-food CPI, at the district-month level	Bank of Uganda
$\Delta CPI, UTILITIES$	Utilities CPI (housing, electricity, gas and other fuels), at the district-month level	Bank of Uganda
$\Delta CPI, TRANSPORTATION$	Transportation CPI, at the district-month level	Bank of Uganda
BUILDING PERMITS	Number of commercial building permits applications submitted to local townships, at district-quarter level	Uganda Bureau of Statistics
EXPORT VOLUME	Volume of exports at the district-product-destination country-year level. There are 96 product categories to 177 destinations.	Uganda Bureau of Statistics
NIGHT LIGHTS	Satellite data on night-time luminosity at the district-quarter level	National Oceanic and Atmospheric Administration (NOAA)
DEMONSTRATIONS	Number of organized or spontaneous demonstrations against a public or private institution, at the district-quarter level	Armed Conflict Location and Event Data Project (ACLED)
FINDEV	Number of bank branches per 100,000 individuals at the district level (time-invariant; bank branch data is for December 2013 and population data is a June 2014 estimate)	Authors' calculations using data from Bank of Uganda and 2014 Statistical Abstract, Uganda Bureau of Statistics.
Bank Balance Sheet Data		
CAPITAL	Total regulatory capital (Tier 1+Tier 2) divided by risk-weighted assets	Bank of Uganda
LIQUIDITY	Ratio of liquid assets to total deposits	Bank of Uganda
BANK AGE	Number of years since bank was established	Bank of Uganda
LARGE BANK	Dummy variable that takes value 1 for banks with above-median total assets, 0 otherwise	Bank of Uganda
FOREIGN	Dummy variable that takes value 1 for banks with majority foreign ownership, 0 otherwise	Bank of Uganda

Table 2: Descriptive statistics

	Obs.	Mean	St. Dev.	p25	p50	p75
Credit register data						
LOAN APPLICATION GRANTED	16,663	83.73	36.90	100.00	100.00	100.00
LOAN AMOUNT (ln)	3,611	18.13	2.35	16.59	18.04	19.70
LOAN RATE	3,377	24.74	6.45	21.00	24.00	28.00
Δ*LOAN RATE*	1,526	-0.08	6.79	-2.00	0.00	2.03
Macroeconomic variables						
IR (7-day interbank rate)	16,663	13.08	6.04	10.70	11.35	16.82
Δ*IR*	16,663	1.00	3.59	-0.38	0.29	1.79
Policy rate	11,298	14.68	4.04	11.50	12.50	17.00
91-day T-bill rate	16,663	10.81	3.88	8.94	9.44	13.38
Discount rate	16,663	16.97	5.21	14.82	15.50	19.00
Δ*GDP*	16,663	1.36	1.69	0.21	1.10	2.65
Δ*CPI*	16,663	2.93	3.48	1.05	1.45	4.17
Δ*NER*	16,663	-0.99	5.62	-2.75	-1.25	0.94
Δ*TOT*	16,663	-0.11	0.42	-0.34	-0.21	0.08
Real effects variables						
Δ*CPI, NONFOOD*	372	9.15	5.53	4.94	7.56	13.09
Δ*CPI, UTILITIES*	372	12.31	10.53	4.31	10.27	17.82
Δ*CPI, TRANSPORTATION*	372	10.66	7.44	5.00	8.78	15.98
BUILDING PERMITS (ln)	1,732	3.46	7.00	0.00	0.00	5.00
EXPORT VOLUME (ln)	7,347	9.39	3.41	6.95	9.49	11.86
NIGHT LIGHTS	1,254	4.86	5.35	3.49	4.05	4.58
DEMONSTRATIONS	229	1.42	2.74	0.00	1.00	1.00
FINDEV	1,170	1.33	1.86	0.41	1.01	1.54
Bank characteristics						
CAPITAL	16,491	20.44	6.08	20.01	21.30	24.37
LIQUIDITY	16,491	37.66	9.86	35.76	37.62	42.98
BANK AGE	16,663	36.41	18.47	28.00	29.00	49.00
LARGE BANK	16,663	76.2%	42.6%	-	-	-
FOREIGN	16,663	76.4%	42.5%	-	-	-

Notes: The table shows summary statistics for selected regression variables. See Table 1 for variable definitions. Summary statistics for loan applications, macroeconomic variables, and bank balance sheets come from the loan-applications datafile, where the unit of observation is an individual loan applications. Summary statistics for loan volumes and rates on granted loans come from the file with loan originations, where the data are aggregated at the bank-firm cluster-quarter level, where a cluster includes all firms in a district-industry pair (see Section 4.1 for details). The period of analysis is 2010:Q3–2014:Q2. Bank capital and liquidity are winsorized at the 1st and 99th percentiles of the capital and liquidity distributions.

Table 3: Extensive margin of credit supply (Loan application granted/rejected)

	(1)	(2)	(3)	(4)	(5)
ΔIR	-0.7877***	-0.5548***	-0.3437***		
	(0.119)	(0.104)	(0.098)		
$\Delta IR \times CAPITAL$				0.0721***	0.1146**
				(0.015)	(0.047)
$\Delta IR \times LIQUIDITY$				-0.0362**	-0.0619***
				(0.014)	(0.019)
ΔGDP		0.9392***	0.8214***		
		(0.194)	(0.191)		
ΔCPI		-0.6320***	-0.3754***		
		(0.172)	(0.138)		
$CAPITAL$			0.8511***	0.4825***	0.7836***
			(0.174)	(0.076)	(0.234)
$LIQUIDITY$			0.3521***	0.4336***	0.3020**
			(0.095)	(0.052)	(0.128)
$\Delta GDP \times CAPITAL$				-0.2142***	-0.0607
				(0.026)	(0.055)
$\Delta GDP \times LIQUIDITY$				-0.0055	0.0393
				(0.025)	(0.031)
$\Delta CPI \times CAPITAL$				0.0580**	-0.0444
				(0.022)	(0.027)
$\Delta CPI \times LIQUIDITY$				0.0205***	0.0176
				(0.006)	(0.015)
Observations	13,870	13,870	13,765	15,714	8,305
R^2	0.403	0.405	0.411	0.276	0.568
Firm FE	Yes	Yes	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
District-industry × year-quarter FE	No	No	No	Yes	No
Firm × year FE	No	No	No	No	Yes

Notes: The dependent variable is *LOAN APPLICATION GRANTED* and takes value 100 (to make coefficients easier to read) for loan applications that are accepted, and 0 otherwise. The unit of observation is an individual loan application. All macro variables are defined as changes between quarter $t-1$ and t and all balance sheet variables are lagged 1 quarter. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Intensive margin of credit supply (Loan volume)

	(1)	(2)	(3)	(4)	(5)
ΔIR	-0.0158***	-0.0314***	-0.0223***		
	(0.003)	(0.006)	(0.008)		
$\Delta IR \times CAPITAL$				0.0039***	0.0046***
				(0.001)	(0.002)
$\Delta IR \times LIQUIDITY$				-0.0022***	-0.0031***
				(0.001)	(0.001)
ΔGDP		0.0821***	0.0684***		
		(0.021)	(0.020)		
ΔCPI		0.0180*	0.0167**		
		(0.009)	(0.008)		
$CAPITAL$			0.0473***	0.0268	0.0343
			(0.010)	(0.031)	(0.027)
$LIQUIDITY$			0.0174***	0.0015	0.0099
			(0.004)	(0.008)	(0.013)
$\Delta GDP \times CAPITAL$				0.0015	0.0012
				(0.002)	(0.003)
$\Delta GDP \times LIQUIDITY$				0.0004	-0.0002
				(0.001)	(0.002)
$\Delta CPI \times CAPITAL$				-0.0022	-0.0014
				(0.002)	(0.002)
$\Delta CPI \times LIQUIDITY$				0.0027***	0.0016
				(0.001)	(0.001)
Observations	3,563	3,563	3,563	2,652	5,438
R^2	0.418	0.423	0.431	0.529	0.760
Bank FE	Yes	Yes	Yes	Yes	Yes
District-industry FE	Yes	Yes	Yes	Yes	No
District-industry $\times$ year-quarter FE	No	No	No	Yes	No
Firm $\times$ year FE	No	No	No	No	Yes

Notes: The dependent variable is the (log-transformed) granted loan amount $LOAN\ AMOUNT\ (ln)$. In columns 1-4 we take the average of loan amounts within firm-cluster, where a cluster refers to all firms in a given district-industry, so the unit of observation is bank-cluster-quarter. In column 5 we take the average of loan amounts granted by each bank to a firm in a given quarter, so the unit of observation is bank-firm-quarter. All macro variables are defined as cumulative changes between quarter $t-2$ and t and bank balance sheet variables are lagged 2 quarters (see Section 4 for details). Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Loan rates

	(1)	(2)	(3)	(4)	(5)
ΔIR	0.3343***	0.4877***	0.4722***		
	(0.035)	(0.039)	(0.039)		
$\Delta IR \times CAPITAL$				-0.0343***	-0.0252
				(0.008)	(0.023)
$\Delta IR \times LIQUIDITY$				0.0239***	0.0295**
				(0.005)	(0.012)
ΔGDP		-0.4024***	-0.3401***		
		(0.103)	(0.113)		
ΔCPI		-0.2059***	-0.2477***		
		(0.055)	(0.065)		
$CAPITAL$			-0.0117	0.0380	0.0075
			(0.044)	(0.055)	(0.122)
$LIQUIDITY$			-0.0845***	-0.1057***	-0.0839
			(0.018)	(0.017)	(0.068)
$\Delta GDP \times CAPITAL$				0.0421***	0.0043
				(0.008)	(0.030)
$\Delta GDP \times LIQUIDITY$				-0.0001	-0.0092
				(0.006)	(0.016)
$\Delta CPI \times CAPITAL$				-0.0009	-0.0082
				(0.010)	(0.014)
$\Delta CPI \times LIQUIDITY$				-0.0003	0.0005
				(0.008)	(0.008)
Observations	1,516	1,516	1,516	1,066	2,052
R^2	0.089	0.103	0.109	0.196	0.562
Bank FE	Yes	Yes	Yes	Yes	Yes
District-industry FE	Yes	Yes	Yes	Yes	No
District-industry × year-quarter FE	No	No	No	Yes	No
Firm × year FE	No	No	No	No	Yes

Notes: The dependent variable is the change in the rate charged on granted loans $\Delta LOAN\ RATE$. To be able to calculate the this change, in columns 1-4 we calculate the (weighted) average of the loan rates within firm-cluster, that is, across loans granted to firms in a given district-industry. Therefore, in columns 1-4 the data is at the firm cluster-bank-quarter level. In column 5 the loan rate is averaged across loans granted by a given bank to a given firm each year and we calculate the change in the loan rate relative to last period's average loan rate for the cluster to which the firm belongs. All macro variables are defined as changes between quarter $t-1$ and t and all balance sheet variables are lagged 1 quarter. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Real effects: Commercial building permits and exports

	(1)	(2)	(3)	(4)	(5)	(6)
	$ln(BUILDING\ PERMITS)$				$ln(EXPORT\ VOLUME)$	
# quarters over which IR is lagged (z)	z=1	z=2	z=3	z=4	z=0	z=0
$CAPITAL \times IR$	0.0038***	0.0031*	0.0028*	0.0026*	0.0818**	0.0808**
	(0.001)	(0.002)	(0.001)	(0.001)	(0.032)	(0.029)
$LIQUIDITY \times IR$	-0.0013**	-0.0010	-0.0010	-0.0010	-0.0130	-0.0152
	(0.001)	(0.001)	(0.001)	(0.001)	(0.011)	(0.012)
$CAPITAL$	-0.0588***	-0.0494**	-0.0506***	-0.0417**	-0.7690*	-0.7884**
	(0.014)	(0.019)	(0.017)	(0.019)	(0.414)	(0.368)
$LIQUIDITY$	0.0114	0.0070	0.0094	0.0104	0.2046	0.2621
	(0.009)	(0.013)	(0.012)	(0.013)	(0.239)	(0.236)
$CAPITAL \times \Delta GDP$	0.0075***	0.0029	0.0021	0.0051	0.1040**	0.1057**
	(0.003)	(0.003)	(0.003)	(0.004)	(0.041)	(0.040)
$LIQUIDITY \times \Delta GDP$	-0.0040**	-0.0005	0.0003	-0.0017	-0.0222	-0.0285
	(0.002)	(0.002)	(0.001)	(0.002)	(0.024)	(0.025)
$CAPITAL \times \Delta CPI$	-0.0033	-0.0022	-0.0014	-0.0011	-7.1449**	-6.9250**
	(0.002)	(0.001)	(0.002)	(0.003)	(3.078)	(2.890)
$LIQUIDITY \times \Delta CPI$	0.0015	0.0009	0.0002	0.0007	1.1663	1.0792
	(0.001)	(0.001)	(0.001)	(0.001)	(0.996)	(1.003)
Observations	1,386	1,320	1,254	1,188	7,347	6,459
R^2	0.326	0.291	0.249	0.185	0.534	0.544
Include exports of raw materials	-	-	-	-	Yes	No
Number of districts	66	66	66	66	18	18
District FE	Yes	Yes	Yes	Yes	-	-
Year-quarter FE	Yes	Yes	Yes	Yes	-	-
Product×destination×year FE	-	-	-	-	Yes	Yes

Notes: The dependent variable is the log-transformed number of applications for commercial building permits that are submitted to local municipalities in each district and quarter $ln(BUILDING\ PERMITS)$ (columns 1-4), and the (log-transformed) volume of exports of a given product to destination country recorded at the custom's office in a given district and year $ln(EXPORT\ VOLUME)$ (columns 5-6). The regressions allow for quarterly lags ($z = 1, 2, 3, 4$, columns 1-4) or a contemporaneous ($z = 0$, columns 5-6) impact of the short-term rate IR and other macro variables, indicated as column headings. The variables $CAPITAL$ and $LIQUIDITY$, lagged 1 quarter, are computed as weighted averages of bank capital and liquidity at the district level, where the weights are given by banks' market share in total local currency lending in each district over the sample period. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Real effects: Night-time luminosity and public demonstrations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	NIGHT LIGHTS				***DEMONSTRATIONS***			
# quarters (z) over which IR is lagged	z=1	z=2	z=3	z=4	z=1	z=2	z=3	z=4
$CAPITAL \times IR$	-0.0011	0.0005	0.0024**	0.0025**	0.0010	-0.0001	-0.0014*	-0.0012*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
$LIQUIDITY \times IR$	0.0008	-0.0002	-0.0010	-0.0016**	-0.0002	0.0004	0.0009*	0.0008**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
$CAPITAL$	-0.0097	0.0234	-0.0357	-0.0021	-0.0133	-0.0181	0.0060	0.0127
	(0.022)	(0.027)	(0.033)	(0.036)	(0.014)	(0.013)	(0.013)	(0.011)
$LIQUIDITY$	-0.0129	-0.0186	0.0107	0.0250*	0.0029	0.0059	-0.0040	-0.0031
	(0.011)	(0.016)	(0.016)	(0.015)	(0.006)	(0.009)	(0.005)	(0.006)
$CAPITAL \times \Delta GDP$	0.0018	-0.0112**	0.0058	0.0099***	0.0002	0.0048	-0.0026	-0.0035*
	(0.004)	(0.005)	(0.005)	(0.003)	(0.001)	(0.003)	(0.004)	(0.002)
$LIQUIDITY \times \Delta GDP$	0.0005	0.0040	-0.0018	-0.0055**	0.0001	-0.0004	0.0026	0.0017
	(0.002)	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
$CAPITAL \times \Delta CPI$	0.0030	-0.0092**	-0.0009	-0.0019	-0.0001	0.0045*	0.0015	0.0003
	(0.002)	(0.004)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
$LIQUIDITY \times \Delta CPI$	-0.0025*	0.0034	-0.0000	0.0015	-0.0001	-0.0027**	-0.0012*	-0.0007
	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	1,254	1,188	1,122	1,056	1,386	1,320	1,254	1,188
R^2	0.390	0.378	0.348	0.275	0.048	0.052	0.047	0.047
Number of districts	66	66	66	66	66	66	66	66
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 night-time luminosity $NIGHT\ LIGHTS$ (columns 1-4) and the number of public demonstrations $DEMONSTRATIONS$ (columns 5-8) at district-quarter level. The regressions allow for lagged effects of the short-term rate IR and other macro variables ($z = 1, 2, 3, 4$), as indicated as column headings. The variables $CAPITAL$ and $LIQUIDITY$, lagged 1 quarter, are computed as weighted averages of bank capital and liquidity at the district level, where the weights are given by banks' market share in total local-currency lending in each district over the sample period. Due to the availability of the $NIGHT\ LIGHTS$ series, in columns 1-4 the sample period is 2010Q1:2013Q4. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8: Inflation

	(1) z=1	(2) z=2	(3) z=3	(4) z=4	(5) z=5	(6) z=6	(7) z=7	(8) z=8	(9) z=9	(10) z=10	(11) z=11	(12) z=12
ΔCPI, NONFOOD												
$CAPITAL \times IR$	0.0114	0.0165**	0.0198***	0.0231***	0.0233***	0.0231***	0.0226***	0.0198***	0.0192***	0.0189***	0.0189***	0.0204***
	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$LIQUID \times IR$	-0.0069	-0.0061	-0.0050	-0.0045	-0.0031	-0.0038	-0.0034	-0.0039	-0.0036	-0.0020	-0.0018	0.0001
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
R^2	0.911	0.912	0.915	0.917	0.918	0.918	0.918	0.917	0.917	0.917	0.917	0.918
ΔCPI, UTILITIES												
$CAPITAL \times IR$	0.1220***	0.1372***	0.1596***	0.1566***	0.1565***	0.1464***	0.1328***	0.1140***	0.0985***	0.0871***	0.0757***	0.0678***
	(0.035)	(0.032)	(0.031)	(0.030)	(0.028)	(0.027)	(0.025)	(0.024)	(0.023)	(0.023)	(0.024)	(0.024)
$LIQUID \times IR$	0.0085	0.0065	-0.0043	-0.0202	-0.0241	-0.0354**	-0.0348**	-0.0331**	-0.0279**	-0.0171	-0.0110	-0.0059
	(0.022)	(0.021)	(0.021)	(0.020)	(0.018)	(0.018)	(0.016)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)
R^2	0.666	0.672	0.683	0.686	0.686	0.680	0.676	0.670	0.666	0.664	0.661	0.659
ΔCPI, TRANSPORTATION												
$CAPITAL \times IR$	0.0563**	0.0747***	0.0892***	0.0975***	0.1035***	0.1068***	0.1090***	0.1026***	0.1001***	0.0935***	0.0939***	0.0909***
	(0.025)	(0.024)	(0.024)	(0.024)	(0.023)	(0.022)	(0.022)	(0.022)	(0.021)	(0.020)	(0.021)	(0.021)
$LIQUID \times IR$	-0.0008	-0.0010	0.0012	-0.0029	-0.0052	-0.0084	-0.0087	-0.0131	-0.0126	-0.0083	-0.0102	-0.0036
	(0.016)	(0.016)	(0.015)	(0.015)	(0.015)	(0.014)	(0.012)	(0.013)	(0.013)	(0.012)	(0.011)	(0.010)
R^2	0.485	0.493	0.509	0.523	0.527	0.530	0.534	0.529	0.529	0.527	0.526	0.524
Observations	356	356	364	372	372	372	372	372	372	372	372	372
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the inflation rate ΔCPI at the district-month level, for 8 districts during 2010:M7-2014M6. All regressions include the control variables from Equation 3, namely bank characteristics, capital and liquidity, and their interactions with GDP growth (coefficients not shown). Capital, liquidity, and GDP growth are lagged 1 quarter. In the second row, z indicates the number of months over which IR is lagged. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9: Role of financial development

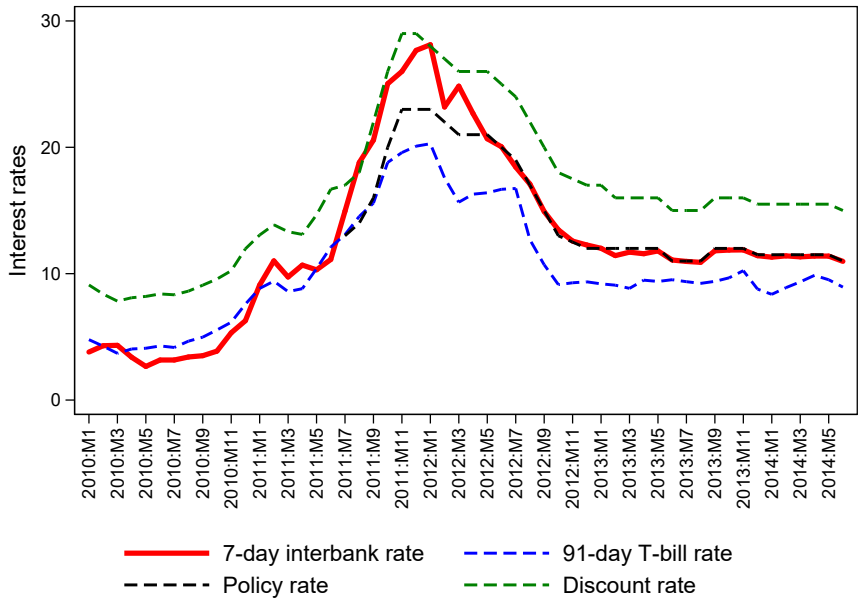
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	$ln(BUILDINGPERMITS)$				$NIGHTLIGHTS$				$DEMONSTRATIONS$			
# quarters over which IR is lagged	z=1	z=2	z=3	z=4	z=1	z=2	z=3	z=4	z=1	z=2	z=3	z=4
$CAPITAL \times IR \times FINDEV, high$	0.0080***	0.0091***	0.0098***	0.0090***	0.0065***	0.0058	0.0046	0.0038	-0.0081	-0.0084*	-0.0112**	-0.0108**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)	(0.005)
$CAPITAL \times IR \times FINDEV, low$	0.0016	0.0015	0.0018	0.0021	0.0001	0.0013	0.0018	0.0020	0.0009	0.0005	-0.0011	-0.0008
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$LIQUIDITY \times IR \times FINDEV, high$	-0.0035**	-0.0042***	-0.0047***	-0.0044***	-0.0034***	-0.0026	-0.0018	-0.0017	0.0053	0.0051*	0.0061**	0.0063**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)	(0.003)
$LIQUIDITY \times IR \times FINDEV, low$	-0.0006	-0.0004	-0.0006	-0.0009	-0.0002	-0.0010*	-0.0012	-0.0015**	-0.0005	-0.0000	0.0006	0.0005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
Observations	1,170	1,170	1,170	1,170	1,040	1,040	1,040	1,040	1,170	1,170	1,170	1,170
R^2	0.688	0.688	0.688	0.688	0.958	0.958	0.958	0.958	0.527	0.530	0.525	0.528
Test of equality of capital coeff.	0.009	0.001	0.000	0.000	0.034	0.154	0.326	0.580	0.143	0.052	0.017	0.052
Test of equality of liquidity coeff.	0.040	0.002	0.000	0.000	0.107	0.430	0.673	0.888	0.157	0.079	0.017	0.046
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variables are: the (log-transformed) number of applications for commercial building permits $BUILDING\ PERMITS(ln)$ that are submitted to local municipalities in each district and quarter (columns 1-4), the night-time luminosity at the district-quarter level ($NIGHT\ LIGHTS$, columns 5-8), and the number of public demonstrations at the district-quarter level ($DEMONSTRATIONS$, columns 9-12). The regressions allow for lags $z = 1, 2, 3, 4$ in in ΔIR and the macro variables, indicated as column headings. $FINDEV, high$ and $FINDEV, low$ are time-invariant district-level indicators for high and low level of financial development measured as the number of bank branches per 100,000 population in 2013. High financial development takes value 1 for districts whose bank branch presence is above the 90th percentile of the variable. Low financial development takes value 1 for districts whose bank branch presence is below the 90th percentile of the variable. The variables $CAPITAL$ and $LIQUIDITY$ are computed as weighted averages of bank capital and liquidity at the district level, where the weights are given by banks' market share in each district over the sample period. All specifications include the all the control variables from the baseline loan-granting and real-effects regressions, Tables 3, 6 and 7 (coefficients not shown). The tests for the equality of coefficients report the p-values. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Online Appendix (not for publication)

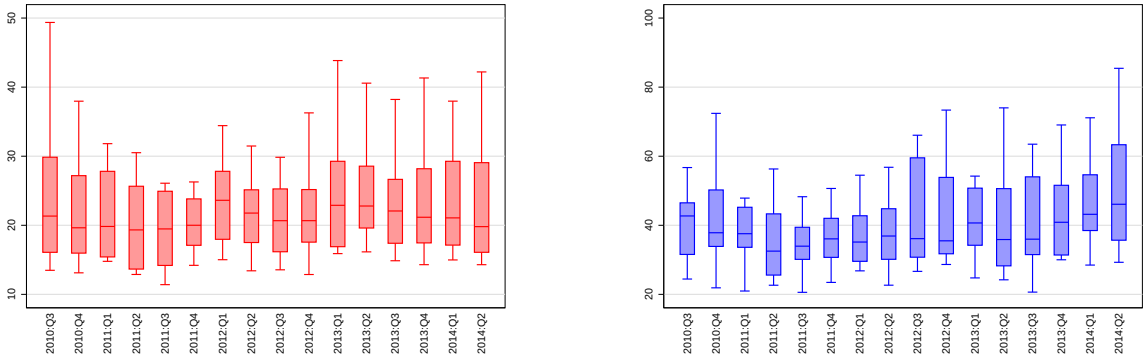
A-I Additional figures and tables

Figure A1: Interest rates



Data sources: Bank of Uganda.

Figure A2: Bank capital and liquidity



(a) Capital (b) Liquidity

Notes: Bank capital is the ratio of total regulatory capital (Tier 1 + Tier 2) to total risk-weighted assets (Panel A). Bank liquidity is the ratio of liquid assets to total deposits (Panel B). *Data sources*: Bank of Uganda.

Table A1: Lending in foreign currencies

	(1)	(2)	(3)	(4)
	A. *LOAN APPLICATION GRANTED*			
ΔIR	-0.0170***	-0.0107**	-0.0098***	
	(0.002)	(0.004)	(0.003)	
$\Delta IR \times CAPITAL$				0.0036***
				(0.001)
$\Delta IR \times LIQUIDITY$				-0.0011***
Observations	1,932	1,932	1,931	2,160
R^2	0.421	0.429	0.444	0.340
Firm FE	Yes	Yes	Yes	No
Bank FE	Yes	Yes	Yes	Yes
District-industry × year-quarter FE	No	No	No	Yes
	B. *LOAN AMOUNT* (ln)			
ΔIR	-0.0098	-0.0062	-0.0066	
	(0.007)	(0.005)	(0.005)	
$\Delta IR \times CAPITAL$				-0.0004
				(0.004)
$\Delta IR \times LIQUIDITY$				-0.0019
Observations	1,008	1,008	1,007	846
R-squared	0.216	0.219	0.220	0.287
Bank FE	Yes	Yes	Yes	Yes
District-industry FE	Yes	Yes	Yes	Yes
District-industry × year-quarter FE	No	No	No	Yes
	C. Δ*LOAN RATE*			
ΔIR	-0.0378**	-0.0519**	-0.0221	
	(0.013)	(0.017)	(0.014)	
$\Delta IR \times CAPITAL$				0.0349
				(0.027)
$\Delta IR \times LIQUIDITY$				-0.0567
				(0.040)
Observations	462	462	461	396
R^2	0.018	0.023	0.028	0.263
Bank FE	Yes	Yes	Yes	Yes
District-industry FE	Yes	Yes	Yes	Yes
District-industry × year-quarter FE	No	No	No	Yes

Notes: The dependent variable is *LOAN APPLICATION GRANTED* in Panel A, the granted loan amount *LOAN AMOUNT* (ln) in Panel B, and the change in the average loan rate Δ*LOAN RATE* in Panel C. The sample includes only foreign currency loan applications and granted loans. All macro and bank level controls are defined as in the baseline specifications (see Tables 3, 4, and 5). In column 1 there are no controls, column 2 includes macro controls, column 3 includes macro and bank level controls, and column 4 includes interactions of macro and bank variables (coefficients not shown). Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A2: Robustness—Alternative interest rates

	(1)	(2)	(3)	(4)	(5)	(6)
	Policy rate		**91-day T-Bill rate**		**Discount rate**	
	A. *LOAN APPLICATION GRANTED*					
ΔIR	-0.5623***		-0.5881***		-0.3618***	
	(0.168)		(0.183)		(0.133)	
$\Delta IR \times CAPITAL$		-0.0045		-0.0521**		-0.0400**
		(0.019)		(0.022)		(0.016)
$\Delta IR \times LIQUIDITY$		0.1091***		0.0997***		0.0683***
		(0.030)		(0.033)		(0.023)
Observations	7,582	9,327	13,779	15,729	13,779	15,729
R^2	0.377	0.203	0.412	0.277	0.412	0.277
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No	Yes	No
District-industry × year-quarter FE	No	Yes	No	Yes	No	Yes
	B. *LOAN AMOUNT* (ln)					
$\Delta^2 IR$	-0.0141**		-0.0164		-0.0198***	
	(0.006)		(0.011)		(0.007)	
$\Delta^2 IR \times CAPITAL$		0.0043		0.0080***		0.0052***
		(0.003)		(0.003)		(0.002)
$\Delta^2 IR \times LIQUIDITY$		-0.0037***		-0.0047***		-0.0026***
		(0.001)		(0.001)		(0.001)
Observations	2,216	1,649	3,563	2,652	3,563	2,652
R^2	0.445	0.542	0.431	0.530	0.431	0.530
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
District-industry × year-quarter FE	No	Yes	No	Yes	No	Yes
	C. Δ*LOAN RATE*					
ΔIR	-0.1094***	-0.0609*	-0.0868***	-0.1075***	-0.0793***	-0.1212***
	(0.032)	(0.032)	(0.019)	(0.015)	(0.018)	(0.014)
$\Delta IR \times CAPITAL$		-0.0213		-0.0011		0.0038
		(0.019)		(0.006)		(0.006)
$\Delta IR \times LIQUIDITY$		0.0464		0.0346***		0.0303***
		(0.031)		(0.007)		(0.006)
Observations	1,090	766	1,516	1,066	1,516	1,066
R^2	0.099	0.192	0.099	0.200	0.103	0.196
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
District-industry × year-quarter FE	No	Yes	No	Yes	No	Yes

Notes: This table examines the robustness of selected baseline lending results to alternative interest rates. Instead of the 7-day interbank rate, here we use the policy rate available starting 2011:Q2 (columns 1-2), the 91-day Treasury bill rate (columns 3-4), and the central bank discount rate at which banks can borrow against eligible collateral (columns 5-6). The dependent variables are *LOAN APPLICATION GRANTED* in Panel A, *LOAN AMOUNT* (ln) in Panel B, and Δ*LOAN RATE* in Panel C. All specifications include the macro and bank-level control variables from the baseline regressions (see Tables 3-5) (coefficients not shown). Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A3: Robustness—Control for nominal exchange rate and terms of trade

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	LOAN GRANTED				***LOAN AMOUNT (ln)***				**ΔLOAN RATE**			
ΔIR	-0.3514***		-0.3253***		-0.0314		-0.0630**		0.4485***		0.4192***	
	(0.130)		(0.099)		(0.036)		(0.026)		(0.061)		(0.066)	
$\Delta IR \times CAPITAL$		0.0456**		0.0729***		0.0050**		0.0041**		-0.0405***		-0.0329***
		(0.022)		(0.015)		(0.002)		(0.002)		(0.010)		(0.009)
$\Delta IR \times LIQUIDITY$		-0.0232*		-0.0337**		-0.0034**		-0.0026**		0.0265**		0.0223***
		(0.013)		(0.013)		(0.001)		(0.001)		(0.010)		(0.007)
$\Delta GDP \times CAPITAL$		-0.1993***		-0.2116***		-0.0012		0.0006		0.0521***		0.0478***
		(0.029)		(0.027)		(0.002)		(0.003)		(0.011)		(0.009)
$\Delta GDP \times LIQUIDITY$		-0.0152		-0.0002		0.0019		0.0007		-0.0131		-0.0170*
		(0.021)		(0.025)		(0.002)		(0.001)		(0.010)		(0.009)
$\Delta CPI \times CAPITAL$		0.0944**		0.0544***		-0.0037		-0.0023		0.0076		0.0005
		(0.038)		(0.020)		(0.002)		(0.003)		(0.015)		(0.012)
$\Delta CPI \times LIQUIDITY$		0.0040		0.0181***		0.0043**		0.0033***		-0.0047		-0.0028
		(0.011)		(0.006)		(0.002)		(0.001)		(0.015)		(0.010)
$\Delta NER \times CAPITAL$		0.0199*				-0.0010				0.0049		
		(0.011)				(0.002)				(0.005)		
$\Delta NER \times LIQUIDITY$		-0.0094				0.0009				-0.0016		
		(0.006)				(0.001)				(0.006)		
$\Delta TOT \times CAPITAL$				0.0953				0.0065				0.0599
				(0.105)				(0.017)				(0.053)
$\Delta TOT \times LIQUIDITY$				0.1096*				0.0017				-0.0873
				(0.065)				(0.006)				(0.060)
Observations	13,765	15,714	13,765	15,714	3,611	3,611	3,611	3,611	1,526	1,526	1,526	1,526
R-squared	0.411	0.276	0.411	0.276	0.449	0.650	0.448	0.650	0.116	0.478	0.119	0.479
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No	No	No	No	No	No	No	No	No
District-industry × year-quarter FE	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the robustness of selected baseline lending results to controlling for the nominal exchange rate (NER) and terms of trade (TOT). The dependent variables are $LOAN\ APPLICATION\ GRANTED$ in columns 1-4, $LOAN\ AMOUNT\ (ln)$ in columns 5-8, and $\Delta LOAN\ RATE$ in columns 9-12. For each dependent variable, the additional controls enter, alternatively, in level (odd-numbered columns), and interacted with bank capital and liquidity (even-numbered columns). All specifications include the macro and bank-level control variables from the baseline regressions (see Tables 3-5) and the additional variables in levels (coefficients not shown). Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

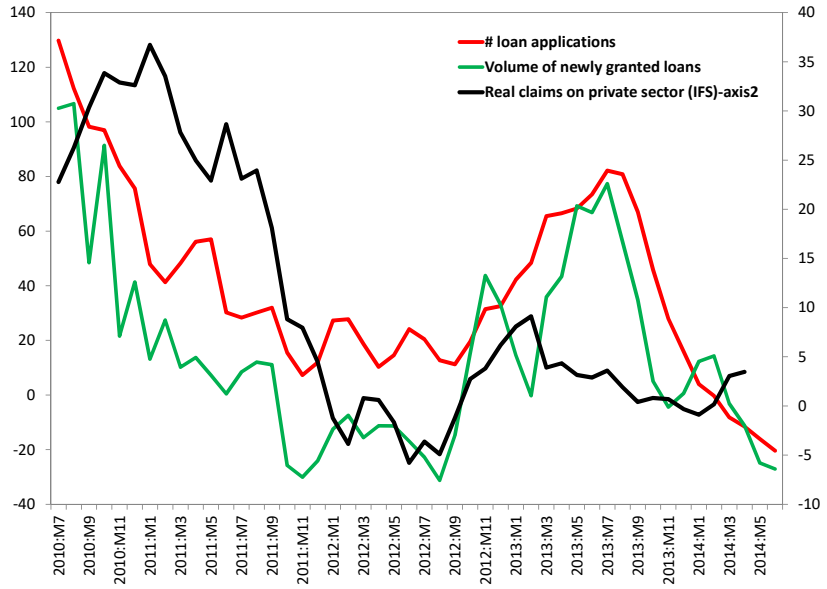
Table A4: Robustness—Additional bank characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	LOAN APPLICATION GRANTED				***LOAN AMOUNT (ln)***				**Δ*LOAN RATE***			
$\Delta IR \times CAPITAL$	0.0566***	0.0674***	0.0285**	0.0526***	0.0040**	0.0050***	0.0044***	0.0040***	-0.0368***	-0.0405***	-0.0438***	-0.0400***
	(0.010)	(0.013)	(0.014)	(0.011)	(0.001)	(0.001)	(0.002)	(0.001)	(0.007)	(0.007)	(0.006)	(0.007)
$\Delta IR \times LIQUIDITY$	-0.0354***	-0.0745***	-0.0061	-0.0096*	-0.0026***	-0.0041***	-0.0028***	-0.0025***	0.0256***	0.0303***	0.0278***	0.0329***
	(0.006)	(0.010)	(0.011)	(0.005)	(0.001)	(0.001)	(0.001)	(0.001)	(0.005)	(0.004)	(0.004)	(0.006)
$\Delta IR \times BANK\ AGE$		0.0359***				0.0016***				-0.0047***		
		(0.007)				(0.000)				(0.001)		
$\Delta IR \times FOREIGN$			-0.8149***				0.0080				-0.3440***	
			(0.256)				(0.039)				(0.063)	
$\Delta IR \times LARGE\ BANK$				-1.1543***				-0.0010				-0.1185*
				(0.229)				(0.026)				(0.064)
Observations	13,765	13,765	13,765	13,765	2,652	2,652	2,652	2,652	1,066	1,066	1,066	1,066
R-squared	0.412	0.416	0.413	0.415	0.535	0.538	0.536	0.536	0.202	0.210	0.207	0.206
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No
District-industry×year-quarter FE	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the robustness of selected baseline credit-supply results, in particular the balance-sheet interactions, to controlling for additional bank characteristics (in levels and interactions with the interest rate). The dependent variables are *LOAN APPLICATION GRANTED* in columns 1-4, *LOAN AMOUNT* (ln) in columns 5-8, and Δ*LOAN RATE* in columns 9-12. The bank balance sheet characteristics are bank age *BANK AGE*, a dummy variable that takes value 1 for foreign banks *FOREIGN*, and a dummy variable that takes value 1 for banks with total assets above the sample median *LARGE BANK*. All specifications include the macro and bank-level control variables from the baseline regressions (see Tables 3-5) and the interacted variables in levels (coefficients not shown). Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

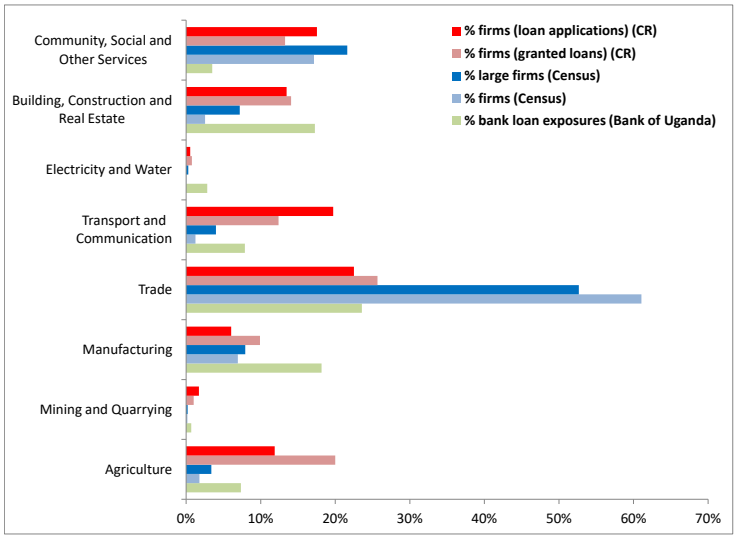
A-II Credit register representativeness

Figure A3: Credit growth: Credit register vs. aggregate statistics

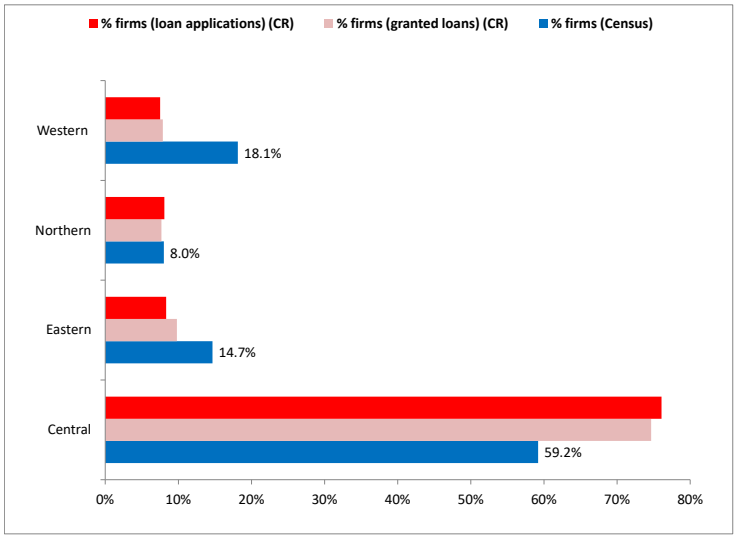


Notes: The figure plots the real growth rate of the total volume of granted loans (from the credit register), that of banking sector claims on the private sector (from the International Financial Statistics), and the growth rate of the total number of loan applications (from the credit register) on a monthly basis. All growth rates are year-on-year. *Data sources*: Bank of Uganda and International Financial Statistics (IFS).

Figure A4: Firm distribution by industry and region: Credit register vs. aggregate statistics



(a) Industry distribution



(b) Geographical distribution

Notes: The figure plots the distributions of loan applicants and borrowing firms (from the credit register "CR") against those from the 2010-2011 Census and aggregate banking system statistics (Bank of Uganda), by industry (Panel A) and by region (Panel B). In Panel A we additionally report the distribution of *large* firms by industry, where firms are large if they have an annual turnover in excess of 10 million Ugandan shillings (approximately 2,800 USD); and the distribution of outstanding loan claims for all commercial banks. *Data sources*: Bank of Uganda and Ugandan Bureau of Statistics.