Journal of Development Economics 139 (2019) 185–202

Contents lists available at ScienceDirect

Journal of Development Economics

journal homepage: www.elsevier.com/locate/devec

Monetary policy and bank lending in developing countries: Loan applications, rates, and real effects☆

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ARTICLE INFO

JEL classification:
E42
E44
E52
E58
G21
G28

Keywords:
Bank lending channel of monetary policy
Bank credit
Real effects
Credit register
Developing countries

ABSTRACT

Recent studies of monetary policy in developing countries document a weak bank lending channel based on aggregate data. In this paper, we bring new evidence using Uganda's supervisory credit register, with microdata on loan applications, volumes and rates, coupled with unanticipated variation in monetary policy. We show that a monetary contraction reduces bank credit supply—increasing loan application rejections and tightening loan volume and rates—especially for banks with more leverage and sovereign debt exposure. There are associated spillovers on inflation and economic activity—including construction permits and trade—and even social unrest.

1. Introduction

In developing countries, institutional constraints hamper financial intermediation and public policy effectiveness (Beck et al., 2000; Levine et al., 2000). Monetary policy transmission, for instance, is hindered by weaknesses in the legal environment, underdeveloped financial markets, and concentrated banking systems (Mishra et al., 2014). 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,

☆ We thank the Bank of Uganda, Compuscan Uganda CRB Ltd., and Uganda Bureau of Statistics, for providing the data used in this study and assisting us with queries and advice. We thank David Lagakos (the editor), three anonymous referees, Thorsten Beck, Andrew Berg, Ata Can Bertay, Olivier Blanchard, Ales Bulir, Rupa Duttagupta, Kinda Hachem, Hideaki Hirata, Tommaso Mancini-Griffoli, Stelios Michalopoulos, Peter Montiel, Steven Ongena, Catherine Pattillo, Mahvash Qureshi, Marta Reynal Querol, André Silva, Silvana Tenreyro, Neeltje Van Horen, Tomasz Wieladek, Ling Zhu, staff at the Bank of Uganda, and participants at numerous conferences and seminars for useful comments and discussions. We thank Jeffrey Dickinson and Manzoor Gill for outstanding research assistance. Earlier versions of this paper appeared as CEPR Discussion Paper 12171 and IMF Working Paper 15/270. This paper is part of a research project on macroeconomic policy in low-income countries supported by the U.K.'s Department for International Development (DFID). The views expressed herein are those of the authors and should not be attributed to the Bank of Uganda, DFID, the IMF, the Federal Reserve System, their staff, management, or policies. José-Luis Peydró acknowledges financial support from project ECO2015-68182-P (MINECO/FEDER, UE).

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https://doi.org/10.1016/j.jdeveco.2019.03.004
Received 2 February 2018; Received in revised form 1 November 2018; Accepted 7 March 2019
Available online 18 March 2019

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 shed new light on the bank lending channel of monetary policy in developing countries using Uganda as a case study. Uganda is a fast-growing, bank-dependent African economy which shares many characteristics with countries at the same level of development (for instance, low levels of financial intermediation).[1] Over the past decade, the financial system experienced rapid growth and diversification and the country became increasingly integrated with regional and global capital markets. These factors led Uganda, like other low and lower-middle income countries, to take steps towards adopting a more forward-looking monetary policy framework (IMF, 2015a). Specifically, in July 2011, the Bank of Uganda transitioned from a traditional, backward-looking monetary targeting framework, to an inflation targeting (IT) "lite" framework, in order to meet the challenges of macroeconomic management generated by the recent transformation of the economy.

We test the bank lending channel in Uganda during a four-year period around the introduction of the new monetary policy framework (2010–2014), with two objectives. First, we wish to better understand the effects of monetary policy in developing economies that pursue price and financial stability objectives through modern monetary policy frameworks. Second, we wish to systematically document the behavior of banks in developing countries in the face of significant fluctuations in monetary conditions. We are able to undertake this analysis because Uganda has an extensive credit register with the universe of loan applications and rates and has had, as we will argue, largely unanticipated variations in monetary policy. In addition to detailed microdata on the lending activities of commercial banks, we also bring to the analysis extensive information on local economic activity, including data on construction permits, trade, and social unrest.

We exploit a high degree of variation in monetary conditions during the period of analysis, ranging from highly contractionary to highly expansionary. Following inflationary pressures from a commodity price shock coupled with strong credit growth, the Bank of Uganda raised the policy rate in the second half of 2011 by a cumulative 1,000 basis points (bps). After this tightening, the economy slowed down and the Bank of Uganda gradually cut the policy rate by a total of 1,100 bps over the following year.[2] Previous studies that employ narrative or data-driven approaches to identify monetary policy shocks argue that the timing and the extent of the tightening episode in mid-2011 were at least partly unexpected by economic agents (Berg et al., 2019; Willems, 2018). One reason is that the track record of the central bank was one of accommodative monetary policy in the face of sizable price shocks, casting doubt on whether a tightening would occur during this period at all. These arguments, together with our own analysis of central bank communications and media coverage during the sample period, suggest a lack of anticipation of central bank actions, and help with identification. Moreover, our specifications include comprehensive controls for economic activity and prices to reduce the influence of potentially confounding factors.

A key challenge for testing the bank lending channel of monetary policy 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 empirical identification challenge, we use granular data from the credit register which covers all corporate loans extended by banks in Uganda. The data includes individual loan applications by non-financial firms, with accept/reject decisions, and the terms of new originated loans, including volume and interest rate. Such granular data, especially on loan applications and loan pricing, are absent in most credit registers around the world, including in advanced economies. We match these loan-level data with supervisory bank balance sheet data on a quarterly basis.

Our specifications include macroeconomic controls, bank balance-sheet interactions, and a multitude of fixed effects. In the baseline lending regressions, we separate the effects of monetary policy proxied by changes in short-term interest rates from those of macroeconomic conditions by controlling for real GDP growth and inflation. Following Kashyap and Stein (2000) and Jiménez et al. (2012), we allow the effects of monetary policy to vary with bank capital and liquidity, while including time fixed effects to capture all macroeconomic factors that change simultaneously with policy rates, as well as bank and firm fixed effects to control for unobserved bank and firm characteristics. In addition, we use time-varying borrower fixed effects in specifications involving bank balance-sheet interactions to control for credit demand shocks. In the spirit of Khwaja and Mian (2008), our main specifications compare loans to firms in narrowly defined clusters (in the same industry and district) that borrow *in the same quarter* from banks with varying levels of capital and liquidity. In more demanding specifications we include firm × year fixed effects and hence compare loans to the same firm borrowing *in the same year* from different banks (similar to Jiménez et al. (2014) and Jimenez et al. (2015)).

Matching the microdata from the credit register with extensive regional statistics, we also analyze the impact of the bank lending channel on the real economy and prices. In particular, we match the locations (districts) of the lending bank branch and the borrowing firm with measures of real economic activity at different frequencies (monthly, quarterly, and yearly). Outcome variables in our real-effects regressions include (non-food, utilities and transport) inflation, permits for commercial construction, volume of exports, and public demonstrations, as a broad indicator of the quality of economic and living conditions.

Our results document a strong bank lending channel of monetary policy (Bernanke and Blinder, 1988, 1992; Kashyap and Stein, 2000), with sizeable 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 the volume of new loans 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. Additionally, we show that better-capitalized banks transmit changes in monetary policy significantly less than lower-capitalized banks, consistent with the behavior of banks in advanced economies (Bernanke, 2007; Jiménez et al., 2012). By contrast, we find that banks with higher liquidity adjust credit supply more (not less) to monetary policy changes.[3] The effect of liquidity—mainly reflecting exposure to sovereign debt—on the bank lending channel is stronger for banks more

[1] In Uganda, the domestic private credit-to-GDP ratio, a measure of financial development, increased from 7.5% in 2006 to 16% in 2016, compared to 25% in low-income countries, 63% in lower-middle income countries, 123% in middle-income countries, and 200% in high-income countries (data from the World Bank's World Development Indicators). Financial development gaps are a common feature throughout Africa and low bank presence is a key contributing factor (Allen et al., 2014). As in other developing countries, banks are the main source of external finance for firms and bank financing is an important driver of entrepreneurship and firm growth (Banerjee and Duflo, 2014; Giannetti, 2003; Rajan and Zingales, 1998).

[2] 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.

[3] For developed countries, see Kashyap and Stein (2000) and Jiménez et al. (2012).

likely to be subject to moral suasion, which 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 that is common in developing countries (Hauner, 2009; Allen et al., 2011).

The real effects of the bank lending channel are consistent with the effects on credit. We show that inflation and real outcomes are less affected by a monetary policy tightening in districts where banks have more capital and lower liquidity. Using granular data on export volumes of individual product categories to individual countries, we find a significant impact of monetary policy on trade controlling for external export demand with product × destination × year fixed effects. We also document significant effects of monetary policy on public demonstrations—a relevant outcome given that tight money and credit can lead to social unrest and populist movements.[4]

Our study contributes to the literature on the bank lending channel of monetary policy in developing countries. In a survey of this literature, Mishra and Montiel (2013) argue that weak monetary policy transmission in developing countries is mainly caused by structural impediments,[5] but they also emphasize methodological deficiencies, in particular the heavy use of vector autoregressions on aggregate time-series data. We bring to this literature an analysis of the bank lending channel in a developing country that is, for the first time, based entirely on microdata from a credit register. These data make it possible to control for changes in loan demand at a more granular level than in previous studies and hence more credibly to isolate credit supply from demand effects. In addition, we can precisely estimate the interest-rate impact on the price of newly originated loans, rather than that on the existing stock of loans that is captured in aggregate lending rate statistics. Our study shows that the effect of monetary policy on loan rates is about half as strong in Uganda compared to advanced economies.

Furthermore, our paper documents important differences in monetary policy transmission between advanced economies and developing countries, where governance, institutions, and the market incompleteness play a relatively more prominent role for the economic impact of monetary policies. In these countries, low intermediation ratios are the result of weak property rights and contractual frameworks, which in turn aggravate informational problems and frictions in lending. Small and illiquid capital markets where short-run government paper is dominant further impair the channels of transmission. Consistently, we show that the bank lending channel in Uganda is stronger for banks with greater sovereign debt exposure due to the crowding-out effects of public debt—a result that is different from developed markets. Uganda is representative not only for the region but also for other developing countries with which it shares the aforementioned structural characteristics. At the same time, in recent years Uganda has experienced rapid economic growth and financial development, prompting efforts to modernize the monetary policy framework and transition to inflation targeting, a common trend among developing countries in other parts of the world as well.[6] These elements provide some comfort in relation to external validity concerns.

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 backward-looking monetary aggregate targeting framework that is common in developing countries (IMF, 2015a; Berg and Portillo, 2018). Over the past decade, financial sector development driven by emerging technologies that enable households to manage money holdings and conduct banking operations, coupled with increasing capital market integration, led to irregularities in money demand and a more unstable relation between money demand and prices (IMF, 2009a).[8] The monetary targeting framework also led to significant interest rate volatility and failed to anchor inflation expectations (IMF, 2008). Following a long process of economic analysis and technical discussions with international financial institutions,[9] in July 2011 the Bank of Uganda moved to an IT-lite monetary policy framework and introduced a policy rate to signal the monetary policy stance.[10]

To place our analysis in context, in this section we describe monetary and macroeconomic developments in the years prior and during our period of analysis 2010–2014. We develop several arguments for the idea that the monetary policy stance was at least in part unanticipated by economic agents, which helps our identification strategy. Then we describe the main characteristics of the banking sector.

2.1. Macroeconomic context: arguments for unanticipated monetary policy

Uganda faced two major external shocks around the period of analysis. First, a major food and fuel price shock generated inflationary pressures in most developing countries just before the 2008 financial crisis. However, as the crisis became global, price pressures subsided

[4] See, e.g., Acemoglu and Robinson (2000); Besley and Persson (2011); Mian et al. (2014); Braggion et al. (2018) and Doerr et al. (2019) for analyses of the link from economic shocks to social stability.

[5] This literature emphasizes the macroeconomic characteristics that weaken the bank lending channel in developing countries, such as smaller banking sectors, illiquid financial markets, and uncompetitive banking landscape (Mishra et al., 2014). Saxegaard (2009) shows that banks in sub-Saharan Africa hold reserves in excess of the level consistent with a precautionary savings motive, and argues that excess liquidity in the banking system weakens the monetary transmission mechanism. Barajas, Chami, Ebeke and Oeking (2018) document that countries with large remittance flows have weaker monetary policy transmission. Bulir and Vlcek (2015) find a stronger interest rate transmission mechanism along the yield curve of government securities in developing countries with relatively more credible IT regimes. Consistent with their findings, for Uganda we observe a fair degree of co-movement between the policy rate introduced in July 2011 and short-term market interest rates (such as the 7-day interbank rate) as well as longer-term rates on government securities (e.g. the 91-day T-bill rate), as seen in Fig. A1.

[6] See EIB (2013) for a comparative analysis of the Ugandan banking system in relation to other countries in the East African Community (Burundi, Kenya, Rwanda, Uganda, and Tanzania); IMF (2015b) for commonalities in financial sector supervisory standards; Berg and Portillo (2018) for the experience with the transition to inflation targeting regimes in sub-Saharan African; and Cas, Carrion-Menendez and Frantischek (2011) for the experience with modern monetary policy frameworks in Central America. In a study of monetary regimes in developing economies, Laurens et al. (2015) place Uganda in the "inflation targeting" group for countries with floating exchange rate regimes alongside low- and middle income countries from Eastern Europe, Latin America, and Asia.

[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] Between 2000 and 2011, the velocity of the M2 aggregate declined from 9.4 to 5.5 in an erratic way.

[9] This process can be traced back to IMF country reports about five years prior to the introduction of the new framework, see e.g., IMF (2007, 2009b).

[10] The policy rate is a benchmark rate that guides short-term interbank rates. The Bank of Uganda carries out 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. See IMF (2018) for details about the new framework and a review of the country's experience with it. See Berg and Portillo (2018), Kasekende and Brownbridge (2011) and Khan (2011) for detailed analyses of monetary policy frameworks in developing countries.

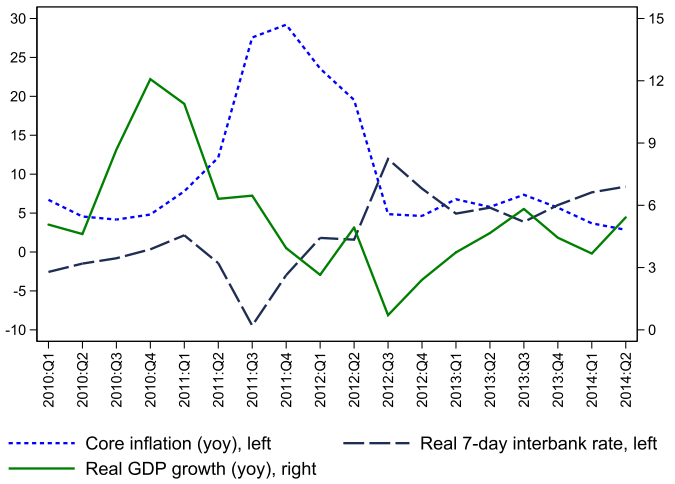

Fig. 1. Monetary conditions, real GDP growth, and inflation.
Data sources: Bank of Uganda and Uganda Bureau of Statistics.

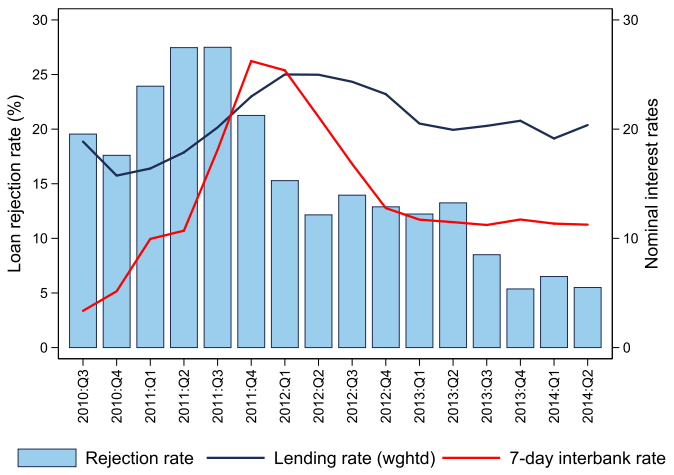

Fig. 3. Monetary conditions, loan rejection rate, and average loan rate.
Data sources: Bank of Uganda and Compuscan Uganda CRB Ltd.

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 simultaneously 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 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, a phase of monetary easing 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 between 2010 and 2014 thus captures a full economic cycle (see Figs. 1, 2 and 3 for macroeconomic conditions and credit dynamics during this period).

Berg et al. (2019) use a narrative approach to identify monetary policy shocks from central bank communications (Romer and Romer, 1989) in the East Africa region. The authors conclude that economic agents in Uganda had little reason to anticipate the dramatic consecutive interest rate hikes that occurred in mid-2011; and argue that the "clean-cut nature of the [tightening] event" allows them "to consider it a *natural experiment* from which significant inferences can be drawn" (p. 5). The authors offer the following arguments. First, the Bank of Uganda had a dovish track record given that monetary policy had remained highly accommodative during earlier episodes of strong credit growth and inflation. For instance, the Bank of Uganda had reacted little to the 2008 commodity price shock despite soaring inflation and credit growth (see Figs. A2 and A3), 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). Third, the tightening phase starting in June 2011 coincided 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), making it difficult for economic agents to form inflation expectations.

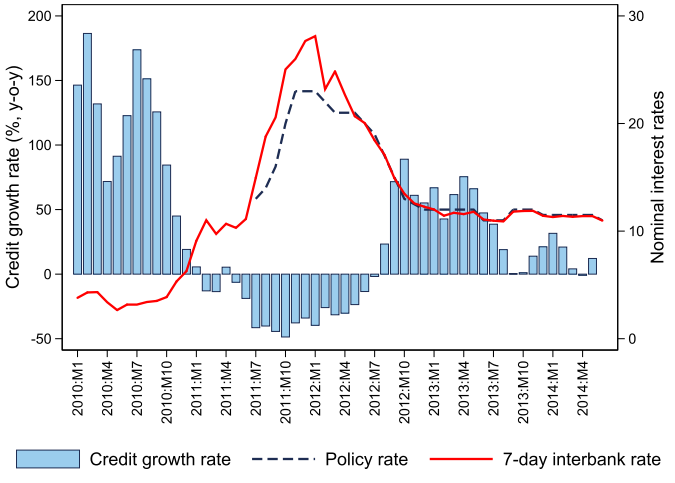

Fig. 2. Monetary conditions and credit.
Data sources: Bank of Uganda and IMF International Financial Statistics (IFS).

To these arguments we bring two additional pieces of evidence to further rule out anticipation effects around the mid-2011 tightening. The first piece of evidence comes from a detailed review of how analysts covered economic issues—especially inflation and monetary conditions—in the leading Daily Monitor newspaper (see Appendix A-IV for an overview of the relevant articles). In early 2011, as inflationary pressures were building up, commentators were praising the country's progress against inflation compared to 2009. As inflationary pressures mounted, in April 2011 the Daily Monitor wrote that "there is nothing the government can do to stop the soaring commodity prices adding that the prices are fixed by market forces of demand and supply." In mid-2011 a series of articles discussed possible policy responses to skyrocketing inflation, including infrastructure reforms to relieve supply-side bottlenecks, but made no reference to a monetary policy response. The newspaper writes that the government "has neither proposed nor implemented any concrete short-term interventions to reverse the escalation in prices." Our review of articles published in the second half of 2011, after the first interest rate hike, reveals no announcements by the central bank to further raise interest rates.

The second piece of evidence comes from a recent data-driven analysis of monetary policy shocks across countries. Willems (2018) develops an algorithm to identify unanticipated monetary contractions, which reflect concerns over inflation rather than the future state of the real economy. The procedure specifically identifies episodes where a long period of monetary easing and high inflation is followed by a large nominal monetary policy rate increase. The author focuses on sizable interest rate increases to rule out instances of central bank optimism about future output developments and hence to identify only episodes of "exogenous" policy shifts. This data-driven algorithm is applied to yearly interest rate time-series from 162 countries over 1970–2017 and identifies 147 large monetary contractions, including Uganda in 2011.

Finally, we would like to rule out potential confounding effects from shifts in central bank policies such as minimum reserve requirements or macroprudential tools. Importantly, the Bank of Uganda does not use cash reserve requirements as an active tool of monetary policy. The only change during the sample period was a reduction in reserve requirements in March 2011 (by 1.5 percentage points to 8% 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. Furthermore, there were no changes in macroprudential policies during the period of interest.[11]

2.2. Banking system

Uganda experienced significant financial development during the 2000s, with bank credit to the private sector reaching 16.4% of GDP in 2016. This ratio remains nonetheless low by international standards and there is a large informal financial sector. Financial deepening in Uganda occurred through an expansion of bank presence and financial access. Data from the IMF's Financial Access Survey indicates that the number of commercial banks rose from 15 in 2006 to 25 in 2016 (the same as in Nigeria) and the number of loan accounts doubled to 36 per 1,000 adults over the same period. The banking system comprises 25 (mostly foreign- and privately-owned) banks at the time of analysis and is highly concentrated, with the largest 5 banks accounting for almost 75% of banking system assets (GFDD, 2011). As is common in developing countries, most firms work with only one bank (Rajan and Zingales, 1998; Giannetti, 2003).

Banks are well capitalized and highly-liquid, with an average regulatory capital ratio of 23% and average liquid-to-total deposits ratio of 41%.[12] 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% (domestic and foreign) interbank assets, and 8% reserves at the central bank. The average loan portfolio is comprised of 64% private sector loans, 35% loans to individuals, and 1% loans to public sector enterprises.

3. Data

3.1. Credit register

Our study employs 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 all loan applications (39,643 applications) and new originated loans (29,960 new 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, as shown in Figs. A5 and A6, which compare the sample composition in the credit register by industry and region with aggregate statistics. 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 accept/reject 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 observe the date and the terms of the loan such as the 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 (34% and 0.2% of observations, respectively).

An important caveat is that banks make separate data submissions on loan applications and new granted loans (that is, there are distinct "loan application reports" and "loan origination reports" that feed into two separate supervisory datasets at the CRB) and they are not required by the CRB to identify borrowers with the same identifier across the two datasets. For these reasons, tracing successful loan applications in the loan origination dataset (and vice-versa) is unfeasible, and we analyze loan applications and new granted loans separately. The final cleaned sample has 16,784 (accepted/rejected) loan applications and 25,948 new granted loans between 2010:Q3 and 2014:Q2.

We identify borrowers uniquely using a numerical code that represents the concatenation of the available identifiers for each firm in each supervisory dataset. This identifier allows us to track firms' borrowing activities 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 firm balance sheets. Looking at loan applications, over the full sample period 83% of firms apply for a loan to only one bank, 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.[13]

We merge the loan-level data with bank balance sheet variables and macroeconomic time series (e.g., interest rates, GDP growth, inflation, fiscal policy, GDP forecasts, etc.) at different time frequencies from the Bank of Uganda, the IMF International Financial Statistics (IFS), and the IMF World Economic Outlook (WEO).

3.2. Real economic activity

To examine the real effects of the bank lending channel we employ several measures of economic activity and living conditions *at the district level*. These measures include construction permits, exports, public demonstrations, and non-food inflation and its main components. We briefly describe each economic indicator in turn.

Quarterly data on commercial building permits comes from Uganda Bureau of Statistics. We have information on the quarterly number of

[11] The relatively short sample period (2010–2014) also 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 banks' 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 global financial conditions.

[12] Fig. A4 shows the cross-sectional distributions of regulatory capital and liquidity—the two financial ratios used to identify the bank balance sheet channel.

[13] The prevalence of single firm-bank relationships and the small number of repeated loan applications have important implications for the empirical strategy, which we discuss in Section 4.1.2.

Table 1
Variable definitions and sources.

Variable	Description	Source
Credit Register Data		
LOAN 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.
NEW LOANS(*ln*)	Amount of new 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 Other Sector (mainly public sector enterprises)	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 91-day Treasury securities.	Bank of Uganda
Re-discount rate	Rate at which banks with a liquidity shortage can borrow from the Bank of Uganda against eligible collateral	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)	IFS
TOT	Terms of trade index.	IFS
FISCAL, *DEFICIT*	Budget balance, in % of GDP.	Bank of Uganda
FISCAL, *DEBT*	Public debt issuance, in % of GDP.	Bank of Uganda
UNCERTAINTY	Calculations based on GDP forecasts.	World Economic Outlook
ΔCPI, *NONFOOD*	Non-food CPI (and its components ΔCPI, *UTILITIES* referring to housing, electricity, gas and other fuels; and ΔCPI, *TRANSPORTATION*) 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 97 product categories to 105 destinations.	Uganda Bureau of Statistics
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)
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

applications for construction permits for all districts. Growth in commercial building permits is a valuable indicator of local economic activity and is highly correlated with income growth across U.S. states (Calomiris and Mason, 2003).

Annual data on export volume is available from Uganda Bureau of Statistics for 20 districts where exports are recorded at customs offices. These highly-granular data are available for 97 distinct product categories (reported in Appendix A-III) and 105 destination countries. Thus we have one observation for each district-product-destination-year, which allows us to comprehensively control for time-varying export demand (as discussed in Section 5.1).

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 records the total number of events defined as “riots and protests” and referring to organized or spontaneous demonstrations against a public or private institution, which may involve targeting property and businesses, as well as clashes with safety and security agencies. We compute the quarterly number of protests from daily data.

Lastly, monthly data on non-food CPI for 8 districts come from the Bank of Uganda. Non-food expenditure accounts for almost 70% of the consumption basket. The main components of non-food expenditure are utilities (that is, 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 footwear, 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 adjustment followed by the pass-through to loan rates. We focus on the identification of credit supply effects using a rich set of controls and 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

Table 2
Descriptive statistics.

	Obs.	Mean	St. Dev.	p25	p50	p75
Credit register data						
LOAN GRANTED	16,663	83.73	36.90	100.00	100.00	100.00
NEW LOANS(*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
Re-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
FISCAL, DEFICIT	16,663	−3.79	3.24	−5.78	−3.93	−3.05
FISCAL, DEBT	16,663	0.68	3.28	−0.20	0.99	2.94
UNCERTAINTY	16,663	0.51	0.37	0.31	0.33	0.51
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
DEMONSTRATIONS	229	1.42	2.74	0.00	1.00	1.00
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 application. 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. The two *FISCAL* variables are budget deficit and public debt issuance, respectively (both divided by GDP). Bank capital and liquidity are winsorized at the 1st and 99th percentiles of the capital and liquidity distributions.

following linear probability model:

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

where $LOAN\ GRANTED_{ibt}$ takes value 1 if a loan application by firm i to bank b in quarter t is accepted, and 0 if rejected. Our measure of monetary policy is the change in the 7-day interbank rate (Δ*IR*). We also add real GDP growth (Δ*GDP*) and inflation (Δ*CPI*) as controls for macroeconomic conditions that influence monetary policy decisions. We allow differences in bank balance sheets to affect the likelihood of loan granting by including the ratio of total regulatory capital to risk-weighted assets as a measure of bank capital (*CAPITAL*) and the ratio of liquid assets to total deposits as a measure of bank liquidity (*LIQUIDITY*). Bank characteristics are lagged one quarter relative to the quarter of the application date.

In a first set of regressions, unobserved time-invariant firm and bank heterogeneity is captured by firm (η_i) and bank (ψ_b) fixed effects, respectively. To account for shifts in credit demand, we control for unobserved time-varying borrower heterogeneity at a level as granular as possible. In particular, in the main specifications we include time-varying fixed effects at the firm-cluster level, where a cluster includes the firms in the same district and industry (that is, we have "district-industry × quarter-year" fixed effects). In a supplementary regression we include firm × year fixed effects. District-industry × quarter-year fixed effects capture unobserved factors such as time-varying demand shocks that are common to all firms in the same industry and district. Firm × year fixed effects exploit multiple loan applications by a given firm in a year to control for time-varying shifts in unobservables (including credit demand) at the firm level.

Interactions of bank capital and liquidity with Δ*IR* allow the bank lending channel to depend on banks' financial positions. Our empirical specifications are guided by several theoretical arguments. For a given increase in short-term interest rates, banks with more capital should be in a better position to support loan growth because they have more loanable funds (Kashyap and Stein, 1994) and/or may be able to attract deposits and market funds on better terms than other

banks (Bernanke, 2007; Gambacorta and Shin, 2018).[14] Therefore, we expect high capital to dampen the effects of a monetary contraction ($\alpha_2 > 0$).

The argument for liquidity may go either way. In advanced economies, higher liquidity is a sign of financial health. Banks with more liquidity can more easily protect their loan portfolio during a monetary tightening by drawing down on the stock of liquid securities (Kashyap and Stein, 2000). Banks with more liquidity may also be seen as financially resilient and enjoy a lower cost of funds (Bernanke, 2007). Therefore, in advanced economies the bank balance sheet channel predicts $\alpha_3 > 0$. By contrast, banks in developing countries tend to hold large amounts of sovereign debt (primarily Treasury securities) due to the high cost of financial intermediation (Allen et al., 2011).[15] An interest rate increase could worsen information frictions in lending (e.g., adverse selection) and affect the risk-return calculus in such a way that banks with more liquidity, which "specialize" in holding government debt over making risky loans—might choose to further invest in Treasury securities rather than to expand the loan portfolio. In this environment it is possible that relatively more liquid banks respond to a monetary tightening by cutting loans more aggressively than other banks (leading to $\alpha_3 < 0$). Furthermore, this effect could be stronger for banks that are more likely to be subject to "moral suasion," a mechanism by which banks are pressured to support the government by holding government debt (Ongena et al., 2019; Altavilla et al., 2017; Becker and Ivashina, 2018).

Following studies of loan approvals (Jiménez et al., 2012; Puri et al., 2011), we estimate Eq. (1) with Ordinary Least Squares (OLS). We choose a linear probability model because nonlinear models can be unidentified if there are many fixed effects and short panels can produce inconsistent estimates of interactions terms (Ai and Norton, 2003). The standard errors are clustered at the district level to allow for serial correlation within districts.

4.1.2. Intensive margin and loan rates

For each granted loan we have information on volume, interest rate, and maturity. Given the prevalence of single bank relationships by individual firms, we set up the data at the bank-firm cluster-quarter level where a firm cluster includes all the firms in a given district and industry (for a total of 287 district-industry pairs). Then we compute average loan volumes for each bank-firm cluster-quarter combination as in Khwaja and Mian (2008). This data set-up allows us to include in the main specifications district-industry × year-quarter fixed effects which control for unobserved factors (e.g., credit demand) under the assumption that all firms in the same industry and district receive a common quarterly demand shock. In an alternative specification we show that the results hold up to setting 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 to control for time-varying unobserved firm-level credit demand.[16]

We estimate the following specification:

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

where $NEW\ LOANS_{jbt}$ is the volume of new loans 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 specification). The main variable of interest is the change in the short-term interest rate ($\Delta IR_{t,t-z}$) over different time horizons, which allows 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.[17]

The coefficient of interest 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 with 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 specifications with balance sheet interactions we control for time-varying loan demand with district-industry × year-quarter fixed effects or with firm × year fixed effects. We expect α_2 and α_3 to take the same sign as in the extensive margin regressions.

Then we examine the pass-through of the interbank rate to interest rates charged by banks on new loans in a specification similar to Eq. (2). The main difference is that the dependent variable is the average loan rate on granted loans and is defined separately for each data structure.[18] For instance, in the bank-firm-year panel, the average loan 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 1 quarter.

Regressions are estimated with OLS and standard errors are clustered at the district level. The specifications for loan volumes and rates are robust to the same sensitivity tests discussed in relation to loan applications (see Section 4.4).

4.2. Results

4.2.1. Extensive and intensive margins of lending

Table 3 reports the results for the extensive margin of lending. We

[14] 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). This mechanism, however, is less relevant for our analysis given that banks in Uganda have capital ratios that are well in excess of the regulatory minimum.

[15] Using the World Bank classification of countries by income group, in low-income countries the share of banking sector sovereign debt exposure in total banking assets was 19% compared to 16.4% in emerging markets and 8.6% in advanced economies during 2000–2014 (IMF International Financial Statistics.).

[16] Our approach of controlling for time-varying unobserved heterogeneity at the district-industry level is similar to Acharya et al. (2018), Auer and Ongena (2016), and De Haas and Van Horen (2013) who examine corporate loan supply following bank financial shocks and control for loan demand at a level of aggregation that is higher than the individual firm (i.e., firm cluster). The motivation is similar to ours: credit rationing at the individual firm level creates intensive margin adjustment at the firm cluster level, and firms mainly from relationships with a single bank. Degryse, De Jonghe, Jakovljević, Mulier and Schepens (2019, p. 34) use credit register data which firms often borrow solely from one bank and show that fixed effects for firms clusters (where a cluster comprises firms of similar size in the same industry and location) "perform very well as controls for the firm-borrowing channel: the bank-loan supply shocks obtained with such demand controls closely resemble the "standard" bank-loan shocks (in terms of ordering and magnitude) for the multiple-bank firm sample." Furthermore, as a robustness test, in Table A11 we show that our main results for the intensive margin and loan rates hold up in the original dataset at the loan level.

[17] For completeness, Table A1 reports the intensive margin results for a lag of 1 quarter or the average over 1 and 2-quarter lags.

[18] Reported results correspond to the unweighted average interest rate, but are virtually identical for the loan volume-weighted average interest rate (not reported).

Table 3
Extensive margin of credit supply (Loan application accepted).

	LOAN GRANTED				
	(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		
Bank FE	Yes	Yes	Yes	Yes	Yes
District-industry × year-quarter FE				Yes	
Firm × year FE					Yes

Notes: The dependent variable is *LOAN 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. Column 4 has more observations compared to columns 1–3 because the fixed effects (even if time-varying) are less demanding (District-industry × year-quarter FE compared to Firm FE) and hence fewer singletons drop out. Column 5 has the lowest number of observations among all regressions due to the most demanding fixed effects (Firm × year FE) triggering the highest number of singletons. 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%.

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 one quarter (359 bps) reduces the probability of loan granting by between 1.2 and 2.8 percentage points, or a semi-elasticity of 7.4–17.2% implied by the loan application rejection rate of 16.3%.[19]

In columns 4–5 we include interaction terms of ΔIR with bank capital and liquidity. Using the estimates in column 4, we find that the differential effect of a rise in the interbank rate by one SD between a highly and a thinly-capitalized bank (90th vs. 10th percentile) is 4.9 percentage points (semi-elasticity of 30.6%).[20] Put differently, banks with higher levels of capital pass on a monetary tightening to the supply of credit less than banks with lower levels of capital. By contrast, we observe that more liquid banks amplify the negative effect of an interest rate rise. In column 5 we show a specification with balance-sheet interactions and even more demanding controls for credit demand in the form of firm × year fixed effects. Despite a sharp reduction in sample size (as singletons drop out), the coefficients on the interaction terms between ΔIR and capital and liquidity remain statistically significant 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 volumes of new loans, 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 two 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 test the bank balance sheet channel. We find that higher capital dampens the transmission of monetary policy 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).[21] 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.

Next, we explore heterogeneity in the bank balance sheet channel for liquidity. We argue that increased sovereign bond holdings by banks are a reflection of the high cost of financial intermediation. Higher interest rates raise yields on government bonds, making government debt more attractive than risky loans, and further crowing out bank lending. This phenomenon, documented for banks in several advanced

[19] 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 documented, for instance, in Claessens et al. (2012).

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

[21] $644 \times (34 - 15) \times 0.0039 = 47.7$.

Table 4
Intensive margin of credit supply (New loan volumes).

	NEW LOANS(*ln*)				
	(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		
District-industry × year-quarter FE				Yes	
Firm × year FE					Yes

Notes: The dependent variable is the (log-transformed) loan amount *NEW LOANS*(*ln*) for new loans. 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 and industry, so the unit of observation is bank-firm cluster-quarter. Column 4 has fewer observations than columns 1–3 due to more demanding fixed effects (District-industry × year-quarter FE compared to District-industry FE). In column 5 the data is set up differently from previous columns, in particular 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. As the data structure is more granular, column 5 has more observations than columns 1–4. 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%.

economies during the European sovereign debt crisis, was caused by government pressure on the banking system to increase their holdings of local sovereign debt (Ongena et al., 2019; Altavilla et al., 2017; Becker and Ivashina, 2018). Taking this argument to our context, we test whether the liquidity channel is stronger for banks that are more likely to be subject to moral suasion. We measure bank-specific exposure to moral suasion with the share of loan applications received by each bank from public sector enterprises over the full period of analysis. We define banks subject to high/low moral suasion as those with above/below mean share of loan applications from the public sector, and re-run the relevant specification (i.e., column 5 in Tables 3 and 4) with a spline on the $\Delta IR \times LIQUIDITY$ term. The results are reported in Table 5, including p-values for a one-sided t-test of the null hypothesis that banks with higher public debt shrink corporate loan supply even more than other banks following an interest rate increase. According to the reported p-values, we fail to reject the null hypothesis, consistent with the moral suasion argument.[22]

4.2.2. Loan rates

Next, we quantify the pass-through of changes in short-term interest rates to retail loan rates. Table 6 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 loan 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 reveal differential effects based on bank capital and liquidity. As seen in column 4 of Table 6, high-capital banks charge 234 bps less than 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.[23] 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).

4.3. Asymmetry and lags in monetary policy transmission

Asymmetry of monetary policy transmission. Studies of the U.S. economy document stronger effects of monetary policy on nominal and real variables—such as consumption of durable goods, investment, and

[22] The results are robust to measuring exposure to moral suasion based on loan volumes rather than number of loan applications (results not reported). We do not find any evidence of bank heterogeneity in the liquidity channel based on bank ownership (foreign vs. domestic), bank age, or other bank attributes such as risk profile and profitability.

[23] $359 \times (34 - 15) \times 0.0343 = 233.9$.

Table 5
Heterogeneity in the liquidity effect—Moral suasion.

	LOAN GRANTED		*NEW LOANS(ln)*	
	(1)	(2)	(3)	(4)
$\Delta IR \times LIQUIDITY \times HIGH\ MORAL\ SUASION$[1]	−0.0708***	−0.0236**	−0.0046***	−0.0062***
	(0.018)	(0.011)	(0.001)	(0.001)
$\Delta IR \times LIQUIDITY \times LOW\ MORAL\ SUASION$[2]	−0.0418***	0.0111	−0.0022***	−0.0036***
	(0.015)	(0.008)	(0.001)	(0.001)
Observations	15,714	8,305	2,652	5,438
R^2	0.277	0.528	0.539	0.764
p-value Wald test Ho: coeff. [1] > coeff. [2]	0.500	0.457	0.483	0.519
Bank controls	Yes	Yes	Yes	Yes
Interactions with GDP and CPI	Yes	Yes	Yes	Yes
Bank capital × ΔIR	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
District-industry × year-quarter FE	Yes	–	Yes	–
Firm × year FE		Yes		Yes

Notes: This table examines heterogeneity in the liquidity effect of monetary policy for banks that are subject to varying degrees of moral suasion. The dependent variables are *LOAN GRANTED* in columns 1–2 and the volume of new loans *NEW LOANS*(*ln*) in columns 3–4. The specifications correspond to baseline regressions in columns 4–5 of Tables 3 and 4, respectively, with the difference that we apply a spline for high vs. low moral suasion banks to the interaction term $\Delta IR \times LIQUIDITY$. We define banks subject to high/low moral suasion as those with above/below the mean number of loan applications from the public sector. All controls and lag structure as in the baseline specifications. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

output—during expansions than contractions (see, e.g., Morgan (1993) and Tenreyro and Thwaites (2016)). We allow for asymmetric effects of monetary policy in our baseline specifications with a spline of the ΔIR variable for the tightening (2010:Q3-2011:Q4) and easing (2012:Q1-2014:Q2) periods. The results are reported in Table 5 together with p-values of a *t*-test of equality of coefficients on the spline terms (the null hypothesis implies symmetric effects). The coefficients on the spline terms are statistically significantly different from one another in the extensive margin regressions, suggesting an asymmetric effect of interest rate increases on the probability of loan granting (columns 1–3). By contrast, there is no evidence of asymmetry for the intensive margin regressions—neither for new loan volumes nor for loan rates (columns 4–9).[24]

Lags of monetary policy transmission. Another key question concerns the speed of transmission of monetary policy to credit aggregates. Kashyap and Stein (1995) examine this question for U.S. banks, allowing for a lagged effect of the change in the Federal Funds rate up to 8 quarters. For ease of comparison with their results, we estimate our baseline specification with 8 lags of the interbank rate by itself, controlling for GDP growth and inflation (following the specification in Kashyap and Stein (1995), Table 3, p. 175). The results are shown in Table A3 which reports only the coefficient estimates on each lag term (with statistical significance), the sum of the coefficient estimates across the 8 lags (representing the cumulative impact of ΔIR), and the p-value from a Wald test that the sum of the coefficients is equal to 0. The results in Table A3 reveal that the cumulative effect of a monetary tightening over 8 lags is negative and statistically significant for both the extensive and intensive margins of loan adjustment. Across the three specifications considered, the cumulative impact of ΔIR on the likelihood of loan granting across 8-quarter lags is negative and statistically significant at least at the 10% level. The same cumulative impact on the volume of loans granted is also negative and statistically significant at least at the 20% level.

[24] A leading factor weighing down on the recovery of bank credit during the easing period were non-performing bank loans that accrued during the tightening period (the ratio of NPLs to gross loans increased from less than 1.9% in 2011:Q2 to more than 6.1% at the beginning of 2014:Q1).

4.4. Robustness

In this section we present several robustness tests relating to (i) additional controls (both at the macro and bank level), (ii) alternative interest rates (including the real interest rate and a measure of monetary policy surprises), and (iii) alternative methodological choices (such as using loan-level data for intensive margin regressions and alternative clustering for the standard errors).

Additional macroeconomic and bank controls. To reduce the likelihood of omitted domestic conditions affecting our results, we consider the following additional controls: the nominal exchange rate, terms of trade, fiscal policy, and economic uncertainty. In Table A4 we add the nominal exchange rate and the change in the terms of trade to selected baseline regressions to account for changes in the external environment that may affect monetary policy transmission during the sample period through a commodity price channel or exchange rate channel. Both variables enter in levels and in interaction with bank capital and liquidity, depending on the specification. Our main results are robust to these additional control variables, with all coefficients on ΔIR, $CAPITAL \times \Delta IR$ and $LIQUIDITY \times \Delta IR$ remaining statistically significant and of similar magnitude to the baseline.

In Table A5 we present similar specifications which aim to account for potential interactions between monetary and fiscal policy. Controlling for fiscal policy is important because fiscal dominance and political pressures often constrain monetary policy in developing countries, giving rise to complex interactions between these policies (IMF, 2015a). We measure the fiscal policy stance with two variables: the budget balance and public debt issuance (both in percent of GDP). Regression estimates on the level fiscal policy variable *FISCAL* are generally positive and statistically significant, indicating that fiscal expansions are associated with more bank credit. However, the inclusion of fiscal policy controls does not affect the impact of the interest rate ΔIR. Furthermore, the estimated coefficients on balance sheet interactions with ΔIR remain unaffected by the additional controls (which themselves enter the specifications in interaction with bank capital and liquidity).

Next we check that our results are not driven by economic policy uncertainty. Previous studies for the U.S. show that policy uncertainty harms the real economy through the banking channel.

Table 6
Loan rates.

	ΔLOAN RATE				
	(1)	(2)	(3)	(4)	(5)
Δ*IR*	0.3343***	0.4877***	0.4722***		
	(0.035)	(0.039)	(0.039)		
Δ*IR* × *CAPITAL*				−0.0343***	−0.0252
				(0.008)	(0.023)
Δ*IR* × *LIQUIDITY*				0.0239***	0.0295**
				(0.005)	(0.012)
Δ*GDP*		−0.4024***	−0.3401***		
		(0.103)	(0.113)		
Δ*CPI*		−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)
Δ*GDP* × *CAPITAL*				0.0421***	0.0043
				(0.008)	(0.030)
Δ*GDP* × *LIQUIDITY*				−0.0001	−0.0092
				(0.006)	(0.016)
Δ*CPI* × *CAPITAL*				−0.0009	−0.0082
				(0.010)	(0.014)
Δ*CPI* × *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		
District-industry × year-quarter FE				Yes	
Firm × year FE					Yes

Notes: The dependent variable is the change in the interest rate charged on granted loans Δ*LOAN RATE*. To be able to calculate this change, in columns 1–4 we calculate the average loan rates within firm cluster, that is, across loans granted to firms in a given district and industry. Therefore, in columns 1–4 the data is at the bank-firm cluster-quarter level. (Note that the number of observations is significantly lower in this table compared to Table 4 due to the loan rate missing on some loans, as per the descriptive statistics in Table 2; and the dependent variable being specified in changes). Column 4 has fewer observations than columns 1–3 due to more demanding fixed effects (District-industry × year-quarter FE compared to District-industry FE). In column 5 the loan rate is averaged across loans granted by a given bank to a given firm each year so the data is at the bank-firm-year level. This granular data structure leads column 5 to have more observations than columns 1–4. Furthermore, to preserve sample size, in column 5 we calculate the change in the loan rate to a given firm 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%.

Berger et al. (2018), for instance, document liquidity hoarding and bank credit retrenchment when policy uncertainty rises. In our context, policy uncertainty is especially relevant given that in 2011 there was not only a significant tightening of monetary policy, but also a change in the monetary policy framework that was accompanied by limited central bank communications (as discussed in Section 4.1). We measure uncertainty with the spread (standard deviation) of GDP forecasts that are published in October of the previous year, April and October of the current year, and April of the following year (first/preliminary GDP data release).[25] The results in Table A6 show that our key coefficient estimates are unaffected by controlling for uncertainty, which itself is associated with less bank credit (on both the extensive and intensive margins) and higher loan rates.

We also rule out the possibility that the bank balance sheet channel is driven by bank attributes other than capital and liquidity. In Table A7 we add to our main specifications, both in levels and in interaction with Δ*IR*, the following bank attributes: bank age (measured as the number of years since establishment), ownership (a dummy variable taking value 1 for foreign banks, 0 for domestic banks), and size (a dummy variable taking value 1 for banks with above-median total assets, 0 otherwise). The results reveal that all coefficients on the terms of interest—Δ*IR*, *CAPITAL* × Δ*IR*, and *LIQUIDITY* × Δ*IR*—remain statistically significant and of similar magnitude to the baseline. Taken together, the results in Tables A4-A7 suggest that neither macro factors nor bank-level characteristics confound our baseline results.

Alternative interest rates. A possible concern could be that our findings hinge on the specific choice of the 7-day interbank market rate to proxy for the monetary policy stance. This choice assumes a strong interest rate transmission mechanism (from the policy rate to market rates), which may be tenuous in developing countries. In a comprehensive review of the literature, Mishra et al. (2012) argue that "traditional monetary transmission through market interest rates and market-determined asset prices are weak or nonexistent," mostly due to underdeveloped secondary securities markets. In a recent study, Bulir and Vlcek (2015) challenge this view with a new analysis of the interest rate transmission mechanism along the yield curve based on government paper for 16 emerging markets and low-income countries. The authors document a stronger link from short-term policy and

[25] As GDP forecasts are done on a yearly basis, we merge the yearly uncertainty variable with our quarterly data on Q4 and linearly interpolate the GDP forecast spread across the remaining quarters. We also check that our results do not change if we assume the forecast to be constant across quarters within the year (results not reported).

interbank rates to longer-term bond yields in credible IT regimes than in other monetary regimes and argue that well-developed secondary markets are not as important as previously thought. Plotting a series of interest rates in Fig. A1, we notice a significant degree of co-movement between our measure of monetary policy in Uganda (the 7-day interbank rate), the policy rate introduced in July 2011, the re-discount rate at which banks access liquidity from the central bank,[26] and the 91-day Treasury bill rate. 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 run our baseline regressions replacing the interbank rate with each of these alternative interest rates. As seen in Table A8, our main conclusions remain unchanged.[27]

Monetary policy surprises. We supplement our findings with an additional interest rate series which is derived under the assumption that interest-rate setting followed a Taylor (1993)-like rule during the period of analysis with particular focus on the behavior of past inflation and output growth. We construct two measures of monetary policy "surprises" as the residuals from a regression of the 7-day interbank rate on 1-quarter lagged GDP growth and inflation, as well as 1- and 2-quarter lags of these variables. The two regressions are estimated on quarterly time series over the 2009:Q1-2014:Q2 period and yield a good fit, with the R^2 of 27% and 50%. We then use the change in these "Taylor residuals" to replace ΔIR in our main specifications. Table A10 shows that the coefficient estimates on the terms of interest are statistically significant in most specifications, and have comparable magnitudes with baseline Tables 3–6.

Clustering of standard errors. We gauge the sensitivity of statistical significance on our main estimates to different assumptions about the correlation structure of errors by allowing for residual correlation within banks (given that the main interactions of interest vary across banks) and within borrowers (given that changes in credit can be correlated across banking relationships and time). As seen in Table A12, we allow for clustering at borrower, borrower and bank, and borrower, bank and year-quarter level (where the borrower is given by a district-industry pair). The results are broadly robust to these alternative approaches to estimating the standard errors, although the coefficient on $\Delta IR \times CAPITAL$ in the intensive margin regression is less precisely estimated (p-value = 0.126, column 6).[28]

5. Monetary policy, real economic activity, and inflation

In this section we further assess the bank lending channel in Uganda by exploring the link between monetary policy and real economic outcomes. To this end, we conduct the analysis at the district level using multiple measures of economic activity (described in Section 3.2). The bank lending channel of monetary policy is effective if short-term rates affect not only market rates and credit aggregates, but also the real sector. This can be 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 monetary policy on real sector outcomes varies with local financial conditions (that is, bank capital and liquidity). We expect a monetary tightening to affect economic activity relatively more in districts where the banking system has less capital and more liquidity, given that those districts also 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. To this end, we compute weighted averages of bank capital and liquidity across banks, where the weights are given by the banks' market shares within each district. 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 that focuses on the bank balance sheet channel, as follows[29]:

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

where $REAL\ OUTCOME_{dt}$ is a measure of economic activity. When these measures are the number of commercial building permits 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 change in the 7-day interest rate ΔIR_{t-z} enters the specification in level and is lagged by z quarters. The bank balance sheet variables are lagged one quarter and their interactions with GDP growth and inflation are also included to avoid confounding effects for our balance sheet interactions with the interest rate. All specifications include district and year-quarter fixed effects. Similar to the credit supply equations, we expect stronger 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 in which the dependent variable is the log-transformed volume of exports. Given that the unit of observation is the district-product-destination-year (where destinations are 105 countries and we have 97 product categories), we are able to control for export demand with product × destination × year fixed effects (in the spirit of Paravisini et al., 2015). Finally, for inflation we have monthly data for a small set of districts, so we examine the impact of monetary policy on prices using a slightly modified Eq. (3) in which we only control for balance sheet characteristics (capital, liquidity) and their interactions with GDP growth, with district and year-month fixed effects.

Empirical identification 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

[26] The re-discount rate is the rate at which commercial banks with a liquidity shortage can sell back their Treasury securities with less than 91 days to maturity to the Bank of Uganda. After the introduction of the policy rate in June 2011, the re-discount rate was pegged to the policy rate with a given margin (of 4 percentage points) set by the Monetary Policy Committee. Before June 2011 the re-discount rate was pegged to the 91-day Treasury bill annualized yield (hence reflecting both market conditions and the monetary policy stance). Therefore we can think of the re-discount rate as in-between a policy and market rate.

[27] The interest rate that influences the behavior of economic agents is the real interest rate. In our main specifications, we effectively examine the economic impact of the real (short-term) interest rate by explicitly controlling for inflation in levels and interactions with bank balance sheet variables. However, we can also test for the effect of the real interest rate more directly. To this end, we calculate the real interbank rate (i.e., the nominal 7-day interbank rate adjusted for inflation) and replace it in our main specifications. As seen in Table A9, our main estimates remain quantitatively and statistically significant.

[28] The results are further robust, across all dependent variables, to clustering only on bank and year-quarter. In addition, in the extensive margin regressions we can define the borrower as a single firm and show that the results are robust to clustering at the firm, firm and bank, and firm, bank and year-quarter level (results not reported).

[29] In specifications where ΔIR enters by itself (similar to the baseline lending regressions in column 2 of Tables 3 and 4), we find insignificant coefficients on ΔIR across most real outcomes and lags (Table A13).

Table 7
Real effects: Commercial building permits, exports, and public demonstrations.

Quarters over which ΔIR is lagged	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	ln(*BUILDING PERMITS*)				ln(*EXPORT VOLUME*)		*DEMONSTRATIONS*			
	z = 1	z = 2	z = 3	z = 4	z = 0	z = 0	z = 1	z = 2	z = 3	z = 4
$\Delta IR \times CAPITAL$	0.0063***	0.0035**	0.0036***	0.0019*	0.0355*	0.0347*	−0.0010	−0.0008*	−0.0016**	−0.0009**
	(0.002)	(0.002)	(0.001)	(0.001)	(0.019)	(0.019)	(0.001)	(0.000)	(0.001)	(0.000)
$\Delta IR \times LIQUIDITY$	−0.0023**	−0.0014*	−0.0014**	−0.0007	−0.0017	−0.0024	0.0021*	0.0016**	0.0039*	0.0021**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.008)	(0.008)	(0.001)	(0.001)	(0.002)	(0.001)
Observations	1,386	1,320	1,254	1,188	7,347	6,459	1,386	1,320	1,254	1,188
R^2	0.081	0.088	0.098	0.109	0.035	0.037	0.009	0.020	0.016	0.015
Number of districts	66	66	66	66	18	18	66	66	66	66
Include exports of raw materials					Yes	No				
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interactions with ΔGDP and ΔCPI	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes			Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes			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 received by local municipalities in each district and quarter ln(*BUILDING PERMITS*) (columns 1–4), the (log-transformed) volume of yearly exports of a given product (see Appendix A-III for full list of product categories) to a given destination country recorded at the customs office in a given district ln(*EXPORT VOLUME*) (columns 5–6), and the number of public demonstrations *DEMONSTRATIONS* (columns 7–10) at district-quarter level. The regressions allow for a lagged impact of up to 4 quarters ($z = 1, 2, 3, 4$, columns 1–4 and 7–10) or a contemporaneous impact ($z = 0$, columns 5–6) of the interest rate ΔIR and other macro variables, indicated as column headings. All regressions include the control variables from Equation (3), namely bank balance sheet variables *CAPITAL* and *LIQUIDITY* and their interactions with CPI and GDP growth (coefficients not shown). Bank balance sheet 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 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
Δ*CPI*, *NONFOOD*												
CAPITAL × Δ*IR*	−0.0061	−0.0039	−0.0024	0.0012	0.0032	0.0058	0.0087*	0.0075*	0.0087**	0.0111***	0.0118***	0.0147***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)
LIQUIDITY × Δ*IR*	−0.0026	−0.0029	−0.0028	−0.0029	−0.0022	−0.0029	−0.0029	−0.0024	−0.0022	−0.0014	−0.0016	−0.0010
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
R^2	0.912	0.911	0.913	0.915	0.915	0.915	0.917	0.920	0.922	0.925	0.926	0.928
Δ*CPI*, *UTILITIES*												
CAPITAL × Δ*IR*	0.0195	0.0330*	0.0506**	0.0613***	0.0722***	0.0808***	0.0827***	0.0733***	0.0634***	0.0607***	0.0529***	0.0567***
	(0.021)	(0.020)	(0.020)	(0.020)	(0.019)	(0.019)	(0.018)	(0.017)	(0.017)	(0.015)	(0.015)	(0.016)
LIQUIDITY × Δ*IR*	0.0012	0.0015	−0.0011	−0.0061	−0.0064	−0.0118	−0.0126	−0.0124	−0.0061	−0.0022	−0.0002	0.0002
	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)	(0.008)	(0.007)	(0.007)	(0.006)	(0.007)
R^2	0.640	0.643	0.653	0.662	0.666	0.669	0.673	0.675	0.681	0.696	0.696	0.705
Δ*CPI*, *TRANSPORTATION*												
CAPITAL × Δ*IR*	−0.0165	0.0005	0.0172	0.0370**	0.0476***	0.0571***	0.0711***	0.0799***	0.0837***	0.0890***	0.0915***	0.0949***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.014)	(0.013)	(0.013)	(0.013)	(0.012)
LIQUIDITY × Δ*IR*	0.0012	−0.0013	−0.0021	−0.0028	−0.0015	−0.0018	−0.0020	−0.0030	−0.0047	−0.0033	−0.0044	−0.0021
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
R^2	0.477	0.475	0.485	0.500	0.506	0.512	0.533	0.549	0.563	0.579	0.589	0.597
Observations	356	356	364	372	372	372	365	358	351	344	337	330
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 Δ*CPI* at the district-month level, for 8 districts over the sample period 2010:M7-2014M6. All regressions include the control variables from Eq. (3), namely bank balance sheet variables *CAPITAL* and *LIQUIDITY* and their interactions with GDP growth (coefficients not shown). Bank balance sheet variables and GDP growth are lagged 1 quarter. In the second row, *z* indicates the number of months over which Δ*IR* is lagged. Standard errors, clustered at the district level, are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

lenders. The availability of such alternative sources of funds would reduce or even neutralize the impact of fluctuations in bank credit on the real sector. We argue alternative sources of funds are largely unavailable to the vast majority of Ugandan firms. While close to half of total credit from commercial banks is extended in foreign currencies (notably the USD), foreign currency loans are granted almost exclusively to large and creditworthy firms in the manufacturing, trade, and agricultural sectors by a small number of banks. In addition, macroprudential rules require that foreign currency borrowers earn revenues in foreign currencies, which effectively restricts the pool of eligible borrowers to large manufacturers or exporting firms. Furthermore, as shown in Table A14, bank credit in USD strongly responds to domestic monetary policy on the extensive margin, casting doubt on the foreign currency loan market acting as a substitute for local currency loans.

In addition, the corporate bond market is still underdeveloped and firms have limited access to cross-border loans.[30] But access 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 informal credit 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 them unlikely to substitute banks as providers of credit to firms.

5.2. Results

Tables 7 and 8 report estimates from our real-effects regressions, which consistently indicate that a monetary policy tightening dampens economic activity and non-food prices relatively more in districts where banks are less well capitalized and—albeit less consistently—more liquid.

Table 7 shows that 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 interest rate with bank capital are significant at conventional levels while those for bank liquidity are statistically insignificant. Comparing low- and high-capital districts (90th vs. 10th percentile), a rise of the interest rate by one SD (359 bps) reduces the number of applications for commercial building permits in the following quarter by 12% more in low-capital districts than it does in high-capital districts (columns 1–4).[31]

Turning to the impact of monetary policy on trade, the results in columns 5–6 of Table 7 reveal 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 shipped to the same destination country and in the same year, of firms from districts with high vs. low bank capital and liquidity, thus controlling for time-varying export demand from different destinations. The coefficient magnitudes indicate a differential impact of an increase in short-term rates by one SD on (log) export volumes of 2.4 in high vs. low capital districts, which corresponds to 25% of the average export volume. The results are also robust to excluding exports of raw materials which may be more responsive to global commodity prices and financing conditions than to domestic monetary policy.

Then, we explore the impact of monetary policy on social unrest using data on public demonstrations. We bring this outcome to the analysis because most corporate loans have variable rates so a change in the policy rate directly affects interest costs and borrowers' debt burden. In addition, there is media coverage of public protests against tight economic conditions—including inflation and high interest rates—during the monetary contraction period[32]; and previous literature shows that tight credit can lead to social instability. As expected, in columns 7–10 of Table 7 we find that for a given increase in interest rates, the number of protests and riots is higher in districts where banks have less capital and more liquid assets. These effects are statistically significant with a 2-, 3- and 4-quarter lag. The coefficient estimates in column 9 indicate that a rise in short-term interest rates by one SD increases the number of demonstrations three quarters later by 0.33 more in low-capital districts than in high-capital districts, or 23% of the average number of demonstrations.[33]

Finally, Table 8 presents estimates of the link between monetary policy and non-food inflation and its components with a lag of up to 12 months. For brevity we only show the coefficients for the main interaction terms, which indicate that the effect of short-term rates on inflation is stronger in districts with less bank capital. 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 12, we obtain that an increase by one SD in the short-term rate (1058 bps in the monthly data) reduces non-food inflation 12 months later by almost 3 percentage points (or 32% of the mean) more in low-capital districts than in high-capital districts.[34] The coefficients are statistically significant for utilities and transportation as well, the two main components of the non-food CPI, and the effects are significant already after 2 and 4 months, respectively. By contrast, these effects are negative but imprecisely estimated for bank liquidity.

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 the case of Uganda, which provides a supervisory credit register with high-quality information on loan applications and rates, coupled with extensive regional statistics on real sector activity, and largely unanticipated variation in monetary policy during 2010–2014.

We find that a tightening of monetary policy reduces the supply of bank credit to firms and 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 quantitatively and statistically significant bank balance sheet channel. The tightening of credit conditions—through higher rejection of loan applications, reduced volume of new loans, 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. Our credit supply results also imply binding effects of monetary policy through the bank balance sheet channel on prices and economic activity measured by commercial construction permits, trade, and public demonstrations.

Our study aims to provide a better understanding of the effectiveness of monetary policy in developing countries using microdata. Credit

[30] According to data from Dealogic Loan Analytics, during 2010–2014 only eight syndicated loans were extended to firms in Uganda (out of 667 loans granted to firms in developing countries over the same period).

[31] Column 1: 3.59 × (34 − 15) × 0.0063 = 0.43, which corresponds to 12% of the average (log) number of building permits (3.46).

[32] See, e.g., coverage in several articles published in 2011 in The New York Times, The Guardian, and Reuters.

[33] Column 9: 3.59 × (34 − 15) × (−0.0016) = 0.11, which is the effect over one quarter. Then, (0.11 × 3)/1.42 = 0.23.

[34] Column 12: *10.58 × (34 − 15) × (0.0147) = 2.95*, which is the effect over 12 months, corresponding to *2.95/9.14 = 32%* of average non-food inflation.

registers, which are increasingly available across the world, offer the opportunity to move away from aggregate time-series analyses of monetary policy, for which identification remains a major challenge, and which historically have provided mixed and inconclusive results. Our results suggest that monetary policy can be an effective macroeconomic tool in developing countries by affecting credit supply and real economic activity. However, more research is needed to understand how banks affect the transmission of monetary policy in countries that experience rapid financial development and changes in monetary policy frameworks.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jdeveco.2019.03.004.

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