

ApaaOkello, Jimmy; Mkenda, Beatrice K.; Luvanda, Eliab

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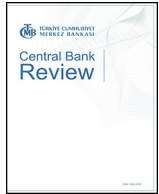
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The distortionary effects of sterilised reserve accumulation on domestic credit markets: Evidence from Uganda

Jimmy Apaa Okello*, Beatrice K. Mkenda, Eliab Luvanda

Department of Economics, College of Social Sciences, University of Dar es Salaam, United Republic of Tanzania

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ABSTRACT

Some small open Least Income Countries embarked on rapid accumulation of foreign reserves in the wake of volatile capital inflows. Foreign reserve accumulation is one way of managing volatile capital flows. However, rapid and persistent accumulation is not only costly, but potentially distort the domestic financial markets, especially when it is financed by sterilisation. This study investigates the potential distortions on commercial bank lending in Uganda. Our empirical results show that sterilised reserve purchases crowd-out bank lending. The crowding-out effect is persistent even when bank capitalisation and shifts in monetary policy regimes are controlled for, which raise important policy implications. The objective of sterilisation is to maintain the prevailing stance of monetary policy. However, when it alters the prevailing stance of monetary policy and consequently the direction of the impact of policy as the empirical result has shown, then sterilised reserve purchases violate the “impossible trinity” i.e. it weakens the monetary authority’s control over domestic monetary conditions.

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1. Introduction

Some small open Least Income Countries (LICs) embarked on accumulation of foreign reserves, especially in the wake of capital account liberalisation leading to rapid expansions in central banks’ balance sheets. For instance, foreign reserve stock for Uganda stood at 20.8 percent of GDP in 2007, up from just 0.3 percent in 1989 (Fig. 1) and has since stayed elevated. Accumulation of foreign reserves is one way of managing volatile capital

flows in open economies.¹ However, rapid and persistent accumulation can be costly directly and indirectly. Directly, there are carry or “quasi-fiscal” costs associated with reserve hoarding.² Indirectly, the costs of foreign reserve purchases and

¹ Reserves also serve to: smooth consumption and production in balance of payments disequilibria, provide liquidity for Lender of Last Resort (LLR), intervene in the foreign exchange market to stabilise currency volatility, and protect the domestic financial stability, especially in liberalised domestic financial markets in which agents can hold foreign currency deposits in domestic banks and foreign deposits. Most LICs use reserves to signal sovereign credibility and to support export-led growth strategies. A large war chest of foreign reserves is believed to buffer national output from foreign shocks. Some countries have used reserve purchases to support export-led growth strategies.

² Quasi-fiscal cost is the difference between returns on foreign reserves and interest cost of external debt. It is found to be sizable in developing countries (see Rodrik (2006)).

* Corresponding author. Research Department, Bank of Uganda, Plot 37–45, Kampala Road, Kampala, Uganda. Phone: +256 312392833; Mobile: +256 776699833.

E-mail addresses: japaa@bou.or.ug, jimkelo_apaa@yahoo.com (J.A. Okello), bkmkenda@gmail.com (B.K. Mkenda), luvanda@icloud.com, luvanda@udsm.ac.tz (E. Luvanda).

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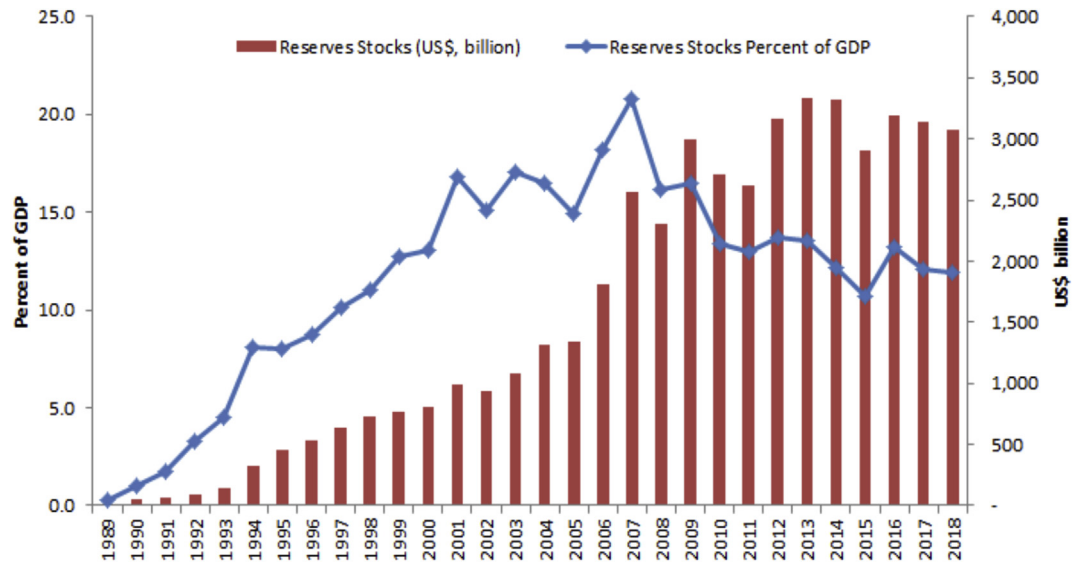


Fig. 1. Foreign reserves, excluding Gold.
Source: World bank world development indicators.

sterilisation include potential distortions to domestic banking behaviour and loss of automatic adjustment of exchange rates in floating systems.³

Foreign reserves can be equated to saving abroad that is funded through central bank domestic borrowing. To accumulate foreign reserves, central banks buy foreign currency in the domestic financial markets. If left unsterilised however, the reserve purchases may jeopardise monetary policy targets due to liquidity injections it creates. Thus, the central bank has to sterilise foreign reserve purchases by issuing government and/or central bank bills and other instruments, which is equivalent to domestic borrowing. It is documented that nearly all foreign reserve purchases are sterilised in emerging and developing countries. For instance, Aizenman and Glick (2009) report that the monetary base for most central banks does not change after foreign reserve purchases, implying that they were offset by sterilisation. For Uganda, the central bank reports that money market rates stay within the desired corridor despite injections of liquidity from foreign reserve purchases (Bank of Uganda, 2018). This signifies that sterilisation of the liquidity due to foreign reserve purchases is near-complete. Sterilised foreign reserves purchases however, has the potential to distort the proper functioning of the domestic credit markets. We test this proposition. We test whether sterilised foreign reserve purchases distort bank lending in LICs; whether the distortion, if any, disappears after controlling for bank capitalisation⁴ and shifts in regimes of monetary policy.⁵ Little empirical attention has so far been paid to the effects of sterilised foreign reserve purchases on credit markets in LICs as previous studies focused on emerging markets economies. For LICs, previous literature instead focused on the direct costs and benefits of foreign reserve purchases.

The literature on foreign reserves began to regain focus mid-2000s when it became apparent that global foreign reserve levels

were rising dramatically. Researchers constructed theoretical models to unearth the motives, benefits and costs of hoarding foreign reserves. For example, Caballero and Panageas (2005), Durdu et al. (2009), Jeanne and Ranchiere (2011), and Bacchetta et al. (2013) developed models showing that foreign reserve accumulation is financed by voluntary saving rather than central bank borrowing. These models, however, assume that foreign reserve purchases have no impact on domestic credit markets. On the other hand, Amador et al. (2016) show that foreign reserve purchases are financed by central bank borrowing. However, they too assume no impact of foreign reserve accumulation on the domestic credit markets since their model does not account for private competition.

Our empirical study assumes that private borrowers compete with central banks in the domestic credit markets pretty much in line with Cook and Yetman (2012), and Yun (2018). Cook and Yetman (2012), and Yun (2018) develop theoretical models of foreign reserves accumulation that show that central banks compete with private borrowers in the domestic credit markets. Their model therefore shows that foreign reserve purchases that are financed by central bank borrowing crowd-out bank lending.

Our empirical model applies panel data regression methods on two subsamples: 2002Q1–2011Q1 (the period of monetary targeting) and 2011Q3–2018Q4 (the period of inflation targeting).⁶ Results show that sterilised foreign reserve purchases crowd-out bank lending. The crowding-out effect is persistent even when bank capitalisation and shifts in monetary policy regimes are controlled for, which raise important policy implications. The objective of sterilisation is to maintain the prevailing stance of monetary policy. However, when it alters the prevailing stance of monetary policy and consequently the direction of the impact of policy as the empirical result has shown, then sterilised foreign reserve purchases violate the “impossible trinity” i.e. it weakens the monetary authority’s control over the domestic monetary conditions. The rest of the paper is organised as follows: Section 2 presents the literature review, while Section 3 discusses monetary

³ We proxy sterilisation as non-monetary liabilities of the central bank, which is calculated as total liabilities less both monetary base and foreign liabilities (see Mohanty and Turner, 2006).

⁴ Well capitalised banks tend to extend more credits as adequate capital help absorb more risks.

⁵ The central bank of Uganda moved from monetary targeting regime to inflation targeting regimes in July 2011 to enhance the efficacy of its monetary policy.

⁶ The central bank of Uganda moved from monetary targeting regime to inflation targeting regimes in July 2011 to enhance the efficacy of its monetary policy.

policy in Uganda. Section 4 lays down the empirical strategy, while Section 5 discusses the estimation results. The conclusion and policy implications are presented in Section 6.

2. Review of literature

Research interests in foreign reserve were refocussed in mid 2000s following the dramatic increase in foreign reserves levels. Researchers developed theoretical models to explain the dramatic increase in foreign reserves. Among these generations of models, there are those that modelled foreign reserve purchases as financed by voluntary savings or external borrowing. These models are due to Caballero and Panageas (2005); Alfaro and Kanczuk (2009); Benigno and Fornaro (2012); Bacchetta et al. (2013). These models however, assume no impact of foreign reserve purchases on domestic credit markets. Other models, such as Amador et al. (2016) nonetheless account for central bank domestic borrowing to finance foreign reserve purchases, but with no competition from private borrowers. Because they do not incorporate private borrowers, their model too, shows no impact of foreign reserves purchases on the domestic credit markets.

Cook and Yetman (2012) developed a small open economy model to examine the impact of central bank foreign reserves accumulation on the real economy when domestic banks are either facing borrowing constraints or not. In this model, central banks finance balance sheet expansions through the banking system while private non-bank firms finance capital formation through financial intermediation. In a slightly similar fashion, Yun (2018) constructed a theoretical model which describes foreign reserves as funded by central banks' domestic borrowing. The model incorporates private borrowers that compete with central banks in loanable fund markets. To be able to meet the demand for central bank borrowing, the domestic financial markets attempt to borrow from abroad, but the international financial intermediation is constrained. The private sector therefore can only partially offset the public outflows. As a result, bank lending is crowded out.

The models due to Cook and Yetman (2012) and Yun (2018) show that when foreign reserve accumulation is financed by domestic borrowing with the private borrowers also competing for the same pool of resources, it crowds-out bank lending. This is akin to open economy LICs. Although some LICs liberalised capital accounts, access to international financial markets remain elusive. Therefore, central banks' domestic borrowing can only be partially offset by the domestic financial markets.

There are recent empirical literature on foreign reserve costs. They include Calvo (1991) on the fiscal costs and perils of sterilised intervention; Mohanty and Turner (2006) on the distortion to the financial sector; Lavigne (2008) on delayed real exchange rate adjustment; Montiel and Reinhart (1999) on the increase in short-term interest rate, which attracts speculative capital inflows; Rodrik (2006) on the social costs; and Summers (2007) on high opportunity costs of holding foreign reserves. These studies however, do not examine how sterilised foreign reserves accumulation distorts the domestic credit markets.

Yun (2018) applied his theoretical model on data for Korea, specifically to investigate the impact of sterilised foreign reserves accumulation on bank loans. He finds that the crowding out coefficient is 0.5 percent of GDP. Cook and Yetman (2012) also applied their theoretical model to investigate whether foreign reserves accumulation crowds-out other types of assets using 55 individual banks in five Asian countries of Indonesia, South Korea, Malaysia, the Philippines and Thailand. They find that for each one percent growth in foreign reserves, there is approximately one percent decline in the growth of the quantity of loans relative to assets. Slightly related is Reinhart et al. (2016) which related the decline in

growth in Asia after 2000 to large foreign reserves accumulation and suggested that private sector investments have been crowded out by foreign reserves accumulation.

A model of the crowding-out effect of government bonds due to Bernanke and Blinder (1988) involves asset holders choosing between loan and bonds depending on the interest rates on the two instruments, and portfolio proportions depending on the rates of return on loans and bonds. Bernanke and Blinder (1988) assumed that money and bonds were imperfect substitutes. Their model showed that loanable funds can be used to purchase loans, bonds or excess foreign reserves. Therefore an increase in government bonds would diminish the amount of loanable funds available for lending, thus crowding-out bank loans.

The supply of government bonds can be expansionary,⁷ although not all government debt is equally expansionary. Demand debt or bank foreign reserves are more expansionary than short-term debt, and short-term debt is more expansionary than long-term debt. An increase in the supply of short-term debt would partly be absorbed by commercial banks. The non-bank public would sell off the excess short-term debt they hold and purchase other assets, including long-term bonds and capital, which lead to a fall in both long-term yield and return on capital, while the short-term interest rate can even rise. The banks would try to sell off the short-term debt they hold by increasing loan since short-term debt is assumed to be a close substitute for bank foreign reserves. Since some banks often use excess foreign reserves to extend loan, the increase in loan will lead to a fall in loan rates, which would prompt the non-bank public to reduce their holding of short-term debt by switching their funds to deposits. With more deposits, banks would be able to provide more loans (Tobin, 1963).

Given that short-term debt are more expansionary than long-term debt, open market operations that lead to the supply of more short-term debt than long-term debt should have a positive impact on bank lending. Gadanecz et al. (2014) argues that commercial banks can easily sell short-term central bank securities to finance new lending, which in turn can stimulate aggregate demand. Investor's ability to leverage depends on their holding of liquid government and central bank securities. Short-term government debt and central bank bills can facilitate increased risk taking in the financial system, leading to increased credit growth due to their ability to sell at short notice and at high collateral value (Gadanecz et al., 2014).

Our study adds to the literature on the costs of sterilised foreign reserve accumulation on the domestic financial markets in open economy LICs. Despite the increasing relevance of foreign reserves as a policy tool in open economy LICs, little empirical research has been devoted to the costs of foreign reserve accumulation on the domestic financial markets, as previous literature paid much attention instead on the costs of and rationale for holding foreign reserves, with particular focus on emerging markets. The study also adds to the burgeoning literature on the constraints of bank lending, which continues to attract intense research interests in recent times. Recent such studies include Baskaya et al. (2017) on how capital inflows may be expansionary in Turkey, Ivashina and Scharfstein (2010) on why some banks cut lending more than others during the great recession, exploiting cross-sectional differences in bank characteristics.

⁷ See for instance the pioneering work of Tobin (1963), Modigliani and Sutch (1966), Friedman (1978) on how portfolio balance leads to domestic debt being expansionary.

3. Monetary policy regime

In the early 1990s, Ugandan authorities embarked on a series of policy reforms. Part of these reforms included the adoption of an indirect and market-based monetary policy. Between 1993 and 2011, the country adopted a monetary targeting monetary policy regime. In the monetary targeting regime, the central bank sets growth targets of broad money and monetary base to be consistent with inflation and economic growth rates.⁸ The central bank then relentlessly adhere to the growth rate of the monetary base.⁹ There are indications that the monetary targeting regime had a good record in controlling inflation. For instance, inflation averaged about 7 percent between 1990 and 2010 from double digits in the 1980s. However, in the latter years of the regime, concerns over monetary targeting efficacy emerged, particularly on the stability of the money demand which may have weakened the relationship between broad money growth and inflation (Christopher, 2009).

In a bid to enhance the efficacy of monetary policy, the central bank shifted to targeting short-term inter-bank interest rates under an inflation targeting (IT) regime in July 2011. It introduced a policy rate called the central bank rate (CBR) with a margin of ± 300 basis points. It then regulated commercial banks' foreign reserves using largely repurchase agreements (repos) and treasury securities to make the short-term inter-bank money market rates move within the CBR margins. In practice, the procedure for implementing the open market operations vary across central banks world over, but for the central bank of Uganda, a cash reserve requirement (CRR), which currently is 8 percent of commercial banks' deposits, was imposed so that banks will have to hold excess reserves to minimise the risk of unanticipated decline in their deposits making them to borrow from the central bank. The commercial banks demand for excess reserves then provides scope for the central bank to alter the short-term inter-bank money market rates through the issuance of repos, treasury securities or other instruments.¹⁰

In the monetary targeting period, all government securities held by commercial banks were issued solely to sterilise excess liquidity. Thus, the government securities were nominally a monetary policy instrument. The reality was, when the government needed to finance its budget deficit, it overdrew its account at the central bank. The central bank then had to issue securities to mop up the liquidity so as to meet its monetary targets. In other words, there was no real difference between securities issued for monetary policy and those issued for fiscal deficit financing. In the IT period, attempts were made to make a distinction between securities issued for fiscal financing and liquidity sterilisation. However, in some years the government's issuance of domestic debt did not fully finance the budget deficit, which resulted in overdrawn accounts at the central bank. Thus, in these instances, some of the securities issued for sterilisation were as a result of the government failing to issue enough securities to finance its budget deficit.

Since 1997, particularly after the liberalisation of the capital account, the central bank of Uganda adopted a flexible-market

determined exchange rate system. Between late 1990s and early 2000s, the government of Uganda was a big recipient of large official aid, approximately 9 percent of GDP, which it had to spend in the domestic economy. In order to spend, the government had to sell the foreign currency to the central bank in exchange for domestic currency. The central bank had to purchase the foreign currency to avoid appreciation pressures on the exchange rate. The purchase of foreign currency led to accumulation of foreign reserves. However, the central bank's purchase of the government's foreign currency led to an injection of domestic currency liquidity to the banking system, which had to be sterilised by selling treasury securities to the market, else it would jeopardise monetary policy operational targets.

However, in mid-2000s to date, official aid inflows declined, averaging just 0.6 percent of GDP in 2014–2018. That is, the government's position moved from a net surplus to a net deficit, resulting in the central bank becoming a net seller of foreign currency to the government, rather than a net buyer as was previously the case.¹¹ That is, the central bank has to purchase foreign currency from the domestic financial markets to accumulate reserve stocks so as to effectively perform the role of stabilising the exchange rate, lender of last resort and at the same time meet the government's demand for foreign currency.

The challenge facing the central bank is that if it does not purchase foreign currency from the domestic financial market to build its stock of foreign reserves, it will suffer foreign reserves decumulation, which would make its foreign reserve level to fall below prescribed thresholds.¹² Foreign currency purchases however, create liquidity, which if left unsterilised would affect the monetary policy operational targets. It then has to sterilise the liquidity it created.

Basically, when the central bank purchases foreign currency, it automatically credits commercial banks' reserve accounts, which leads to an expansion in the monetary base and in order to minimise risks of increasing money supply and the associated inflationary pressures, the central bank has to issue instruments to sterilise the local currency liquidity it injected through purchases of foreign currency. In practice, sterilisation can be achieved through an array of instruments. For example, a central bank may just increase domestic currency as long as foreign reserve purchases are small as the demand for domestic currency may be increasing with the increase in the economy. However, when foreign reserve purchases are large and far exceed the public's domestic currency needs, a central bank faces a financing gap,¹³ which it must close using array of instruments. It may issue non-monetary liabilities, increasing either government deposits or government equity at the central bank (Table 1).¹⁴ However, increasing government deposits would require the government to operate a surplus budget, which is not feasible in most LICs as governments lack capacity to raise adequate tax revenue and/or run countercyclical fiscal policy. In terms of government equity, since 2014, the government has been

⁸ Before January 1967, Uganda belonged to the East African Currency Board, which basically run a fixed exchange rate system and issued a common currency for Kenya, Uganda, and Tanzania. The central bank of Uganda was established in January 1967 following the promulgation of the Bank of Uganda Act of 1966. Although Bank of Uganda issued its own currency, it continued to maintain a fixed exchange rate regime and controlled interest rates. It also directed the allocation of credits. In 1987–1992, the government implemented an economic recovery programme, principally to restore macroeconomic stability (see Musinguzi and Katarikawe (2001) for a detailed discussion of the historical developments of monetary policy regimes in Uganda).

⁹ The success of the monetary targeting framework is underpinned by the assumptions of constant money velocity and stable money demand.

¹⁰ For a detailed review of interest rate targeting, see Keister et al. (2008).

¹¹ Unlike other typical reserve accumulators in emerging Asia, large capital inflows is not the main cause of large reserve accumulation in Uganda as most of the financial inflows are matched by capital goods imports. The central bank would have to purchase foreign currency from the domestic market even if there were limited capital inflows because of the large reserve needs from the government's spending patterns and large structural deficit in foreign currency.

¹² The East African Community convergence criteria for the impending monetary union require that reserve level be 5 months of import cover, while the IMF's rule of thumb reserve adequate level is 3 months of import cover.

¹³ Mohanty and Turner (2006) define financing gap as the difference between foreign currency assets and currency in circulation.

¹⁴ In Table 1, we present a typical balance sheet of the banking system to illustrate how various reserve accumulation financing options potentially affect the financial system.

Table 1
Banking system balance sheet.

| Central Bank | | Commercial Bank | |
|-----------------|---------------------------|---------------------------|----------------|
| Assets | Liabilities | Assets | Liabilities |
| Foreign assets | Monetary liabilities | Foreign reserves deposits | Deposits |
| Reserves | Currency | Loans | Private sector |
| Domestic assets | Foreign reserves deposits | Investments | Gov't deposits |
| | Central bank bill | Gov't bills & bonds | Loans |
| | Non-monetary liabilities | Private bonds | Equity |
| | Gov't deposits | Note & coins | |
| | Other liabilities | | |
| | Equity | | |

Source: [Gadanecz et al. \(2014\)](#).

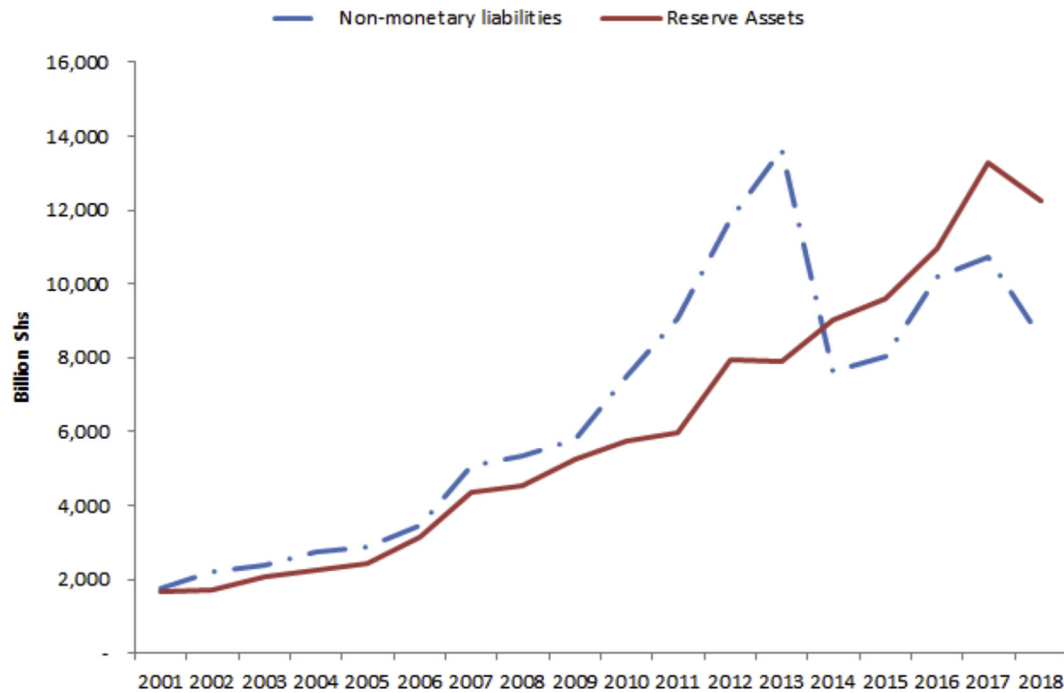


Fig. 2. Non-monetary liabilities and reserve assets of the central bank (Billion Shs).
Source: Bank of Uganda.

increasing its equity at the central bank by allocating treasury bonds, which the central bank uses to sterilise liquidity.

In addition, a central bank may finance its foreign reserve purchases by increasing the CRR. However, continuous increase in the CRR may weaken the banking system's profitability as it is often not remunerated in most LICs. The central bank therefore, has to use an array of instruments, including the CRR, repurchase agreements, sale of treasury securities and deposit auction facility to sterilise liquidity.

The use of an array of instruments however poses a challenge to the computation of what would specifically constitute sterilisation instruments of foreign reserve purchase. Our study relies on non-monetary liabilities of the central bank to proxy the amount of sterilisation instruments.¹⁵

¹⁵ There is a strong positive correlation between the stock of non-monetary liabilities and the stock of foreign reserves (Figs. 2 and 3), with a correlation coefficient in excess of 97 percent in 2002Q1–2014Q2. Despite the downward shift in 2014Q3, the correlation coefficient remains positive at 69 percent.

4. Empirical approach

The study applies panel data regression on quarterly data of commercial banks' balance sheets. Panel data models have advantages in empirical research. For example, they consider cross-sectional characteristics of banks simultaneously by analysing the dynamic interaction between, in this case, bank loan to the private sector and sterilisation instruments. In addition, by pooling together several time series and cross-sections, the number of observations increases, which in turn increases the degrees of freedom (see [Baltagi \(2008\)](#)).

Our empirical identification scheme starts with a specification of a baseline model in which two competing hypotheses are tested. The first hypothesis states that sterilisation instruments crowd-out bank lending based on the assumption that bank loans and sterilisation instruments are substitutes in the asset portfolio of commercial banks. The second hypothesis states that large and persistent holding of instruments provide liquidity buffers under imperfect markets, which can easily be converted to ease liquidity constraints, hence crowding-in banking lending.

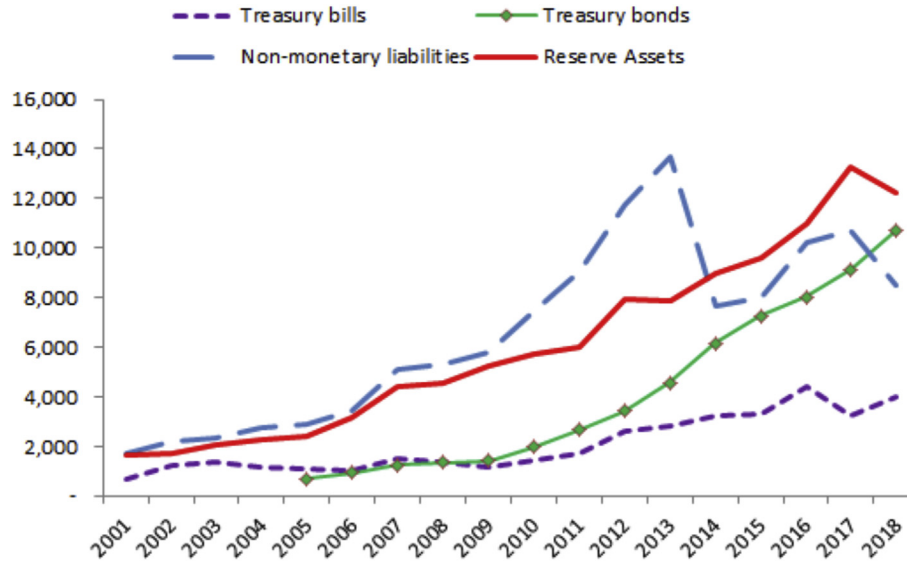


Fig. 3. Treasury securities, non-monetary liabilities and reserve assets (Billion Shs).
Source: Bank of Uganda.

4.1. The baseline model

The baseline model is a reduced form representation of equilibrium in the supply and demand conditions in the credit market. Following Pazarbaşıoğlu (1997), Ghosh and Ghosh (1999), and Gadanez et al. (2014), the supply of loans is a function of banks' characteristics and macroeconomic conditions at any given point in time. Thus,

$$L^s = f(r^c - r^r, C, y) \quad (1)$$

where $r^c - r^r$ is interest margin, measured as the difference between real interest rates on loan and real cost of funds, which in this case is deposit rate; C is banks' lending capacity, measured as the total of deposit liabilities at the bank; and y is current real output, which is used to proxy borrowers' credit worthiness. The central bank sterilisation instruments is introduced in equation (1) as one of the factors that influences banks' lending capacity, C .

The demand for bank loan is expected to be negatively affected by real interest rates, real output and the general price levels. Thus,

$$L^d = f(r, y, \pi) \quad (2)$$

where r is the real interest rate, y is real output and π is consumer price inflation. The real output and inflation represent the general macroeconomic environment.

The reduced form bank loan growth is therefore a representation of an equilibrium condition in the loan supply, equation (1) and loan demand equation (2). Thus,

$$\Delta L = f(\Delta C, r, \Delta y, \pi) \quad (3)$$

In equation (3), the real growth in bank loan is influenced by the change in banks' lending capacity, ΔC , the real interest rates, r , and the change in real income, Δy , and inflation, π . The change in banks' lending capacity is in turn determined by commercial banks' holding of sterilisation instruments, proxied by non-monetary liabilities of the central bank, the risk environment or quality of loan book and capitalisation requirement. Taking into account these factors, the baseline model is specified as

$$\begin{aligned} \log(l_{it}) = & \alpha_i + \beta_1 \log(r_{it}) + \beta_2 \log(y_{it}) + \beta_3 \log(npl_{it}) + \beta_4(lev_{it}) \\ & + \beta_5 \log(nom_{it}) + \varepsilon_{it} \end{aligned} \quad (4)$$

where l_{it} is the ratio of real bank loans to total assets for bank i in quarter t .¹⁶ The variable r_{it} is the real interest rate, derived using the Fischer type equation, where annual inflation rate is subtracted from nominal interest rate; y_{it} is the real GDP; npl_{it} is the ratio of non-performing loans to total loans—used to measure the risk environment; lev_{it} is the leverage ratio; nom_{it} is percent change in non-monetary liabilities of the central bank; ε_{it} is the disturbance term and i and t stands for bank and quarter, respectively.

A commercial bank loan supply is expected to decrease when a bank's non-performing assets ratio or quality of loan book deteriorates, consistent with risk averse behaviour. An increase in the real interest rate is expected to negatively affect the demand for commercial bank loan, while larger real GDP is expected to lead to more demand for bank credit since high economic growth require more credit to finance rising investment. Regulatory capital requirement imposes a constraint on banks to lend. It should thus have a negative relationship with the change in bank loan. The sign of the coefficient on nom depends on which of the two competing hypotheses stated above dominates. If nom is a close substitute of bank foreign reserves, the sign of the coefficient will be positive implying that holding of large sterilisation instruments by commercial banks leads to credit expansion. In contrast, large supply of sterilisation instruments crowd-out bank lending.

4.2. Alternative model

The alternative model seeks to examine cross-sectional heterogeneity, which may make some banks more responsive to

¹⁶ Other literature use the natural logarithm of real loans. See for example Baskaya et al. (2017).

sterilised foreign reserves accumulation than others. We test the hypothesis that well capitalised banks are more likely to use their holding of sterilisation instruments to extend more credit than under-capitalised banks. To examine this cross-sectional heterogeneity, we introduce an interaction term: sterilisation instruments, nom and a measure of well capitalisation of banks - a binary variable. Thus,

$$\log(l_{it}) = \alpha_i + \beta_1 \log(r_{it}) + \beta_2 \log(y_{it}) + \beta_3 \log(npl_{it}) + \beta_4 \log(nom_{it}) + \beta_5 \log(nom_{it}) * k_{it} + \varepsilon_{it} \quad (5)$$

where the impact of the interaction term between sterilisation instruments, nom_{it} and well capitalisation, k_{it} will be measured by the parameter β_5 .

During 2002Q1–2011Q2 when the central bank implemented monetary targeting regime, government securities were nominally sold to sterilise liquidity. When the central bank implemented IT regime in 2011Q3–2018Q4, much of the sale of government securities were to finance the budget deficit. The central bank nonetheless continued to sell treasury bonds in the secondary market, repos and other instruments to regulate commercial bank reserves so that the money market rates move within the bands on the central bank policy rate. We attempt to discern whether the shift in policy affected the lending behaviour of commercial banks in the face of an increase in sterilisation instruments. We divide the sample into two: 2002Q1–2011Q2, which is the period of monetary targeting and 2011Q3–2018Q4, which is the period of the IT over which we replicate the above estimations.

4.3. Estimation strategy

Panel data with small cross-sections, N and small time period, T usually relies on traditional estimation techniques such as fixed/random effects estimators or instrumental variable methods of [Arellano and Bond \(1991\)](#). In these estimators, individual groups are usually pooled together, such that the slope parameter is homogeneous across groups and only the intercepts are allowed to vary. However, the assumption of pooling is inappropriate (see [Baltagi \(2008\)](#) for a detailed discussion).

When panel data is of high frequency with the number of cross-sections, N and time period, T large, the asymptotic properties are quite different from the asymptotic properties of panels with small N and small T . Also, with large N , and large T , non-stationarity becomes a concern ([Blackburne and Frank, 2007](#)). To alleviate these problems, [Pesaran \(1997\)](#) and [Pesaran et al. \(1999\)](#) suggest the use of Mean Group (MG) and Pooled Mean Group (PMG) estimators in which the parameters are heterogeneous across groups.

The MG technique estimates N time series and averages the coefficients, while the PMG combines both N time series estimates with averaging of the coefficients. These estimators have attracted empirical application in recent times. [Frank \(2005\)](#), for example, used the PMG to assess the long-run impact of income inequality on economic growth of states in the USA. [Goswami and Hossain \(2013\)](#) used the PMG estimator to test the long-run stability of exchange rate and the short-run dynamics of the black market versus the official market exchange rates for eight groups of countries. [Boubaker and Jouini \(2014\)](#) used the PMG to investigate the link between emerging equity markets of Europe and developed countries using monthly data for the period 2000M10 to 2012M09.

Our panel data is of quarterly frequency containing seventeen (17) cross-sections of commercial banks, and sixty eight (68) points

of time series, which makes it suitable for the PMG to be used.¹⁷ The PMG estimator relies on Autoregressive Distributed Lag (ARDL) models of order (p, q_1, \dots, q_k) . Thus, rewriting equation (4) in the ARDL form yields ARDL(1,1,1,1,1) as,

$$\begin{aligned} \log(l_{it}) = & \alpha + \delta_{10} \log(r_{it}) + \delta_{11} \log(r_{i,t-1}) + \delta_{20} \log(y_{it}) \\ & + \delta_{21} \log(y_{i,t-1}) + \delta_{30} \log(npl_{it}) + \delta_{31} \log(npl_{i,t-1}) \\ & + \delta_{40}(\text{lev}_{it}) + \delta_{41}(\text{lev}_{i,t-1}) + \delta_{50} \log(nom_{it}) \\ & + \delta_{51} \log(nom_{i,t-1}) + \gamma \log(l_{i,t-1}) + \varepsilon_{it} \end{aligned} \quad (6)$$

where the number of groups $i = 1, 2, \dots, N$; the number of time periods $t = 1, 2, \dots, T$. If the variables in equation (6) are $I(1)$ and are cointegrated, the error term is an $I(0)$ process for the individual group. A key feature of a cointegrated relationship of the variables is an error correction term, which measures the speed of adjustment of the variable to their long-term equilibrium after the shocks to the system. Rewriting equation (6) into an error correction model yields

$$\begin{aligned} \log(l_{it}) = & \varphi [\log(l_{it}) - \beta_0 - \beta_1 \log(r_{it}) - \beta_2 \log(y_{it}) - \beta_3 \log(npl_{it}) \\ & - \beta_4(\text{lev}_{it}) - \beta_5 \log(nom_{it})] - \delta_{11} \log(r_{it}) - \delta_{21} \log(y_{it}) \\ & - \delta_{31} \log(npl_{it}) - \delta_{41}(\text{lev}_{it}) - \delta_{51} \log(nom_{it}) + \varepsilon_{it} \end{aligned} \quad (7)$$

where $\varphi = -(1 - \gamma)$, $\beta_0 = \frac{\alpha}{1-\gamma}$, $\beta_1 = \frac{\delta_{10} + \delta_{11}}{1-\gamma}$, $\beta_2 = \frac{\delta_{20} + \delta_{21}}{1-\gamma}$, $\beta_3 = \frac{\delta_{30} + \delta_{31}}{1-\gamma}$, $\beta_4 = \frac{\delta_{40} + \delta_{41}}{1-\gamma}$, $\beta_5 = \frac{\delta_{50} + \delta_{51}}{1-\gamma}$. The parameter φ is the error-correction term, which measures the speed of adjustment towards the long-run equilibrium after a shock to the system. [Pesaran et al. \(1999\)](#) assumes that for the system to be cointegrated, the parameter φ should not be equal to zero. The parameter φ is expected to be negative and statistically significantly to allow for a return to the long-run equilibrium after a shock. Equation (7) is non-linear in parameters, so it is estimated by a maximum likelihood estimator developed by [Pesaran et al. \(1999\)](#).

4.4. Data description

To estimate the impact of sterilised foreign reserves accumulation on bank lending in Uganda, we utilise panel data from monthly balance sheets of commercial banks. On a monthly frequency, commercial banks' chief executives report detailed bank balance sheets and income statements to the central bank of Uganda, which is the regulator. In addition to the regulatory needs, the statements are used as inputs for the compilation of monetary and financial statistics. We discuss the characteristics of each data set in the subsequent sub-sections.

4.4.1. Bank level data

The financial sector in Uganda, like many other LICs is dominated by commercial banks. In 2012–16 for example, as a percent of GDP, banks' assets averaged 83.2 percent of the country's total financial assets and nearly 100 percent of the financial system deposits ([Beck et al., 1999](#)). We focus on commercial banks since they seem to represent the country's overall

¹⁷ The Hausman test confirm the PMG estimator to be efficient and consistent. The results are presented in Table 5. In the PMG, the intercepts, short-run coefficients and error variances are allowed to vary across groups, but the long-run coefficients are constrained to be homogenous across groups ([Blackburne III and Frank, 2007](#)). Constraining the long-run coefficients to be uniform for all groups is plausible in our case, given that banks may be influenced by common macroeconomic and regulation environments which lead to similar reaction patterns.

financial sector.¹⁸

As at December 2018, there were twenty four (24) regulated commercial banks in Uganda, of which seventeen (17) have had consistent time series through end December 2018.¹⁹ To allow for a PMG estimator, we therefore selected seventeen (17) commercial banks, which have consistent time series for the period 2002Q1–2018Q4. The sample period is motivated by data availability as well as the desire to test whether the shift in monetary policy regime in July 2011 may have changed the results.

Since the reporting frequency is monthly and the data is stock, we derive quarterly data by computing simple averages of data for three-months in a typical quarter for each variable. The bank-level variables are the stock of loans and advances extended to the private sector, ratio of non-performing loan to total loan and regulatory capital ratio. The ratio of non-performing loan is computed as non-performing loans divided by total gross loans. The regulatory capital ratio that we use in the analysis is the leverage ratio, which is computed as the ratio of capital to risk weighted assets including off-balance sheet items. Although the central bank does not impose the leverage ratio as a regulatory requirement on commercial banks in Uganda, we bravely apply it based on the notion that it is more stringent because it includes off balance sheet asset items when calculating the ratio, unlike other regulatory capital requirements, such as ratio of capital to risk-weighted assets, ratio of regulatory tier 1 capital to risk-weighted assets, and total capital to total assets which do not. Baskaya et al. (2017) used the leverage ratio to represent bank characteristics. The threshold for the leverage ratio is 10 percent.

All the nominal variables were deflated using the 2009 base year consumer price index for Uganda. Following Gadanez et al. (2014), we develop a dummy variable (dummy = 1, if leverage ratio \geq 10 percent or well capitalised banks, otherwise dummy = 0 for poorly capitalised banks) to categorise banks into well capitalised and poorly capitalised, which we then interact with sterilisation instruments to test whether well capitalised commercial banks extend more credit when sterilisation instruments increase than weakly capitalised ones. All variables are transformed to natural logarithm so that the regression coefficients are interpreted as elasticities.

We present the summary statistics for the commercial bank level dataset in Table 2. The summary statistics show a considerable variation in all the variables, particularly the dependent variable, which is a crucial requirement for our empirical identification strategy. The mean and median of all the variables are nearly similar, implying that the data are symmetric. The minimum and maximum points of the data clearly show that there are no outliers in the data. As shown by the Skewness statistics, the data is negatively skewed, while the Kurtosis statistics for non-performing loans show some levels of outliers in the data.

4.4.2. Macroeconomic data

The macroeconomic variables that we have included in the regression are the log of the growth in aggregate output²⁰, log of

Table 2

Summary statics for bank level variables.

| | loan | npl | lev.ratio | k | nom*k |
|-------------|----------|----------|-----------|---------|---------|
| Mean | 0.3236 | 0.0005 | 0.1215 | 0.6218 | −0.0164 |
| Median | 0.3335 | 0.0003 | 0.1094 | 1.0000 | 0.0000 |
| Range | 0.6547 | 0.0212 | 0.7002 | 1.0000 | 2.7357 |
| Min. | 1.67e-06 | 0.0000 | −0.2527 | 0.0000 | −1.8030 |
| Max. | 0.6547 | 0.0212 | 0.4475 | 1.0000 | 0.9327 |
| Std. dev. | 0.0981 | 0.0010 | 0.0620 | 0.4852 | 0.4408 |
| Skewness | −0.2803 | 10.7691 | 1.3131 | −0.5022 | −1.8738 |
| Kurtosis | 2.9411 | 210.8756 | 7.7593 | 1.2522 | 8.5060 |
| Observation | 1082.00 | 1084.00 | 1084.00 | 1084.00 | 1028.00 |

Note: loan is natural log of the ratio of loans and advances to total assets, npl is natural log of ratio of non-performing loans to total loans, lev.ratio is natural log of leverage ratio, k = 1 if lev.ratio \geq 10, otherwise k = 0.

Source: Author's computation

consumer price inflation, log of lending rate and log of the change in non-monetary liabilities of the central bank. The lending rates are derived as weighted average rates, weighted by the ratio of the amounts of loan awarded to each individual borrower to total loan by each commercial bank. The nominal interest rates are transformed into real interest rates by netting off annual inflation rates from the nominal lending interest rates. The values are converted into natural logarithm so that the coefficients are interpreted as elasticities. All the macroeconomic datasets are obtained from the central bank of Uganda.

Table 3 presents the correlation coefficients of the dependent variable and all the explanatory variables as represented in equation (4). It is clearly shown in Table 3 that there is a negative correlation between the change in the stock of non-monetary liabilities, change in stock of government securities, real interest rate, non-performing loans, leverage ratio and change in bank loans. Save for the change in the stock of non-monetary liabilities and non-performing loans, the correlation coefficients are statistically significant at 5 percent level. As expected, the correlation between the change in bank loan and real GDP is positive albeit not statistically significant at 5 percent level.

5. Empirical results

Our empirical investigation focused on two crucial issues. First, we test the impact of sterilised foreign reserves purchases on bank lending behaviour. The question here is what is, the nature of the impact of large supply of sterilisation instruments on bank lending? Does it crowd-out or crowd-in bank lending? Second, we test whether banks' characteristics, measured by capitalisation buffer and shifts in monetary policy regimes affect the nature of the impact of sterilisation instruments on bank lending. In July 2011, the central bank of Uganda shifted from monetary targeting to inflation targeting regime. The test for regime shifts is done over two subsamples 2002Q1–2011Q2 (the period of monetary targeting) and 2011Q3–2018Q4 (the period of inflation targeting).

We start off by testing for heterogeneity across banks to determine whether the Ordinary Least Square (OLS) estimator would be consistent and unbiased. The results (Fig. 4) show that the OLS estimator is inconsistent and biased. We thus use a Pooled Mean Group (PMG) estimator by Pesaran and Smith (1995) and Pesaran et al. (1999). The PMG is an efficient estimator in situations where the number of cross-sections, N and time, T are large. The PMG estimator utilises the Autoregressive Distributed Lag (ARDL) model and the associated error correction representation. One of the merits of the ARDL model is the ability to deal with variables with mixed order of integration.

To select the optimal lags for the ARDL, we use Akaike (AIC) and

¹⁸ The role of banks has been clarified by Diamond (1997). Banks are important in emerging market economies where debt and equity markets are shallow and illiquid and there is limited participation of non-bank financial institutions in financial intermediation. When markets are deep and non-bank financial institutions fully participating in intermediation processes, banks become unimportant.

¹⁹ Confidentiality clause conditions us not to reveal names of the commercial banks included in the sample. Many commercial banks drop out of the sample due to mergers, acquisitions and closures.

²⁰ Other studies have use level of per-capita income (Baskaya et al. (2017) and Gadanez et al. (2014)) or output gap (Gadanez et al. (2014)).

Table 3
Correlation of real bank loan with regressors.

| | loan | nom | gsec | i.rate | GDP | npl | lev.ratio | nom*k |
|-----------|---------|---------|--------|---------|---------|---------|-----------|-------|
| loan | 1.000 | | | | | | | |
| nom | −0.026 | 1.000 | | | | | | |
| gsec | −0.081* | 0.050 | 1.000 | | | | | |
| i.rate | −0.110* | −0.296* | 0.078* | 1.000 | | | | |
| GDP | 0.276 | −0.225* | −0.051 | 0.186* | 1.000 | | | |
| npl | −0.006 | −0.006 | −0.005 | −0.063* | 0.132* | 1.000 | | |
| lev.ratio | −0.145* | −0.019 | −0.032 | −0.028 | −0.037 | 0.176* | 1.000 | |
| nom*k | −0.023 | 0.778* | 0.043 | −0.223* | −0.151* | 0.1130* | −0.034 | 1.000 |

Note: * denote 5% level of significance. loan is natural log of the ratio of loans and advances to total assets, nom is natural log of percent change in non-monetary liabilities, gsec is natural log of percent change in government securities, i.rate is natural log of real interest rate, GDP is real gross domestic product, npl is natural log of ratio of non-performing loans to total loans, lev.ratio is natural log of leverage ratio, $k = 1$ if $\text{lev.ratio} \geq 10$, otherwise $k = 0$.

Source: Author's computation

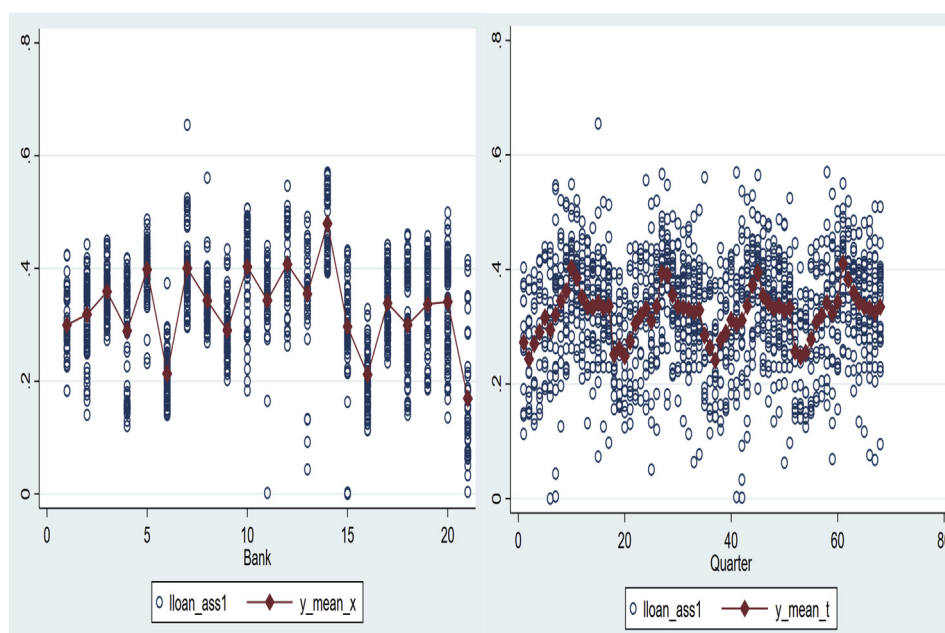


Fig. 4. Test of heterogeneity across banks and time.

Table 4
Lag selection criteria.

| 2002Q1–2018Q4 | | | | | |
|---------------|-------------------|---------------|----|------------|-----------|
| ARDL | Lag Selection | N=Observation | DF | AIC | BIC |
| PMG | ARDL(1,1,1,1,1,1) | 958 | 12 | −3707.218* | −3648.84* |
| PMG | ARDL(2,2,2,2,2,2) | 890 | 12 | −2986.546 | −2929.051 |
| PMG | ARDL(3,3,3,3,3,3) | 822 | 18 | −1685.915 | −1629.374 |

Note: DF stands for degrees of freedom; * represents optimal lag selected by the criterion. MTF and ITL stands for sub-sample for monetary targeting and inflation targeting periods, respectively.

Source: Authors' Computation

Bayesian Information Criteria (BIC). We apply a maximum lag length of three (3). We find that lag length one (1) produces the smallest AIC and BIC statistics in all the three sub-samples (Table 4). Thus, lag length one (1) is the optimum lag for the ARDL model.

In the PMG estimator, the long-run estimates are constrained to be the same for all groups. If the pooling assumption is true, the PMG estimator yields efficient and consistent estimates. The MG estimator is consistent in either case. We estimate the Hausman test statistics to select an efficient and consistent estimator. As shown in Table 5, the Hausman test statistics show that the PMG

estimates are consistent.²¹

5.1. Baseline model results

In the baseline model, we test whether increase in sterilisation instruments crowd-out commercial bank lending. We present the empirical results in Table 6. The regressor is the change in non-

²¹ If the p-value > 0.05, use PMG, otherwise use MG.

Table 5

Hausman test: Mean group vs. Pooled mean group.

| | (b) MG | (B) PMG | (b-B) Difference | S.E. |
|----------------|-----------|----------------------|---------------------|--------|
| nom | −0.0299 | −0.0186 | −0.0113 | 0.0504 |
| i.rate | −1.0571 | −0.6520 | −0.4051 | 1.4083 |
| GDP | 0.1528 | 0.0724 | −0.0803 | 0.1477 |
| npl | −0.6123 | −1.1654 | −0.5531 | 0.4448 |
| lev.ratio | −0.2326 | −0.0191 | −0.2135 | 0.8137 |
| Chi2(8) = 3.89 | | Prob > Chi2 = 0.5656 | | |

b = consistent under H_0 and H_a ; B = inconsistent under H_a , efficient under H_0 . Test: H_0 : difference in coefficients not systematic.

Source: Authors' Computation

monetary liabilities of the central bank as discussed in [Mohanty and Turner \(2006\)](#). We also experiment with the change in commercial bank's holding of sterilisation securities in line with [Yun \(2018\)](#) and [Gadanecz et al. \(2014\)](#). The results are essentially consistent.

The coefficient on the error correction term or speed of adjustment term is negative as expected and statistically significant. A negatively signed coefficient on the error correction term (ϕ) also indicates the presence of cointegration among the variables used in the PMG estimation (see [Goswami and Hossain \(2013\)](#)). However, the size of the speed of adjustment coefficient is small, ranging from -0.38 to -0.44 in the three trials, implying that the adjustment process toward the equilibrium after a shock to the system is slow.

An analysis of the determinants of bank lending show that increases in the non-monetary liabilities of the central, which represents the magnitude of sterilisation instruments, treasury bill rate, which represents both monetary policy environment and the costs of funding, the ratio of non-performing loans to total gross loans, which measures risk levels in banks, and the leverage ratio, which represents the regulatory capital requirements lead to a reduction in the ratio of loans to total assets. Except for the leverage ratio, all the coefficients are statistically significant. A one percentage point increase in sterilisation instruments leads to a 0.02 percentage point decrease in bank lending, suggesting that sterilised foreign reserves accumulation crowd-out bank lending. Also, a one percentage point increase in the real interest rate and the ratio of non-performing loans to total gross loans lead to 0.65 and 1.2 percentage point decreases in bank lending.

As expected, the coefficient on the real GDP variable is positively signed and statistically significant. That is, a one percentage point increase in real GDP leads to about 0.07 percentage point growth in commercial bank lending. This finding suggests that credit is procyclical, rising with income. In the business cycle interpretation, a robust economic activity leads to increases in asset prices, which leads to increases in the value of borrower's collateral, making private borrowers more credit worthy, in turn making them to seek for more credit from the banking sector ([Igan and Pinheiro, 2011](#)).

5.2. Shift in monetary policy regimes

We test whether the shift in monetary policy regime might have affected the impact of sterilisation instruments on commercial

Table 6

Impact of sterilised foreign reserves accumulation on bank lending.

| | Full sample | MTF | ITL | Full sample | MTF | ITL |
|-------------------------|------------------------|-----------------------|------------------------|------------------------|------------------------|-----------------------|
| LONG-RUN | | | | | | |
| log(% change in nom) | −0.0186** (0.0064) | −0.0577** (0.0243) | −0.0371*** (0.0046) | | | |
| log(% change in gsec) | | | | −0.1428*** (0.0150) | −0.0952*** (0.0093) | −0.0718** (0.0113) |
| log(real interest rate) | −0.6520*** (0.0803) | −0.1394 (0.1002) | −0.5628*** (0.1064) | −0.7397*** (0.0746) | −0.2361** (0.0927) | 0.0939 (0.0895) |
| log(real GDP) | 0.0724** (0.0135) | 0.2062*** (0.0244) | −0.0089** (0.0212) | 0.0677** (0.0139) | 0.1445** (0.0228) | 0.0156 (0.0229) |
| log(npl) | −1.1653*** (0.1503) | −0.0136 (0.0202) | −0.1165* (0.07118) | −0.7137** (0.1286) | −0.0576** (0.0281) | −1.2459** (0.1796) |
| log(lev.ratio) | −0.0191 (0.0901) | 0.1879** (0.0727) | −1.0286*** (0.1030) | 0.2103* (0.1117) | −0.0659 (0.0787) | −0.3377** (0.1145) |
| Error correction | −0.3869*** (0.0445) | −0.6126** (0.1176) | −0.5358*** (0.0698) | −0.3829*** (0.0377) | −0.6636*** (0.0885) | −0.4875** (0.0801) |
| SHORT-RUN | | | | | | |
| log(% change in nom) | −0.0056* (0.0034) | −0.0224** (0.0107) | −0.0106** (0.0042) | | | |
| log(% change in gsec) | | | | −0.0463*** (0.0034) | −0.0429** (0.0073) | −0.0287** (0.0053) |
| log(real interest rate) | −0.2202*** (0.0455) | −0.1033 (0.0811) | −0.3035** (0.0623) | −0.1531** (0.0379) | −0.1332* (0.0733) | −0.0529 (0.0563) |
| log(real GDP) | 0.0012 (0.0654) | 0.0003** (0.0481) | −0.1164 (0.0905) | 0.0883* (0.0612) | 0.0597 (0.0503) | −0.1444** (0.0648) |
| log(npl) | −0.2566** (0.1024) | −0.2269 (0.2412) | −0.0023** (0.1719) | −0.1643 (0.0972) | −0.1483 (0.2651) | −0.4116** (0.1945) |
| log(lev.ratio) | 0.1540* (0.1100) | 0.3689* (0.2251) | 0.0951 (0.1976) | 0.1621 (0.1249) | 0.3997* (0.2698) | 0.1061 (0.1867) |
| Constant | −0.0892*** (0.0131) | −0.9318** (0.1888) | 0.3210*** (0.0423) | −0.1004** (0.0154) | −0.6398** (0.0954) | 0.1474 (0.0252) |
| Log likelihood | 1865.609 | 896.9219 | 1058.292 | 1927.826 | 935.5968 | 1037.751 |
| Observations | 958 | 420 | 420 | 947 | 420 | 420 |
| Groups | 17 | 14 | 14 | 17 | 14 | 14 |
| Observation per groups | 56 | 30 | 30 | 55 | 30 | 30 |

Note: The standard errors are in (.) and */**/** denote 10%/5%/1% level of significance. Dependent variable is the natural log of the ratio of loans and advances to total assets, (loan).

Source: Author's Computation

bank lending behaviour. We divided the main sample into two: 2002Q1–2011Q2, the period of monetary targeting regime and 2011Q3–2018Q4, the period of the ITL regime. As a result, three commercial banks (3), especially those that started operations in the latter years of 2002Q1 to 2011Q2 fall out of the sub-sample because of insignificant data points, which leaves only 14 cross-sections. To ensure appropriate comparison of the estimates over the two sub-samples, we maintain the sample of 14 cross-sections for the period 2011Q3 to 2018Q4. Nonetheless, the sub-samples are still adequate to conduct the PMG estimation.

The results are shown in Table 6. The coefficient on the error correction term or speed of adjustment in both sub-samples increases and remain statistically significant. All the coefficients on the macroeconomic and bank level variables have the correct the signs and is statistically significant, save for the coefficient on the real interest rate, and the ratio of non-performing loans. The results show that an increase in the supply of sterilisation instruments by the central bank lead commercial banks to cut lending to the private sector during the period of monetary targeting and ITL regimes. For instance, a one percentage point increase in sterilisation instrument lead to a 0.06 and 0.04 reduction in commercial bank credit to the private sector in both the monetary targeting and ITL regimes, respectively. The estimates are consistent even when bank holdings of sterilisation securities are used instead of commercial non-monetary liabilities of the central banks.

These results are similar to findings of previous studies. Notable is the findings in Yun (2018). Yun (2018) examined the impact of sterilised foreign reserve accumulation on monthly bank balance sheet data of South Korea over the 2003–2008 period. He finds that bank loan growth rate declined significantly after foreign reserve accumulation. He estimated the crowding out coefficient to be 0.5. In addition, Cook and Yetman (2012) report a negative relationship between foreign reserves holding and growth of bank credit in some emerging Asian economies. Cook and Yetman (2012) however find that in countries where sterilisation was incomplete, foreign reserves accumulation leads instead to increases in broad money, inflation and credit growth. However, our estimates are different from the findings in Gadanecz et al. (2014). Gadanecz et al. (2014) examined the impact of banks' holding of government and central bank securities due to foreign reserves accumulation on bank lending in 22 emerging market economies over the 2001–2011 period. They find that bank holding of government and central bank paper lead to expansions in bank credit. The impact is strongest in economies with well capitalised banking system. They attribute these results to the notion that government and central bank paper tend to be liquid, which make them easily substitutable with banks' excess reserves.

To summarise, the estimates from the baseline model indicate that an increase in the supply of sterilisation instruments, measured by the non-monetary liabilities of the central bank crowd-out lending to the private sector. The findings are similar in both the monetary targeting and ITL regimes. The estimates are robust to the inclusion of bank characteristics and macroeconomic controls. For instance, commercial bank lending decreases with the increase in the stock of non-performing loans and regulatory capital requirements. In addition, we find that commercial bank lending increases with the increase in real GDP. The estimates are also robust to the use of commercial bank holding of sterilisation securities in place of the change in the non-monetary liabilities of the central bank.

5.3. Alternative model results

The alternative model test whether well capitalised banks' lending behaviours are different from poorly capitalised banks

when the supply of sterilisation instruments by the central bank increases. We create a dummy variable as follows: dummy = 1, if the leverage ratio ≥ 10 , otherwise dummy = 0 if the leverage ratio < 10 . This dummy variable is then interacted with the log of the change in the sterilisation instruments. We replicated the estimation over the two sub-samples: 2002Q1–2011Q2 – the period of monetary targeting regime, and 2011Q3–2018Q4 – the period of inflation targeting 'lite' regime.

The results are presented in Table 7. As shown in column 2 of Table 7, the coefficient on the sterilisation instruments turns positive and statistically insignificant. However, the coefficient on the interaction term is negative and statistically significant implying that an increase in sterilisation instruments crowd-out bank lending irrespective of commercial banks capitalisation. Even when commercial banks are well capitalised, a one percentage point increase in capitalisation instrument, measured by non-monetary liabilities of the central bank leads to a 0.03 percentage point reduction in bank lending to the private sector. This result is robust to the use of the change in bank holding of sterilisation securities instead of the change in the non-monetary liabilities of the central bank. For instance, with a one-quarter lag, even when banks are well capitalised, lending decreases by 0.05 percentage points for every one percentage point increase in holdings of sterilisation securities. The results are significant at the 10 percent level. However, when the capitalisation dummy is interacted with the change in foreign reserves instead of the non-monetary liabilities of the central bank, the coefficient is statistically insignificant at all levels.

5.4. Shift in monetary policy regimes

The results remain consistent in the 2002Q1–2011Q2 sample, which is the period of monetary targeting regime. For example, in column 3 of Table 7, for well capitalised banks, with a one-quarter lag, bank lending to the private sector declines by 0.10 percentage point for a one percentage point increase in sterilisation securities measured by the change in non-monetary liabilities of the central bank. The results are statistically significant at the 5 percent level. Similarly, the results remain significant in the 2011Q3–2018Q4 sample, which is the period of ITL regime. For example, in column 4 of Table 7, for well capitalised banks, bank lending reduces by 0.01 percentage points for every one percentage point increase in sterilisation instrument, measured by the change in the non-monetary liabilities of the central bank.

6. Conclusion and policy implications

Our study tests the potential distortion effects of sterilised foreign reserves accumulation on bank lending behaviour in Uganda. We find that sterilisation of foreign reserves accumulation crowd-out bank lending. The crowding-out effect occur even when banks are well capitalised. Moreover, shifts in policy regimes do not alter results. Sterilised foreign reserves accumulation crowd-out bank lending both under monetary targeting and interest rate targeting or inflation targeting regimes.

Our empirical results raise important policy implications. The objective of sterilisation is to maintain monetary policy stance constant in the face of foreign currency purchases, which in the absence of sterilisation, would be similar to easing monetary policy. But if sterilisation of foreign currency purchases by the central bank alters the stance of monetary policy as our results have shown, then rapid and large sterilised accumulation of foreign reserves raises concerns of monetary policy "trilemma" proposition in which rapid foreign exchange interventions or rapid accumulation of foreign reserves weakens the central bank's control over domestic monetary policy.

Table 7
Capitalisation and lending behaviour of commercial banks.

| | Full sample | MTF | ITL | Full sample | MTF | ITL |
|-------------------------|------------------------|-----------------------|------------------------|------------------------|------------------------|------------------------|
| LONG-RUN | | | | | | |
| log(% change nom) | −0.0139* (0.0096) | −0.0009** (0.0459) | −0.0376** (0.0071) | | | |
| log(% change gsec) | | | | −0.1277** (0.0238) | −0.1101** (0.0248) | −0.1794** (0.0439) |
| log(real interest rate) | −0.9215*** (0.0762) | −0.1768* (0.1050) | −0.9571*** (0.1289) | −0.9096*** (0.0845) | −0.1968** (0.0970) | −0.0869 (0.0623) |
| log(real GDP) | 0.0946*** (0.0138) | 0.2243*** (0.0265) | 0.0230 (0.0246) | 0.0877** (0.0158) | 0.1766*** (0.0242) | 0.0245** (0.0205) |
| log(npl) | −0.8419 (0.1234) | −0.0011 (0.0244) | −0.2935** (0.0986) | −0.8196** (0.1417) | −0.0506* (0.0271) | −1.0857*** (0.1545) |
| nom*kdm | −0.0048 (0.0118) | −0.0858** (0.0441) | −0.01231* (0.0080) | | | |
| Gsec*kdm | | | | −0.0481* (0.0282) | 0.0213 (0.0251) | 0.1266** (0.0443) |
| Error correction | −0.4014*** (0.0443) | −0.5740** (0.1052) | −0.5293*** (0.0547) | −0.3465*** (0.0369) | −0.6361*** (0.0881) | −0.5191*** (0.0742) |
| SHORT-RUN | | | | | | |
| log(% change nom) | −0.0024 (0.0034) | −0.0262 (0.00190) | −0.0354 (0.0239) | | | |
| log(% change gsec) | | | | −0.0414** (0.0062) | −0.0506** (0.0092) | −0.0694** (0.0225) |
| log(real interest rate) | −0.2874** (0.0429) | −0.1339** (0.0681) | −0.4604*** (0.0554) | −0.1787** (0.0307) | −0.0905* (0.0497) | −0.0783* (0.0424) |
| log(real GDP) | −0.0076** (0.0695) | −0.0245 (0.0551) | −0.1404* (0.0889) | 0.0809* (0.0569) | 0.0385** (0.0496) | −0.1143** (0.0839) |
| log(npl) | −0.1904* (0.1139) | −0.2007 (0.2458) | −0.0624 (0.1702) | −0.1827** (0.0974) | −0.0839 (0.2527) | −0.3222* (0.1765) |
| nom*kdm | −0.0089* (0.0067) | −0.0160 (0.0299) | *0.0173 (0.0237) | | | |
| gsec*kdm | | | | 0.0049 (0.0132) | −0.1767 (0.1911) | 0.0579** (0.0227) |
| Constant | −0.1901*** (0.0223) | −0.9782** (0.1876) | 0.1071*** (0.0131) | −0.1442*** (0.0195) | −0.8055** (0.1232) | 0.0951** (0.0177) |
| Log likelihood | 1851.099 | 882.8192 | 1000.047 | 1900.495 | 908.3619 | 987.8592 |
| Observations | 958 | 420 | 420 | 947 | 420 | 420 |
| Groups | 17 | 14 | 14 | 17 | 14 | 14 |
| Observation per group | 37 | 30 | 30 | 35 | 30 | 30 |

Source: Author's Computation

Nonetheless, our results support the open economy policy preference to use foreign reserves accumulation as a tool for managing volatile capital flows. Recent theoretical literature demonstrates that capital inflows are expansionary in emerging markets through the credit channel (see for instance, Blanchard et al., 2017; Cerutti et al., 2017). This view is supported by empirical evidence. For example, Baskaya et al. (2017) found that capital inflows to Turkey lead to a reduction in the cost of borrowing, which in turn lead to growth in commercial bank credit.

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