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The Monetary Transmission Mechanism in Uganda

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EXECUTIVE SUMMARY

There are strong *a priori* reasons to believe that monetary transmission may be weaker and less reliable in low- than in high-income countries. This is as true in Uganda as it is elsewhere. While its floating exchange rate gives the Bank of Uganda monetary autonomy, the country's limited degree of integration with world financial markets limits the strength of the exchange rate channel of monetary transmission. The country lacks large and liquid secondary markets for debt instruments, and its stock market is both extremely small and very illiquid. This means that monetary policy effects on aggregate demand would tend to operate primarily through the bank lending channel. Yet the formal banking sector is small, and doesn't intermediate for a large share of the economy. Moreover, there is evidence both that the costs of financial intermediation are high and that the banking system may not be very competitive. The presence of all of these factors should tend to weaken the process of monetary transmission in Uganda.

This paper examines what the empirical evidence has to say about the strength of monetary transmission in Uganda, using the vector autoregression (VAR) methods that have been applied broadly to investigate this issue in many countries, including high-, middle-, and low-income ones. I estimate a monthly VAR with data from December 2001 to June 2011, when the Bank of Uganda switched its monetary policy regime from one that used the monetary base as its operating instrument to one that relies on a policy interest rate. Applying a variety of methods to identify exogenous movements in the monetary base in the data, I find consistently that positive shocks to the base result in statistically significant effects on the exchange rate, bank lending rate and the price level in the direction predicted by theory, a set of findings that is unusual among low-income countries. However, the effects on the price level are quantitatively small, and while the impacts on my monthly proxy for real economic activity are in the theoretically-expected direction on impact, this does not hold true over a longer horizon and such effects are never statistically significant. In other words, the empirical tests do not yield evidence of strong impacts of monetary policy on aggregate demand in Uganda. The most likely explanation is that the formal financial system remains rather small relative to the size of the economy.

This situation appears to be evolving rapidly, however. Uganda is becoming increasingly more integrated with international financial markets, a development that will strengthen the exchange rate channel of monetary transmission, and the recent change in the monetary policy regime can be expected to strengthen the links between monetary policy actions and bank lending rates, as well as between bank lending rates and aggregate demand. Though these developments will strengthen monetary transmission in Uganda, their scope for doing so will remain constrained in the short run by the size of the formal financial sector.

The Monetary Transmission Mechanism in Uganda

The channels through which monetary policy affects aggregate demand depend on a country's financial structure. Relevant factors include the extent of a country's links with external financial markets, its exchange rate regime, the size and composition of its formal financial sector, the degree of development of its money, bond, and stock markets, the liquidity of its markets for real assets such as housing, and both the costs to its banks of doing business as well as the competitive environment in its banking sector. These characteristics differ significantly among countries, and those differences become especially dramatic when comparing high- and low-income countries (LICs). There is therefore no reason to expect that mechanisms of monetary transmission in LICs would be similar to those that have been found to operate in high-income countries. Indeed, in contrast with results for high-income countries, careful studies of the effectiveness of monetary transmission in LICs have often found monetary policy effects that are counterintuitive, weak, and/or unreliable.[1]

This is an unsatisfactory state of affairs, because central banks in LICs have recently not only begun to take a more active role in short-run macroeconomic stabilization, but also to commit themselves publicly, through the adoption of some form of inflation targeting, to deliver specific medium-term paths for the aggregate price level. In order for LIC central banks to carry out these roles effectively, it is important for them to understand the extent to which the policy instruments that they control have a reliable effect on aggregate demand.

This paper represents an attempt to explore this issue for the case of Uganda. Uganda is a particularly important case because the Bank of Uganda (BOU) has recently begun to move toward the implementation of an inflation-targeting regime, which will eventually require it to hit publicly-announced inflation targets. In order to do so, the BOU must understand the links between its policy instruments and aggregate demand in the Ugandan economy not just qualitatively, but also quantitatively. The objective of this paper is to explore the effectiveness of these links, using the VAR methodology that has commonly been applied to investigate monetary policy effectiveness not only in advanced and emerging economies, but also in many other low-income countries.

The structure of the paper is as follows: the next section reviews Uganda's financial architecture, with the objective of identifying key components of that architecture that are likely to affect the monetary transmission mechanism. As indicated above, such components include the strength of linkages between the domestic and foreign financial markets and the evolution of the country's exchange rate regime, as well as the size and composition of its

[1] Mishra and Montiel (2012).

formal financial sector. These characteristics of the Ugandan economy constitute the context in which monetary transmission operates in the country, and thus provide the basis on which to build an analytical framework to interpret the paper's empirical results. Section II describes the evolution of monetary policy formulation in Uganda. The purpose of the discussion in that section is to provide guidance in the selection of the monetary policy instrument to be used in the empirical work, as well as to indicate the types of variables to which the BOU has responded in setting the values of that instrument (the BOU's reaction function). Section III discusses a variety of issues concerning the specification of the VAR from which the dynamic response of several macroeconomic variables to monetary policy shocks will be estimated. That estimation, in the form of impulse responses, is presented in section IV, which also discusses the key issue of identifying monetary policy shocks in the data. Section V conducts some robustness tests, and section VI concludes.

I. Capital Account Regime, Exchange Rate Regime, and Domestic Financial Structure

As indicated above, the effectiveness of monetary transmission in a specific country depends on a variety of characteristics of its economy. These are usefully classified into macroeconomic and microeconomic factors. Macroeconomic factors include the economy's degree of integration with external financial markets as well as its exchange rate regime, and microeconomic factors refer specifically to the structure of its financial system. This section describes the roles of both factors in the Ugandan economy.

I.1 Macroeconomic factors

A standard approach in macroeconomic modeling --- at least until the current international financial crisis – has been to assume away financial frictions in the domestic economy, so that returns on all domestic interest-bearing assets (that is, on all assets but money) are assumed to be perfectly arbitraged – i.e., risk-adjusted returns are equalized among all domestic nonmonetary assets. Under these circumstances, all nonmonetary assets can be treated as perfect substitutes. In this case, the effectiveness of monetary transmission depends only on macroeconomic factors, in the form of the degree of integration between domestic and foreign financial markets and the exchange rate regime.

The "impossible trinity" of Mundell provides the main result: with fixed exchange rates, the effectiveness of monetary policy *decreases* as the degree of integration between domestic and foreign financial assets *increases*. In the limit, with perfect integration, monetary policy has no effect on aggregate demand. Under floating rates, monetary policy is transmitted to aggregate demand through two channels: through domestic interest rates (which affect the overall level of absorption) and through the exchange rate, which affects the composition of

absorption between domestic and foreign goods. In this case, as the degree of financial integration increases, the power of monetary policy to affect aggregate demand *increases* with it. The reason is that increased integration implies a reduced scope for monetary policy to create rate-of-return differentials between domestic and foreign assets. This means that a given policy-induced change in the domestic interest rate must create a larger offsetting expected change in the exchange rate (i.e., an expected depreciation of the domestic currency in response to an increase in the domestic interest rate, and an expected appreciation in response to a decrease) the greater the degree of financial integration. Holding the expected future exchange rate constant, the exchange rate must depreciate today in order to create the expectation of an appreciation tomorrow, and it must appreciate today in order to create the expectation of a depreciation tomorrow. Since increases in domestic interest rates are therefore associated with exchange rate appreciations, while decreases are associated with depreciations, these exchange rate changes reinforce the effects of policy-induced interest rate changes on aggregate demand. The upshot is that the higher the degree of financial integration, the greater the extent to which exchange rate changes reinforce the effects of interest rate changes on aggregate demand, and therefore the stronger the monetary transmission mechanism.

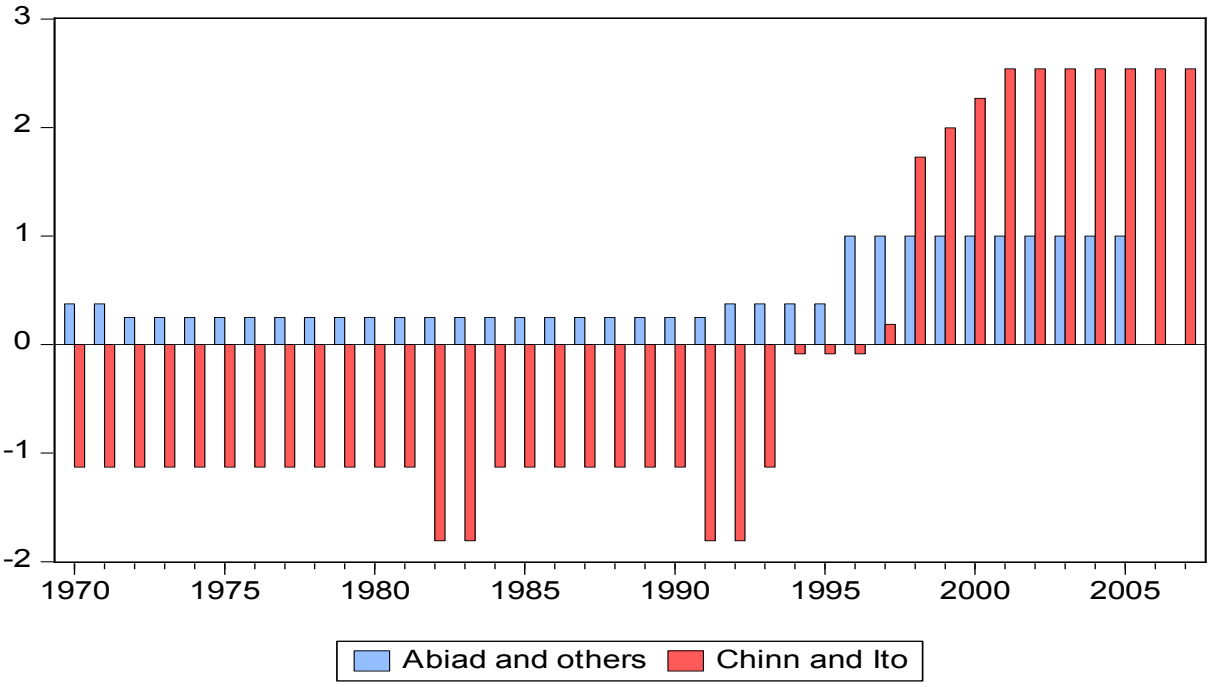
To form an *ex ante* expectation of the strength of monetary transmission in Uganda, I therefore begin by considering its economy's degree of financial integration with the rest of the world, as well as its exchange rate regime.

I.1.1 International financial integration

Uganda liberalized the capital account of its balance of payments in July of 1997, and since then there have been no restrictions on capital movements in or out of Uganda. Two well-known indices of *de jure* capital account restrictions, constructed by Abiad and others (2008) and by Chinn and Ito (2007) are presented for Uganda in Figure 1. These indices are constructed on the basis of information in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*, and both increase as the capital account becomes more liberalized. The two indices concur in finding a step change in Uganda's capital account regime in the mid-1990s, with an effectively open capital account by 1997 according to the index constructed by Abiad and others, and by 2000 according to Chinn and Ito.[2]

[2] For the sake of comparison, by the Chinn-Ito measure the index value for the United States was 2.54 during the entire 1970-2009 period, while that for Japan increased from -0.09 in 1970 to 2.54 in 1983, following a process of financial liberalization in that country. The index for Tanzania, by contrast, registered -1.13 continuously from 1996 to 2009.

Figure 1. De Jure Indicators of Capital Account Openness in Uganda, 1970-2007



However, financial integration requires more than the absence of *de jure* restrictions on capital movements, because "natural" barriers to capital flows may also prevent effective arbitrage between domestic and external financial markets. Such barriers can be of various types. An important one is the presence of a prospectively insolvent government – i.e., of a "debt overhang." In this case, the inability of the government to meet its financial obligations creates a prospective tax on any assets located within its political jurisdiction (either extracted by the government itself or by its creditors) and therefore acts on prospective capital inflows very much as would a formal tax on such flows. But even in the absence of a debt overhang, financial frictions operating across international boundaries, in the form of asymmetric information and costly contract enforcement (the same factors that create an external finance premium domestically) may "throw sand in the wheels" of international finance and prevent effective arbitrage flows, thereby limiting the degree of effective integration between domestic and foreign financial markets.

Since Uganda is a HIPC country, and since its domestic financial system is relatively poorly developed (see section I.2), these considerations may be quite relevant to the Ugandan case. Figure 2 considers the potential relevance of natural barriers to capital flows into Uganda by examining the size and composition of private capital flows into the country compared to a benchmark: the international transfers that the country has received during the same period of time. There are three takeaways from the figure:

- Although there was a perceptible increase in 1997, until 2005 total net private capital inflows in Uganda have been relatively small – less than half the magnitude of the transfers received by the country. This suggests that the removal of *de jure* restrictions on capital flows mattered, but was not decisive in changing the country's degree of financial integration with the international economy.

- Even when capital inflows came to rival transfers in size (2006-2011), these were dominated by FDI inflows – not the type of flow that is typically associated with arbitrage between domestic and foreign financial markets – i.e., not the type of flow that influences the effectiveness of monetary policy in the Mundellian sense.

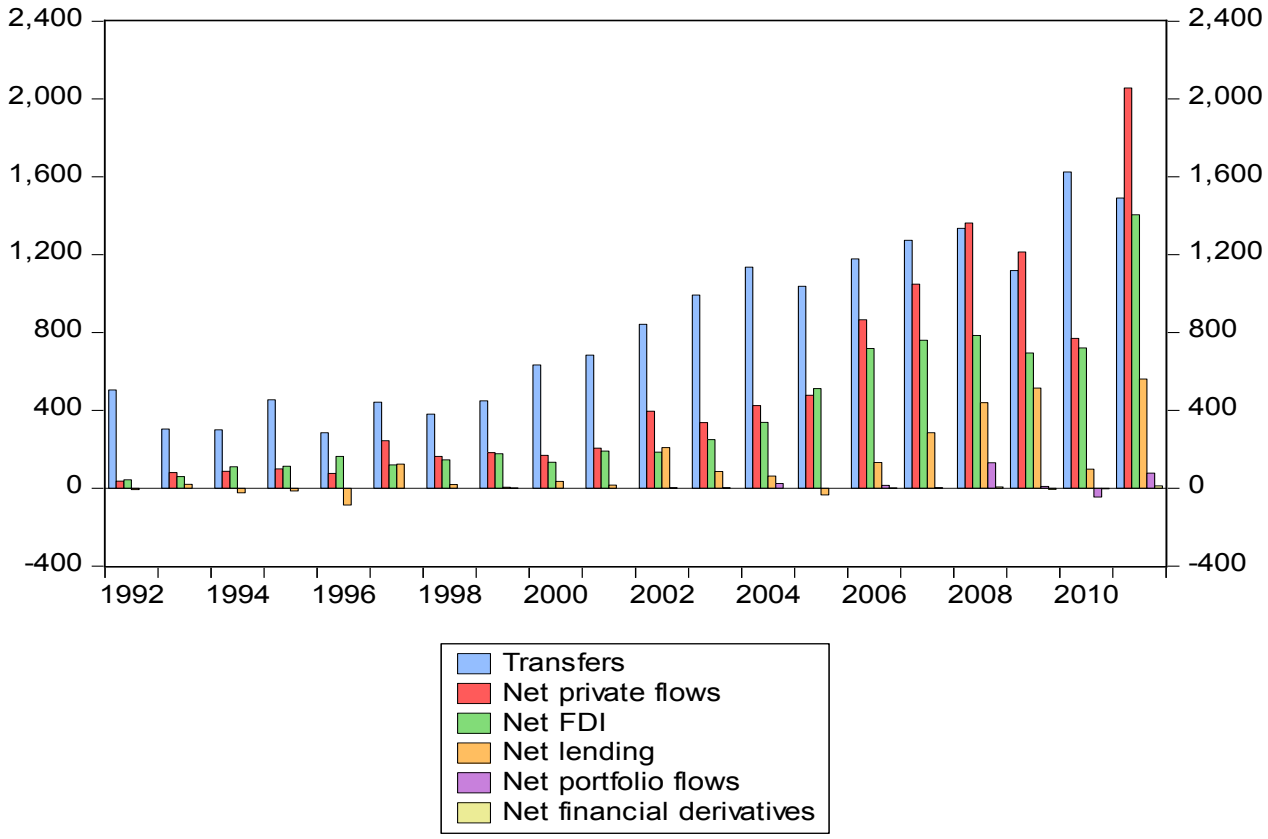
- Other private capital inflows (net lending to Ugandan residents, portfolio flows and net inflows of financial derivatives) became important only after 2008, and among these bank borrowing was overwhelmingly important relative to portfolio flows (flows of financial derivatives were almost nonexistent). To the extent that Ugandan banks borrowed externally to lend to public entities within Uganda, however (e.g., to hold government securities), this may also not represent the type of arbitrage flow that is associated with uncovered interest rate parity.

The flow data in the Ugandan balance of payments thus suggests that while the Ugandan economy may be financially open *de jure*, natural barriers to capital flows remain important, albeit decreasingly so.

As a final *de facto* measure, consider the ratio of foreign assets and liabilities to GDP, a measure of *de facto* openness popularized by Lane and Milesi-Ferretti (2006). This ratio is not strictly appropriate for countries with large amounts of assets and liabilities attributable to the public sector (e.g., in the form of foreign exchange reserves or of concessional debt from bilateral and multilateral donors, because such stocks are not the product of arms' length market transactions among private agents. I therefore use an alternative measure constructed by Dhungana (2008) that excludes concessional financing and holdings of foreign exchange reserves. His measure is available most recently for the year 2007. Again using the United States and Japan as benchmarks, this ratio was 2.78 for the United States, and 1.72 for Japan. For Tanzania, it was 0.53 and for Uganda it was 0.48.

Overall then, while Uganda has had an open capital account de jure since the late 1990s, de facto indicators concur in suggesting that the country has enjoyed only a limited degree of integration with international financial markets during recent years.

Figure 2. Uganda: Size and Composition of Private Capital Flows

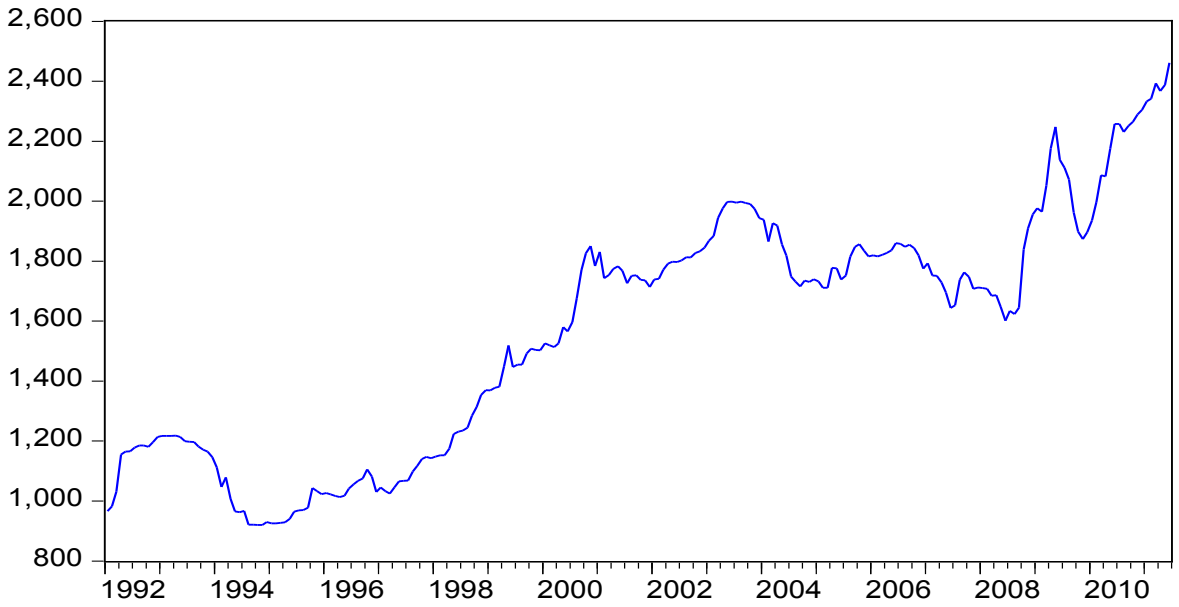


I.1.2 Exchange rate regime

The IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* provides a *de facto* annual indicator of each country's official exchange rate regime – i.e., a measure based on what countries actually do, rather than on their self-declarations. Uganda's regime has been classified in the *AREAER* as "independently floating" since 1992. Consistent with this classification, the BOU describes its exchange rate policy as one in which it intervenes in the foreign exchange market only to stem volatility, with no medium-term exchange rate target.

The evidence appears to be consistent with this self-declaration. First, as shown in Figure 3 below, the shilling-dollar rate has displayed substantial volatility during the period that the shilling was officially classified as floating, so it passes a simple "eyeball test" as a floating rate.

Figure 3. Uganda: Shilling/Dollar Rate, 1992-2011



More formally, the log of the Ugandan real effective exchange rate (LREER) can be decomposed into the sum of the log of the nominal effective exchange rate (LNEER) and the log of the relative price level between Uganda and its trading partners (LRELP). LREER has been stationary over the 1992-2011 period, so the behavior of Uganda's equilibrium real exchange rate can be well approximated by relative purchasing power parity (PPP). If the BOU had been targeting a nominal exchange rate during this period (i.e., if it had been using the nominal exchange rate as a nominal anchor), deviations of the REER from its equilibrium level would predominantly have been closed by adjustments in RELP, rather than in NEER. But in fact the opposite has been true. In a simple error-correction framework, deviations of REER from its equilibrium value have been closed by adjustments in NEER, with approximately 3 percent of the gap closed each month.

The evidence therefore suggests that, even though Uganda has maintained an open capital account de jure for some time, de facto it has enjoyed only a very limited degree of integration with international financial markets until very recently. Coupled with evidence that the country has indeed maintained a free-floating exchange rate regime, macroeconomic considerations suggest that the BOU has in all likelihood enjoyed a substantial degree of monetary autonomy – i.e., the effectiveness of monetary transmission has not been undermined by a loss of monetary autonomy. However, this does not imply that macroeconomic factors necessarily favor strong monetary transmission in Uganda. Given the country's floating exchange rate, its limited degree of integration with international financial markets would tend to weaken the exchange rate channel of monetary transmission that typically supplements the

interest rate channel under floating exchange rates, increasing the relative importance of the latter in determining the effectiveness of monetary transmission.

I. 2 Structure of the domestic financial system

The next question, therefore, is whether the structure of the Ugandan domestic financial system is consistent with effective monetary transmission through interest rate effects. Uganda's financial system consists of the Bank of Uganda, 24 commercial banks, 8 credit institutions, 4 microfinance deposit-taking institutions, the National Social Security Fund (NSSF), a postal bank, 25 insurance companies, 2 development banks, 102 foreign exchange bureaus and the Uganda Securities Exchange. The key issues are three (Mishra et al 2012):

- The size and reach of the system.

Specifically, how important is the formal financial system in the Ugandan economy – i.e., how much financial intermediation in Uganda occurs through the formal financial system? The larger the system, and the more it dominates the process of financial intermediation in Uganda, the larger the impacts that monetary policy is likely to have on the Ugandan economy, since monetary policy operates through the terms on which the financial system conducts financial intermediation.

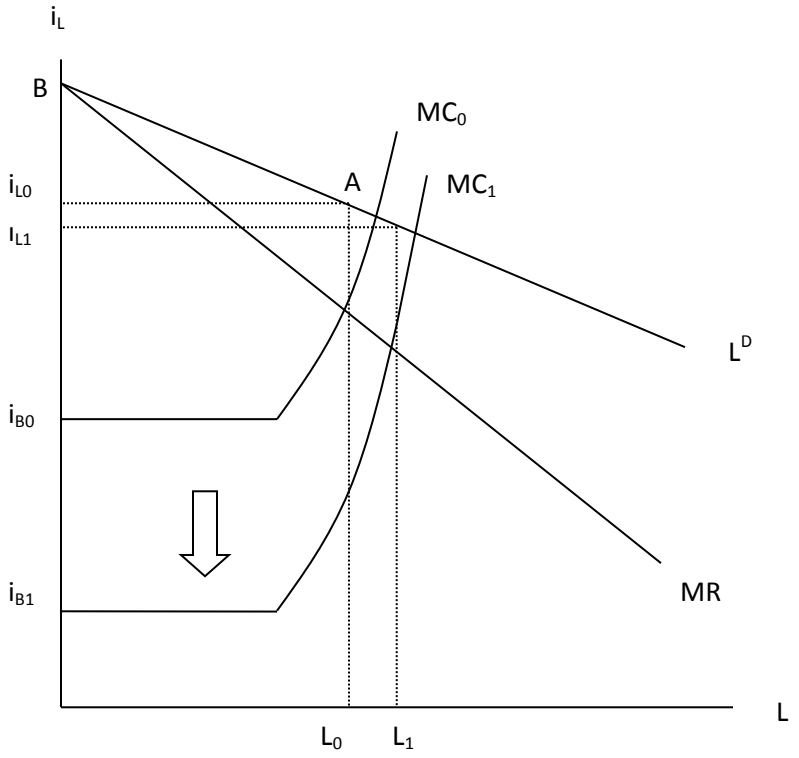
- The magnitude of financial frictions.

Financial intermediation is a costly activity because of the importance of asymmetric information and costly contract enforcement in financial transactions. These frictions require financial intermediaries to incur a variety of costs (loan evaluation costs, monitoring costs, and contract enforcement costs). The magnitude of those costs depend on the quality of the domestic institutional environment (the security of property rights, the quality and enforcement of its accounting and disclosure standards as well as of its bankruptcy laws, and the efficiency of the domestic legal system), as well as on the characteristics of domestic borrowers (specifically their collateralizable net worth and opacity).

These considerations have implications for the shape of the marginal cost of lending for financial intermediaries in low-income countries. The production structure in many LICs tends to be dualistic, with the economy consisting of a small number of large and transparent firms with significant collateralizable net worth and a large number of small, opaque enterprises with little collateralizable net worth. Under these conditions, the marginal cost of lending tends to be relatively flat over the range of lending to large firms and then to quickly become very steep when lending is extended to smaller firms. Figure 4 depicts this situation. The figure depicts a profit-maximizing equilibrium for a financial intermediary possessing some monopoly power and operating in a LIC-type environment. Its marginal cost curve MC_0 has a flat range

corresponding to loans extended to large, relatively transparent firms, but then a sharply rising range when the intermediary extends its lending to small and opaque borrowers. When the marginal cost curve has this shape, changes in the opportunity cost of funds to financial intermediaries, such as those caused by monetary policy, may shift the marginal cost curve vertically (e.g., in the case of a monetary expansion, to MC_1 in Figure 4), but have little effect on the total supply of funds and therefore on the terms offered by financial intermediaries, weakening the power of monetary policy to affect the economy.

Figure 4. Financial Frictions, Monopoly Power, and Monetary Transmission



- The degree of competition in the formal financial sector.

For a given shape of the marginal cost of lending curve for each financial institution, the less competitive the financial sector (the steeper the demand curve facing each individual financial intermediary), the less responsive the supply of funds will be to changes in monetary policy. The reason is that steep demand curves are associated with steep marginal revenue

curves, and since firms with monopoly power maximize profits by setting marginal revenue equal to marginal cost, the steeper the marginal revenue curve facing an individual financial intermediary, the less responsive its supply of lending to the private sector will be to a change in its marginal cost of lending caused by a change in monetary policy.

To see this, imagine rotating the loan demand curve L^D in a clockwise direction around the point A in Figure 4. Doing so makes the loan demand curve steeper, decreasing its elasticity and increasing the bank's degree of monopoly power. As L^D become steeper, the point B moves vertically upward along the vertical axis, and MR becomes steeper as well. Consequently, the profit-maximizing points of intersection between marginal revenue and marginal cost move to the southwest along their respective marginal cost curves MC_0 and MC_1. The effect is to narrow the *horizontal* distance between those points, thereby reducing the expansion of the bank's loans for a given reduction in its opportunity cost of funds.

How relevant might these considerations be for Uganda? As mentioned previously, the institutional environment in which financial intermediaries operate – the security of property rights, the efficiency and impartiality of the legal system, the adequacy of accounting and disclosure standards – has strong effects on the costs of overcoming financial frictions, especially for lending to smaller and more opaque borrowers. Direct measures of these factors are not available, but since they are all particular aspects of a country's general institutional environment for the conduct of economic activity, more general indicators of such institutional quality are likely to be correlated with them. Table 1 reveals where Uganda ranks compared to other countries in terms of such indicators.

Table 1. Uganda: Indicators of Institutional Quality

Indicator	*Percentile rank*
Rule of Law	44
Government Effectiveness	37
Regulatory Quality	50
Control of Corruption	20
Voice and Accountability	30
Political Stability and Absence of Violence/Terrorism	15

Source: Worldwide Governance Indicators (World Bank).

While not all of the indicators listed in the table are of equal relevance for the costs of doing financial business in Uganda, the key point that emerges from the table is that Uganda

does not rank above the median on any of the indicators listed. Particularly worrisome are the country's low ranking in the areas of government effectiveness and control of corruption. This suggests that the types of government-provided public goods on which the financial system depends (enforcement of property rights, of accounting and disclosure standards, of legal contracts) may not be as readily available in Uganda as in some other countries. The relative scarcity of such public goods would tend to make financial intermediation a costly activity.

Is this borne out by the structure of Uganda's financial system? Some of the relevant data are presented in Table 2, which compares some characteristics of the Ugandan financial system with those in high-income countries, low- and middle-income countries, and countries in sub-Saharan Africa.

Table 2. Uganda: Indicators of Financial Development

	High income	*Low income*	*Sub-Saharan Africa*	*Uganda*
Deposit money bank assets to GDP (%)	129.66	19.58	23.70	19.76
Non-bank financial institutions assets to GDP (%)	17.70	0.13	0.13	na
Private credit by deposit money banks and other financial institutions to GDP (%)	111.59	15.53	17.53	13.41
Bank branches per 100,000 adults (commercial banks)	30.12	2.92	3.37	2.49
Adults with an account at a formal fin. inst. to total adults (%)	93.05	14.35	17.46	20.46
5-bank asset concentration (%)	79.46	83.14	87.47	72.64
Net interest margin (%)	1.63	4.33	4.37	4.65
Cost to income ratio	54.30	62.42	59.40	69.20
Return on equity (10 year average)	11.96	15.83	17.84	33.40
Stock market capitalization to GDP (%)	58.38	20.80	26.21	15.39
Number of listed companies per 10,000 people	0.32	0.01	0.02	0.00
Stock market turnover ratio (value traded/capitalization) (%)	77.15	9.35	6.31	0.57

Source: World Bank, World Development Indicators.

A first important observation is that in total size as measured by conventional indicators, (such as the ratio of deposit bank assets and the assets of nonbank financial institutions to GDP, the ratio of private credit from formal financial institutions to GDP, the number of bank branches scaled by population, or the fraction of adults with accounts at formal financial institutions) the formal financial system is relatively small in Uganda. This is consistent with financial intermediation being a costly activity in the country. It is worth noting that Uganda is not appreciably different in this regard from other low-income countries in sub-Saharan Africa and elsewhere, but it is clear that such countries obviously operate in a very different financial environment from that of high-income countries, as shown in the table. However, note that the cost to income ratio for banks in Uganda is not only significantly higher than in high-income countries, but at 69.2 percent it is even higher than the average for all LICs (62.4) or for LICs in sub-Saharan Africa (59.4).

There are two implications of high-cost intermediation for the likely effectiveness of monetary transmission. The first is based on the resulting small size of the formal financial sector. To the extent that monetary policy actions affect only the share of the economy that is served by the formal financial sector, the small size of that sector limits the reach of monetary policy, thus reducing its impact on the economy. The second is that costly intermediation likely implies a sharply rising marginal cost of intermediation as banks try to serve smaller and more opaque borrowers, so even for the share of the economy that is served by the formal financial sector, central bank actions may have weak effects on the supply of bank lending.

This is reinforced, as shown in Figure 4, by limited competition in the banking sector. Uganda's banking sector does not appear to be more highly concentrated than that in other LICs, or for that matter, even than in high-income countries. But there are indications that it may be less competitive. First, banks' net interest margin is quite high in Uganda. However, it is not significantly different from that in other LICs and, as we have seen, this may at least in part be due to the high costs of financial intermediation in the country. That this may not be the sole reason for the high spreads, however, is suggested by the fact that returns to equity in the Ugandan banking sector are exceptionally high, not only by the standards of high-income countries, but also by those of LICs both in sub-Saharan African and elsewhere.

Finally, it is worth noting that, as shown by the last three rows of Table 2, the stock market is not well developed in Uganda. Very few companies are listed in the market, market capitalization is quite small, and the market is not very liquid. The implication is that the asset channel of monetary transmission, which operates through monetary policy effects on the price of marketable financial (and real) assets, is unlikely to be strong in Uganda.

In short, microeconomic factors pertaining to the structure of the country's domestic financial system suggest that a) a relatively small share of the Ugandan economy may be

affected by the impacts of monetary policy on the formal financial system, and b) those impacts may themselves be limited by sharply rising costs of lending to the private sector at the margin, as well as by imperfect competition in the banking sector.

While these considerations create *ex ante* reasons to suspect that the power of monetary transmission may be limited in Uganda, the issue is ultimately an empirical one. A key step in any empirical investigation of this issue is to identify monetary policy shocks (exogenous changes in monetary policy) in the data, in order to examine their effects. To do so, we need both to determine which monetary policy variable the BOU has been controlling as well as to separate out endogenous movements in this variable from exogenous ones.

II. Monetary policy regime

There is ample evidence that from 1993, when the Bank of Uganda statute granted autonomy to the BOU, until July of 2011, the BOU conducted monetary policy by targeting the stock of base money. [3] The primary instrument used to control the base during this period was biweekly Treasury bill auctions, which have been conducted since April of 1992. In these auctions, the BOU determined the amount of the offer based on its desired outcome for the monetary base and let the market determine the interest rate.

The bank determined its desired outcome for the monetary base within a financial programming framework, referred to as the Reserve Money framework (RMP). In this framework, the BOU's ultimate objective was to achieve a desired path for the aggregate price level. In order to seek to achieve its price level objective, the bank proceeded in standard financial programming fashion: the path for the stock of base money was set on the basis of forecasts for the growth rate of nominal GDP (based on the inflation target and forecasts of real GDP growth), M2 velocity, and the money multiplier. The key information inputs for setting the base money target, therefore, were (in addition to whatever variables determined the bank's inflation objective, such as, past inflation) those which would affect its forecasts of future real GDP growth, of M2 velocity, and of the money multiplier. The BOU set the reserve money target for a 12-month period, but it was subject to review every month. In principle, therefore, one can conceive of the BOU's monthly reaction function during the period from 1993 to mid-2011 as relating the stock of base money set during the month (which was completely under the central bank's control) to any observable variables that would have tended to affect the inflation target set for the year and that would potentially have provided information about the future behavior of real income, of M2 velocity, and of the money multiplier.

[3] See Musinguzi and Katarikawe (2001) and Mugume (2012).

Base money targeting was replaced by "inflation targeting lite" in July 2011. For present purposes, the most important consequence of the change in monetary policy regime is that the operating instrument for monetary policy became an interest rate (the central bank rate, or CBR), rather than the monetary base.

III. VAR specification

This description of the behavior of monetary policy in Uganda over the recent past helps to inform the specification of a VAR that can be used to describe the economy's macroeconomic dynamics, including its response to monetary policy shocks. The specification of the VAR requires making several choices, however. The rationale for each of the specific choices made in this paper is explained in this section. In the next section I use the estimated VAR to investigate the response of the Ugandan economy to monetary policy shocks.

III. 1 Variables and sample period

An exploration of the effectiveness of monetary transmission requires estimating the effects of a shock to the monetary policy instrument on aggregate demand. Based on the discussion in section III, the BOU used the monetary base as its monetary policy instrument until July of 2011, when it began to implement inflation targeting lite, at which time it switched to an interest rate instrument (the central bank rate). It would be inappropriate to use an interest rate as the monetary policy instrument during a period when the BOU was actually targeting the base, because shocks to the demand for the base during such a period would affect market interest rates and therefore be incorrectly interpreted as a monetary policy shock. The same would be true if the base was treated as the monetary policy instrument when the BOU was actually targeting a market interest rate, because a base demand shock would require the BOU to change the base in order to continue to hit its interest rate target, and in this case the change in the base would be incorrectly interpreted as a monetary policy shock.

Because there is only a year and a half of data under the new regime in which the BOU relies on an interest rate instrument, there are simply not enough data available yet to implement a study of monetary transmission under inflation targeting lite using VAR methods, which are extremely data-intensive. I therefore use the base as the monetary policy instrument and omit the period after July of 2011 from the sample used for the estimation.

The second issue is how to measure the effects of monetary policy on aggregate demand. In principle one wants to use both an indicator of real economic activity and the price level, because using just one or the other risks biasing the exercise against a finding of effective

monetary transmission by making the results depend on the shape of the economy's aggregate supply curve. For example, if the price level is used as the sole indicator of aggregate demand and the economy's aggregate supply curve is very flat, then a monetary policy shock that has a strong impact on aggregate demand would nevertheless have little impact on prices, and the finding of minimal effects on the price level would be erroneously interpreted as weak monetary transmission. I therefore include both the price level (in the form of the CPI) and an indicator of aggregate economic activity in the VAR.

Unfortunately, the latter presents a problem. The obvious indicator to choose is real GDP. However, while Uganda has real GDP numbers available on an annual basis from 1990 to 2012, it has quarterly figures only from the first quarter of 1999 to the first quarter of 2012, and a special monthly indicator of aggregate real economic activity created by the BOU has data only from January of 2006 to December 2012. For reasons explained in the next section, I have opted to use monthly data. Unfortunately, this means that using the BOU's monthly estimate of real economic activity would require restricting the sample to the period from January 2006 to June 2011, a total of 66 monthly observations. Given the large number of parameters to be estimated in the VAR, this would provide far too few degrees of freedom. Accordingly, I have opted for the use of a proxy for real economic activity, in the form of real imports, for which data are available from July of 1997.[4]

The remaining variables to be included in the VAR are the nominal exchange rate and the bank loan rate. These variables play two roles. First, they represent two different channels of monetary transmission that are potentially operative in Uganda: the bank lending channel, expected to operate through the effects of monetary policy on the bank lending rate, and the exchange rate channel, operating through the effects of monetary policy on the exchange rate and therefore on expenditure switching between domestic and foreign goods. In these roles, these two variables are useful in interpreting the results of the impulse response functions. To the extent that monetary policy shocks affect the price level and real economic activity, the effects of policy on the lending rate and the exchange rate help to interpret the mechanisms though which it does so, and to the extent that it does not, the effects on these two variables may help explain where the transmission breaks down. In addition, the exchange rate is likely to be used as an information variable by the BOU, since it is continuously observable and may predict future changes in the price level through exchange rate pass-through.

In short, I will estimate a VAR with five endogenous variables: the exchange rate, the consumer price index, real imports, and the monetary base (all in logs), as well as the bank loan

[4] This required splicing the series in July of 2002, when the base of the import volume index was changed. A regression of the log of monthly real imports on the log of the BOU's indicator of monthly real activity yields an R^2 of 0.72, when a dummy for the international crisis months of September 2008 to March 2009 is included, during which Uganda's real imports were unusually high (see section V).

rate (in levels). Since these variables are seasonally unadjusted, I will also include a set of monthly dummies as exogenous variables. The choice of the monetary base as the relevant monetary policy instrument dictates the sample period, because monthly data on the base are available only from December 2001. The sample period is therefore December 2001 to June of 2011, for a total of 115 monthly observations.

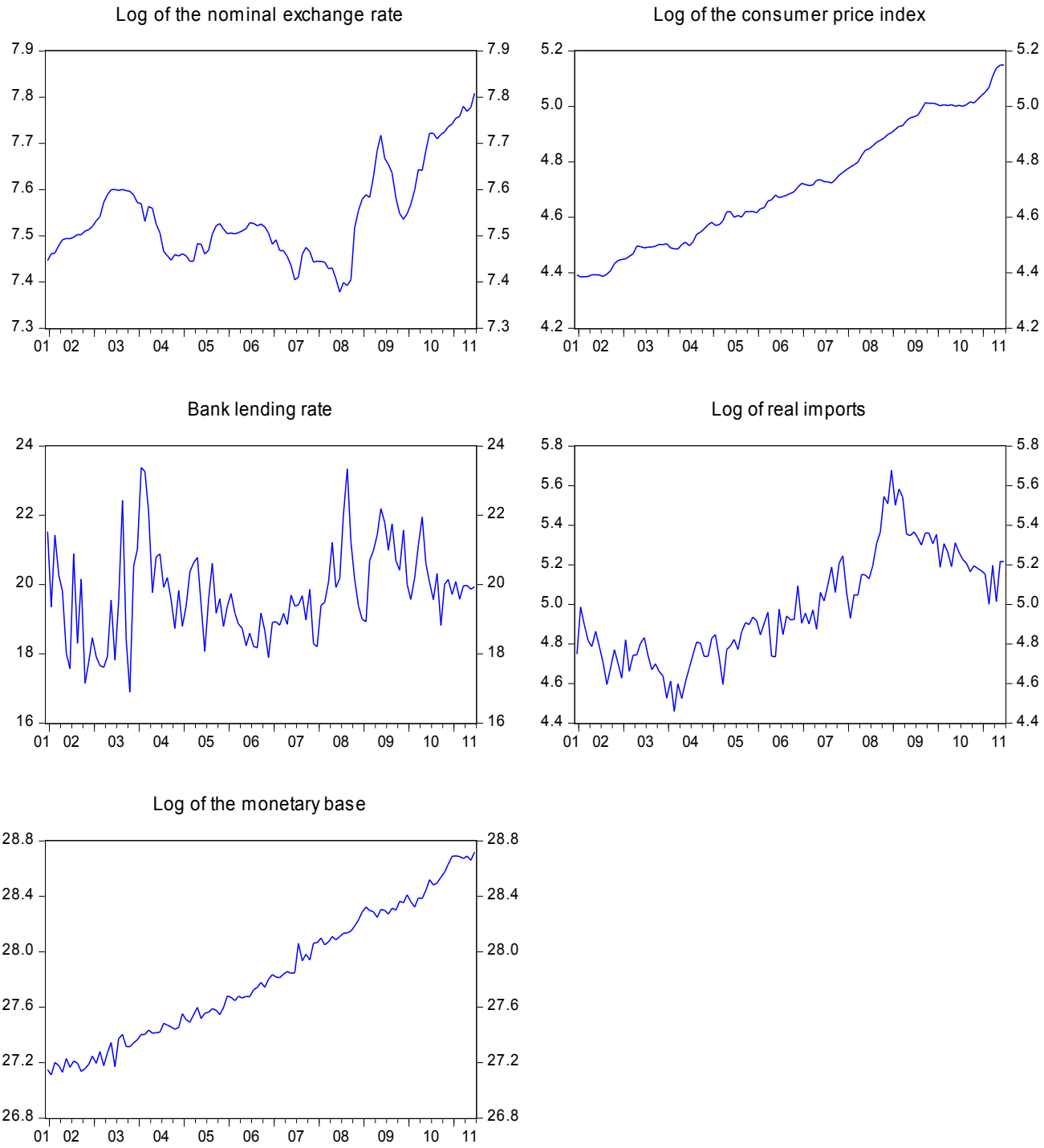
III.2 Time series properties of variables and VAR specification

The VAR methodology requires that the innovations in the system be white noise errors. For that to be the case, they have to be stationary. To achieve stationarity in the residuals, the endogenous variables in the VAR have to either themselves be stationary or cointegrated. The time series plots of the five variables are provided in Figure 5. As is evident from the figure, the nominal exchange rate, price level, and monetary base have all tended to trend over time. This suggests including a trend in the VAR as an additional exogenous variable. Table 3 provides Augmented Dickey-Fuller and Phillips-Perron tests for the stationarity of the five endogenous variables in the VAR. Real imports, the bank lending rate, and the monetary base are all trend-stationary, but the price level and nominal exchange rate are not. However, both of the latter

Table 3. Unit Root Tests on Endogenous Variables

	Augmented Dickey-Fuller *p-value*	*Phillips-Perron* *p-value*
CPI	0.42	0.67
Real imports	0.00*	0.00*
Exchange rate	0.18	0.31
Bank lending rate	0.01*	0.01*
Monetary Base	0.01*	0.00*

Figure 5. Endogenous Variables



are difference-stationary, and a Johansen-Juselius test finds them to be cointegrated.[5] Accordingly, I estimated the VAR in levels.

3. VAR lag length

The next issue concerns lag length in the VAR. The criterion here is that the length of the lags should be sufficient to remove all autocorrelation from the residuals, but not longer than required to achieve that outcome, in order to conserve degrees of freedom. I proceeded by specifying an initial lag length of six months.[6] I then successively applied lag selection criteria, lag exclusion tests, and tests of residual autocorrelation – in that order – to settle on an appropriate lag length. Starting from 6-month lags, lag selection criteria converged on an appropriate lag length of no more than three months, and lag exclusion tests concurred in being unable to reject zero restrictions on all lags beyond three months. To be conservative, I next considered four-month lags. Again, lag length criteria converged on optimal lags of no more than three months and lag exclusion tests were unable to reject the exclusion of the fourth lag from all equations at the 95 percent confidence level. However, the p-value for rejection of the exclusion of the fourth lag from the exchange rate equation was extremely close to 0.05, so I provisionally retained the fourth lag. Lagrange Multiplier (LM) tests for autocorrelation in the residuals in the VAR with four lags were consistent with no autocorrelation up to eight lags, so I retained four lags in the VAR.

IV. Identification and impulse responses

The VAR captures the full dynamic interactions among the variables included in the model, so given a shock to the monetary base it is possible to trace out the empirical response of all five variables to that shock period by period. But this cannot be done by simply shocking the residual in the equation for the monetary base, because a structural shock to the monetary base may affect the residuals in at least some of the other equations in the VAR at the same time. The residuals from the estimated VAR represent the innovations in the autoregressive representation of each variable in the VAR, but they cannot be interpreted as the orthogonal structural shocks in the underlying data-generating process (DGP) unless they are contemporaneously uncorrelated, since the structural shocks may appear in more than one of the reduced-form equations of the underlying DGP represented by the VAR. Table 4 reports the contemporaneous correlation among the VAR residuals. Looking down the last column of

[5] The p-values for the null hypothesis of no cointegration were both effectively zero under both the trace and maximum-eigenvalue tests, and the null of not more than one cointegrating vector could not be rejected.
[6] This was based on the results of Mugume's (2012) study using quarterly data, who found an optimal lag length of two quarters.

the table, it is evident that the innovations to the monetary base are only weakly correlated with the innovations in the other equations. This suggests that the impulse responses should not be overly sensitive to the identification strategy chosen. The results reported below confirm that this is indeed the case.

Table 4. Contemporaneous Correlation among VAR Residuals

	Exchange rate	*CPI*	*Lending rate*	*Imports*	*Monetary base*
Exchange rate	1.00	-0.09	-0.13	0.24	0.17
CPI	-0.09	1.00	-0.25	0.18	0.00
Lending rate	-0.13	-0.25	1.00	-0.10	0.07
Imports	0.24	0.18	-0.10	1.00	0.15
Monetary base	0.17	0.00	0.07	0.15	1.00

To consider how to proceed, let u_t denote the vector of estimated reduced-form innovations in period t, e_t the vector of orthogonal unit-variance structural shocks in period t (such that $E(e_te_t') = I$, the identity matrix), and A an invertible 5x5 matrix linking the reduced-form innovations to the contemporaneous structural shocks, such that $u = Ae$. If we knew the elements of A, then we could simply extract e from $e = A^{-1}u$, since u is observable. We have some information about the elements of A, since the variance-covariance matrix of the u's, given by $\Omega = E(uu') = E(Aee'A') = E(AA')$ is observable. But Ω is a symmetric matrix, so it only imposes 15 restrictions on the 25 unknown elements of A. To solve for the remaining elements, we need 10 additional restrictions.

One way to obtain them is to impose theoretical restrictions on the contemporaneous relationships among the structural shocks and the reduced-form innovations. These could take various forms, the simplest of which would be exclusion restrictions, such that specific structural shocks are assumed not to affect specific reduced-form innovations. With enough information about the structure of the Ugandan economy, we could specify such restrictions. The problem is that if we get this wrong, our estimated monetary shocks may in reality be an amalgam of different types of shocks, thereby misrepresenting the effects of a monetary shock on the reduced-form residuals, and potentially invalidating the entire exercise.

Unfortunately, the requisite knowledge about the structure of the Ugandan economy (or of any other, for that matter) is not typically available, so what we require is an

identification strategy that makes minimal use of such knowledge. One such strategy is to rely on lags in the availability of information to the monetary authorities and in the timing of the effects of monetary policy actions on the economy (specifically, on the other variables in the VAR). This is what makes the use of monthly data desirable in this case. It is plausible to assume that the central bank cannot observe the variables that enter its monetary policy reaction function contemporaneously within the month, but less plausible to assume that they cannot do so within the quarter, and even less that they cannot do so within the year. Similarly, it is plausible to assume that monetary policy actions do not affect some subset of macroeconomic variables within the month, but as the relevant unit of time becomes longer, this assumption becomes less and less plausible. The assumption that the central bank cannot observe all of the variables that enter its reaction function within the month yields exclusion restrictions on shocks to nonmonetary variables in the equation linking nonmonetary structural shocks to innovations in base money, while the assumption that structural shocks in base money do not affect specific other variables within the month yields exclusion restrictions in the equations linking innovations in those other variables to structural shocks to base money. This is the rationale for using monthly observations in this exercise.

While these assumptions minimize the amount of structural knowledge about the economy required to identify monetary policy shocks, they are not altogether free of arbitrariness, since the central bank may have information about some variables, however imperfect, within the month, and not about others. Similarly, some variables, such as the exchange rate, for example, may react to monetary policy shocks within the month, while others may not. Accordingly, I will proceed in this section by making two extreme assumptions about the information available to the central bank within the month and about whether nonmonetary variables react to the base within the month, and compare the results under both sets of assumptions. First, I will assume that the central bank can observe all nonmonetary variables in the month in which it sets the value of the base, but that shocks to the base do not affect any of the nonmonetary variables within the month (so that the base is last in the Choleski ordering). Second, I will examine how the results are affected when the central bank is not assumed to be able to observe any of the nonmonetary variables within the month, but all nonmonetary variables are able to react to changes in the base within the month (so the base is ordered first).

The resulting impulse responses are plotted in figures 6 and 7. As is evident from inspection of these figures, the results are not particularly sensitive to these alternative assumptions, as expected. In addressing what the results have to say about the effectiveness of monetary transmission in Uganda, we need to answer three questions:

Figure 6. Impulse Responses +/- Two Standard Deviations: Choleski with Base Ordered Last

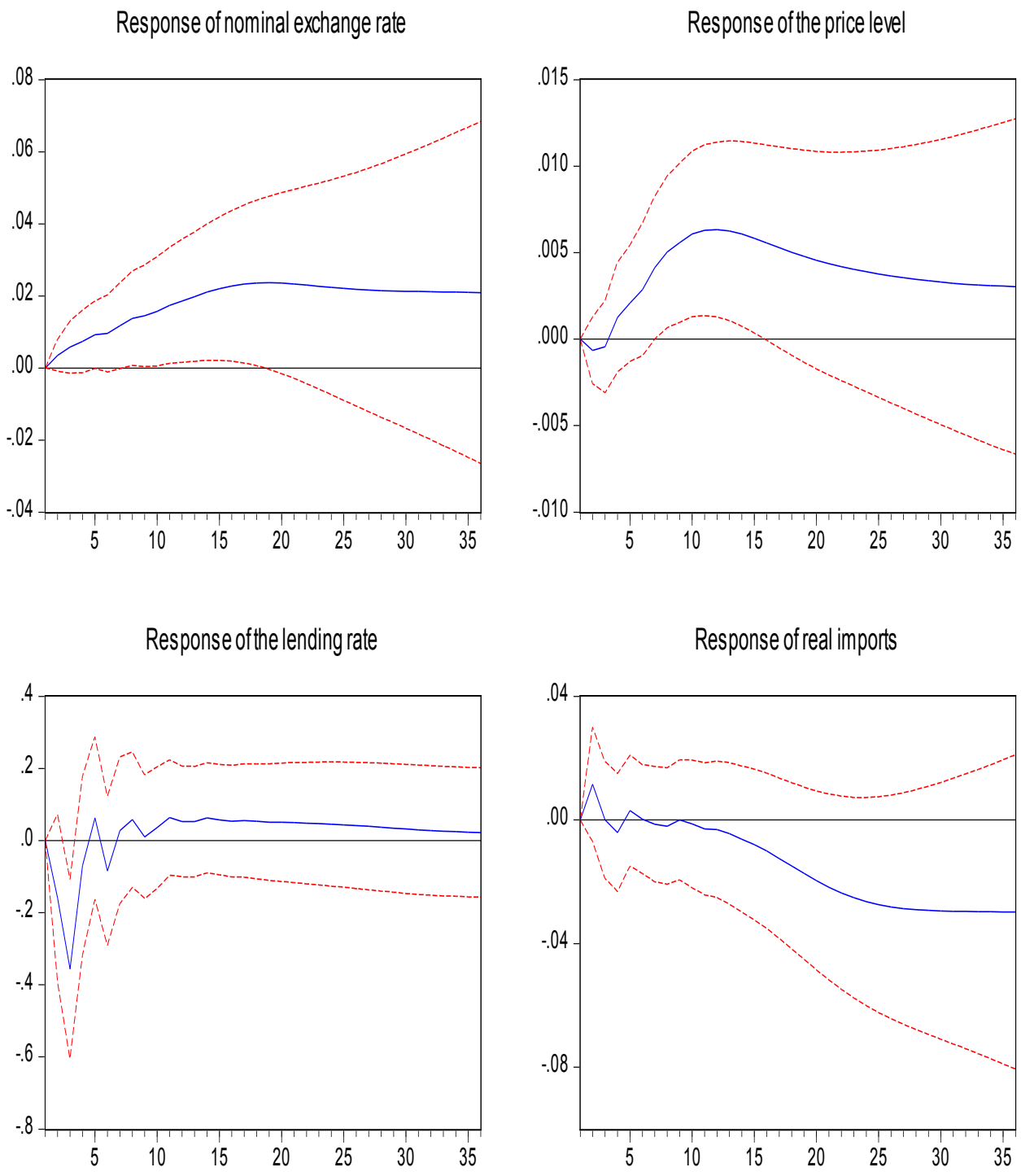
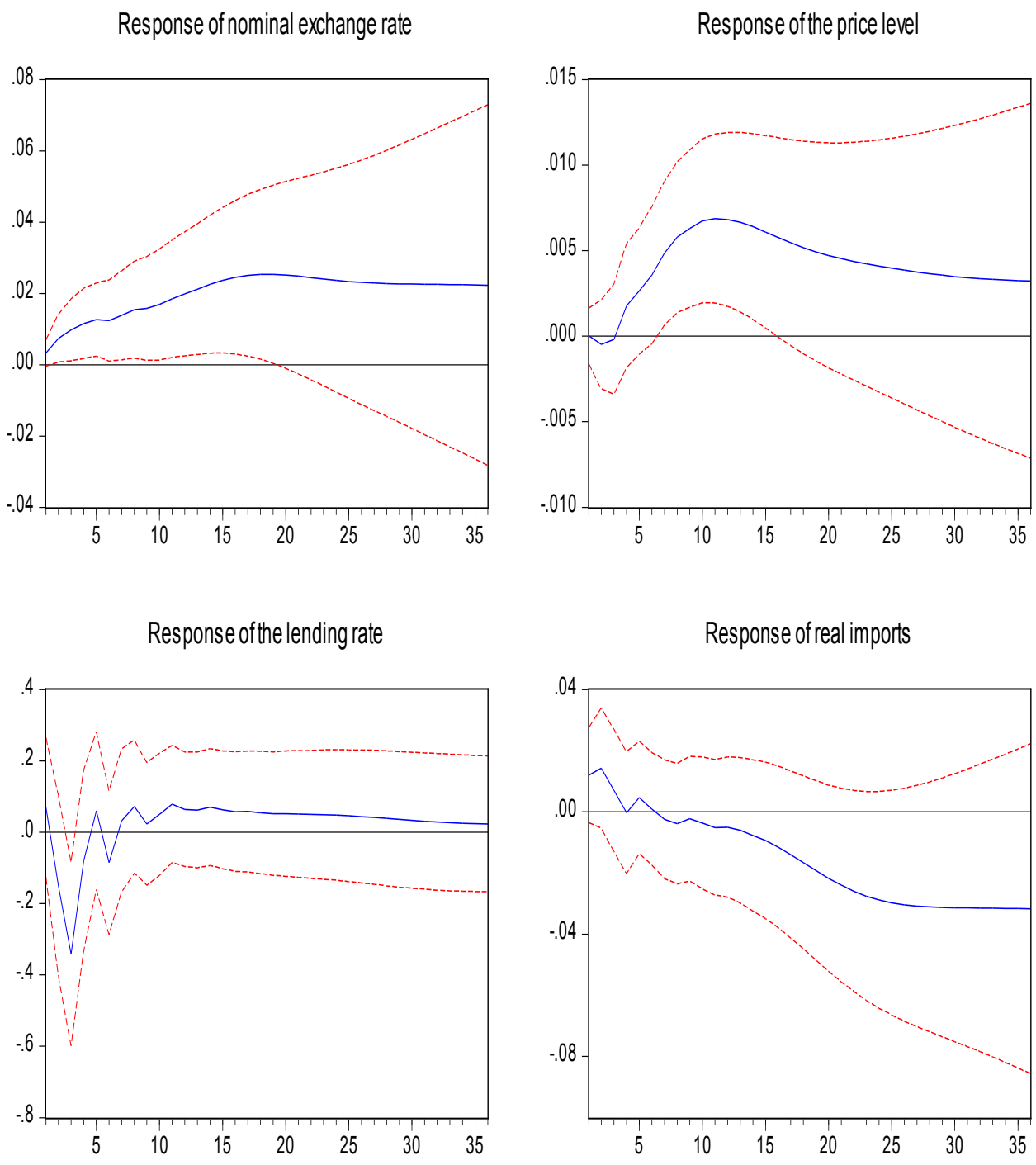


Figure 7. Impulse Responses +/- Two Standard Deviations: Choleski with Base Ordered First



- How consistent are the results with economic theory?
- How precisely are the impacts of monetary policy shocks estimated?
- What is the economic (as opposed to the statistical) significance of the estimated effects?

Theory suggests that a shock to the monetary base should expand aggregate demand by reducing the bank loan rate and depreciating the currency. This expansion in aggregate demand should lead to an increase in prices and output. It is possible to make the case that all of these effects are supported by the estimation results.

The top left-hand panels in Figures 6 and 7 indicate that an unanticipated expansion in the monetary base leads to an exchange rate depreciation on impact in Uganda and that this depreciation, though decreasing over time, is sustained over the 36-month horizon displayed in the figure. Effects on the price level (top right-hand panels) are not as rapid. Price level increases begin to appear after about two months, and then cumulate over time, peaking after about a year, after which time they begin to decline. The monetary expansion has a rapid negative effect on the bank loan rate (bottom left-hand panels), which reaches its minimum value two months after the shock. The loan rate returns to its original value after about five months and then overshoots slightly, falling back to its original value gradually. The effect that is least consistent with theory is that on real imports, used here as a proxy for real economic activity (bottom right-hand panel in both figures). Although real imports rise on impact (as theory would predict in light of the exchange rate depreciation and decrease in the bank loan rate), signifying an increase in economic activity, this effect dissipates quickly, and actually becomes consistently negative after about 10 months. Overall, the qualitative picture is one of a transmission mechanism that is consistent with theory, except for the longer-term effect on real imports, which presents a puzzle.

One possible response to this puzzle is to note that of the four effects examined, those on real imports are the only ones that are never statistically significant over any horizon. A fair rendering of the results regarding this variable, then, is that the estimation failed to uncover any statistically significant effect of a monetary policy shock on real economic activity. This could mean that there are no such effects in reality or that the real import proxy used here is just not very satisfactory – in other words, the data are just too noisy. All of the other variables show statistically significant effects of the monetary policy shock over at least some horizon: for about a year and a half after the shock in the case of the exchange rate, for about a nine-month

window beginning some 7-8 months after the shock in the case of the price level, and in the second month after the shock in the case of the lending rate.

How large are the estimated effects? While the estimated effects of the monetary shock is consistent with theory and statistically significant over at least some horizon for three of the four variables considered, the estimated effect on the main target variable – the price level – is quantitatively rather small. Although a monetary shock consisting of a one-percent increase in the monetary base results in a peak exchange rate depreciation of 0.5 percent and a very large reduction in the lending rate in the second month after the shock (8 percent compared to a June 2011 lending rate of 27 percent), it results in a *peak* price level increase of only 0.15 percent. The 95 percent confidence interval for the peak impact on the price level ranges from about 0.02 percent to 0.28 percent. While the effect on the peak reduction in the lending rate seems implausibly large, it is not estimated very precisely, with the 95 percent confidence interval ranging from a reduction of 2 percent to one of about 14 percent. Overall, the weak effect on the price level and imperceptible effect on the measure of real activity used here are consistent with what might be expected in light of the small size of the formal financial sector in the Ugandan economy, as indicated previously.

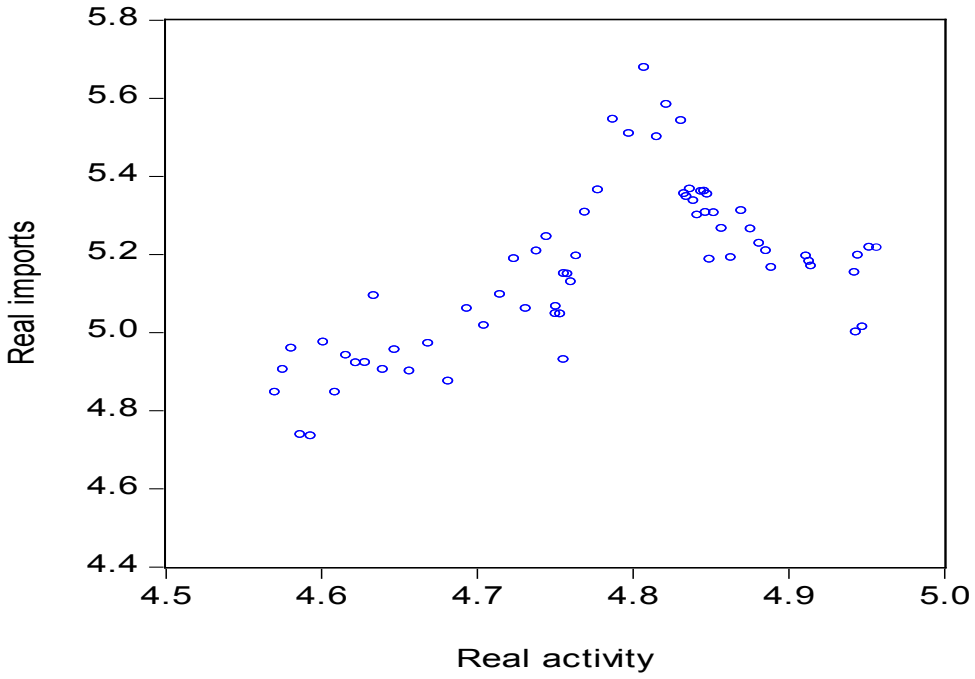
V. Robustness checks

As just discussed, a disturbing feature of the results derived in the last section is the counterintuitive response of real imports, my proxy for real economic activity. A possible explanation is that this is simply a very poor proxy. To try to evaluate this possibility, Figure 8 provides a scatter plot of real imports against the monthly measure of real economic activity constructed by the Bank of Uganda over the period for which the latter is available. It is clear that the fit is imprecise, and that the main outliers are six observations near the top of the figure, when real imports are unusually high relative to the level of real activity. As it happens, these observations correspond to the period October 2008 to March 2009 – the most acute phase of the international financial crisis immediately after the collapse of Lehman Brothers. Why imports to Uganda would have been unusually high during these months remains an open question (see also Figure 5), but it seemed at least worth exploring whether correcting for this unusual period could improve the performance of the proxy. To do so, I constructed an "adjusted" real imports series by removing the crisis effect, as captured by a dummy for the relevant months in a regression of log real imports on log real activity. I then replaced the original series with the adjusted series in the VAR.

The resulting impulse responses are reported in Figure 9. As is evident from the figure, this adjustment makes little difference. The counterintuitive contraction in real imports is

indeed reduced in size, and adjusted imports return to their pre-shock value more quickly, but the weak initial response and prolonged period of contraction remain. Other results are essentially unaffected.

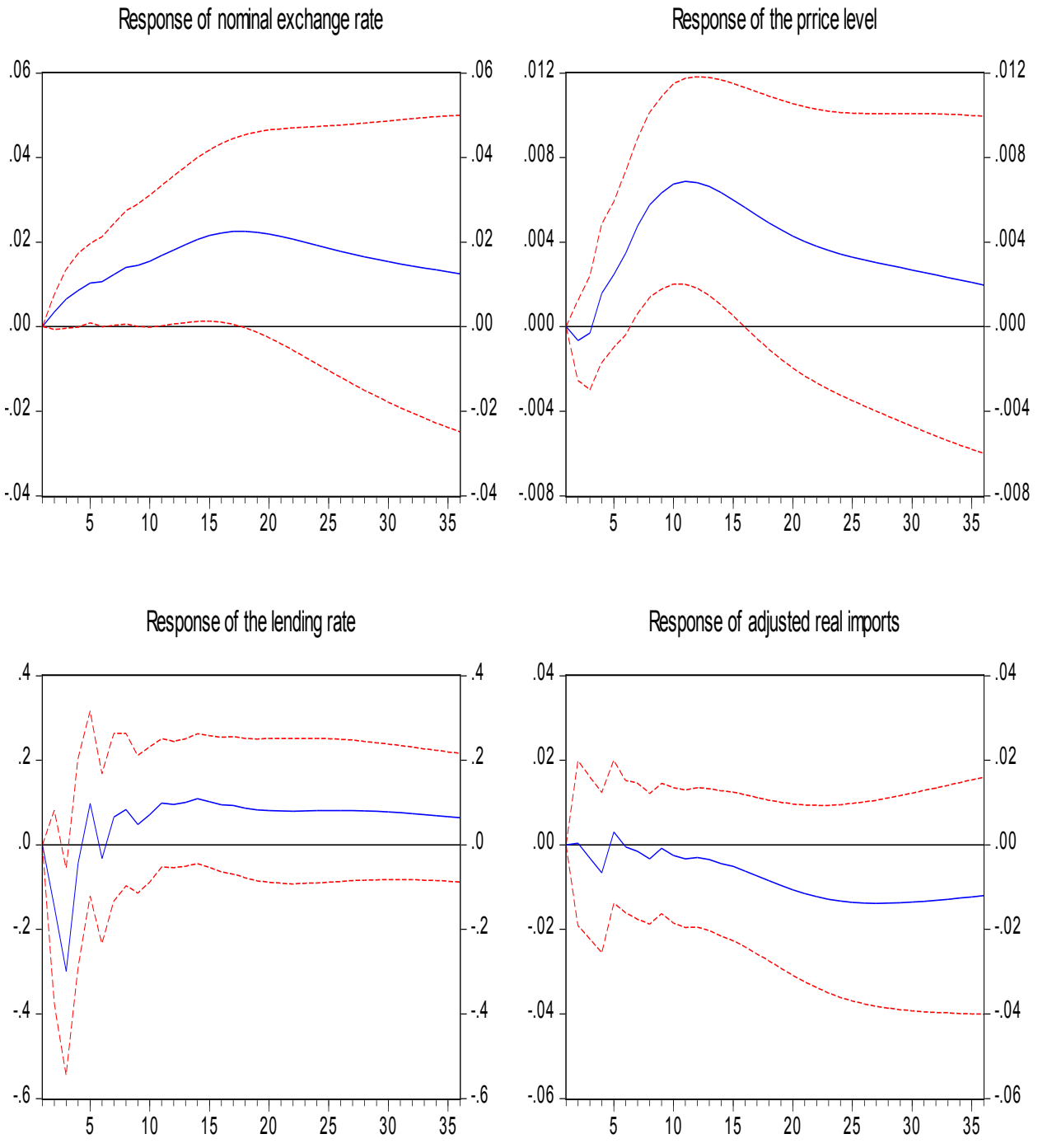
Figure 8. Scatter of Real Imports vs. BOU Index of Real Activity, 2006-12



A second issue concerns the identification scheme. I considered two extreme assumptions about the information available to the monetary authorities at the time they make their monetary policy decisions: one in which they could observe all of the relevant variables contemporaneously and one in which they could observe none of them. While these are useful schemes to consider, in the sense that they span the possibilities for the authorities' information set, they have two shortcomings:

- First, they ignore intermediate possibilities, in which information on some variables in the relevant set is available to the authorities, and not others.

Figure 9. Impulse Responses with Adjusted Imports, Base Ordered Last



- Second, the structure of the relationship between the reduced-form innovations and the structural shocks is recursive, which means that it imposes somewhat arbitrary assumptions about the contemporaneous interactions among the other variables in the VAR.

To remedy these shortcomings, an alternative is to rely on short-run structural identifications that impose more defensible restrictions. For example, in a floating exchange rate regime such as that of Uganda, the exchange rate is continuously observable in the marketplace, so it is not reasonable to assume that the monetary authorities cannot observe the contemporaneous exchange rate when they make monetary policy decisions. At the same time, information on the aggregate price level and the level of real economic activity may be available with more than a one-month lag, and commercial bank lending rates may be insufficiently flexible for contemporaneously-observed rates to convey much useful information for the setting of monetary policy. Similarly, while it may be reasonable to suppose that real activity, the aggregate price level, and bank lending rates react to monetary policy shocks with more than a one-month lag, it is not reasonable to suppose that the exchange rate, which is an asset price, also behaves sluggishly.

An alternative identification scheme can be based on these assumptions. Specifically, suppose that:

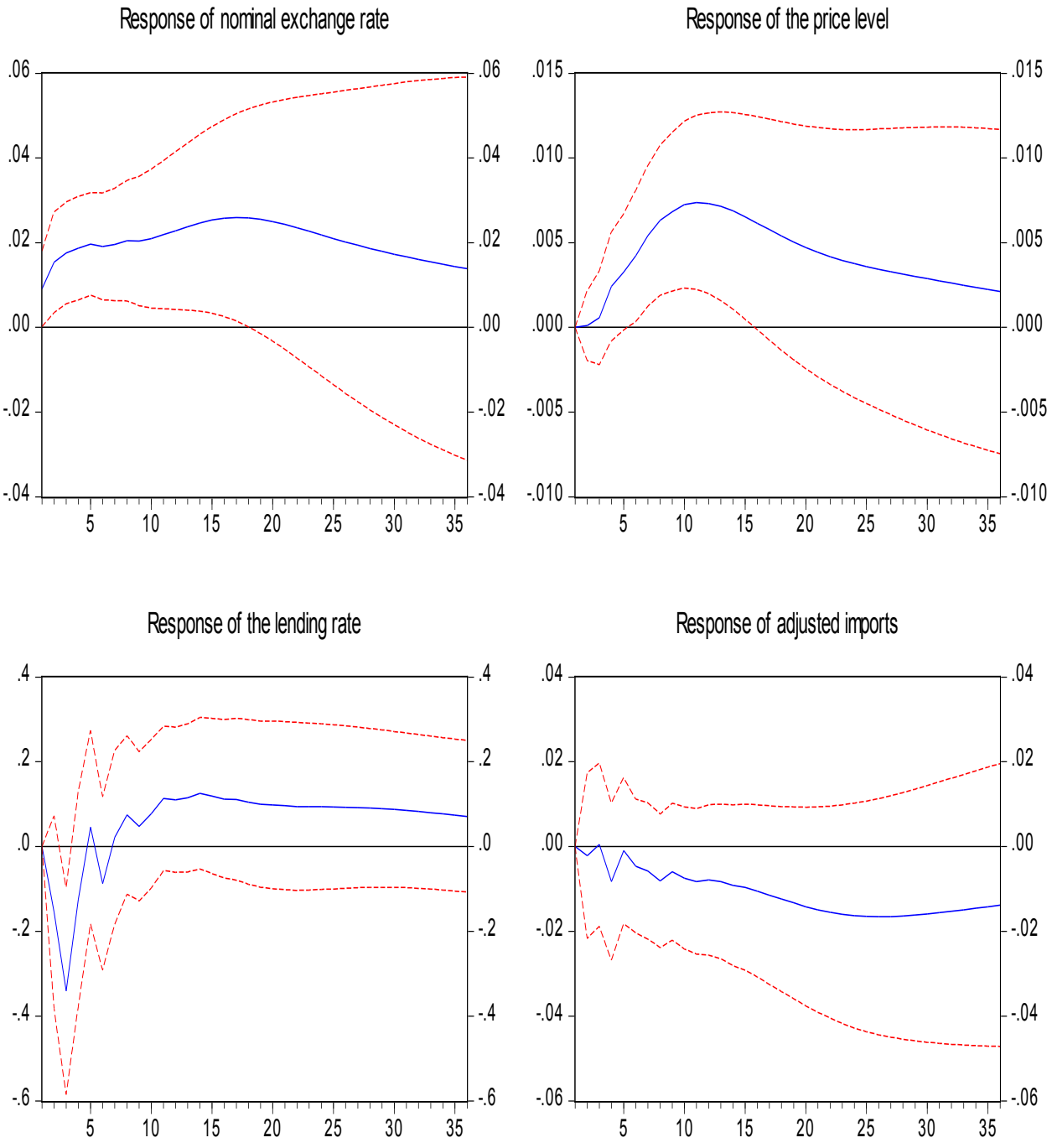
- Real activity, the aggregate price level, and bank lending rates are "sluggish" variables – i.e., their responses to shocks in the other variables, including to monetary policies, takes more than one month to show up in the data.

- Monetary policymakers can observe the nominal exchange rate, but not the remaining variables in the VAR, contemporaneously.

- The exchange rate reacts to shocks in all of the other variables within the month.

Impulse responses with shocks identified based on these "structural" assumptions are reported in Figure 10, using "adjusted" real imports. As is evident from the figure, the alternative identification scheme makes little difference. The most notable change is that the exchange rate now "jumps" on impact in response to a monetary shock, and its path over time is estimated more precisely (its associated +/- 2 standard error bands are narrower) than previously.

Figure 10. Responses with Adjusted Imports, Structural



The results derived previously therefore prove to be robust both to an attempted improvement in the proxy for real economic activity as well as to a more plausible identification scheme. In short, monetary policy appears to work as theory would predict in Uganda – specifically, a monetary expansion reduces bank lending rates in the short run and depreciates the exchange rate, but its effects on real economic activity are hard to detect, and its effects on the price level are relatively small.[7]

VI. Conclusions

The strength of monetary transmission in any country depends on both macroeconomic as well as microeconomic factors. Because of strong differences in these factors, there are strong *a priori* reasons to believe that monetary transmission may be weaker and less reliable in LICs than in high-income countries. This is as true in Uganda as it is elsewhere. While its floating exchange rate gives the Bank of Uganda monetary autonomy, the country's limited degree of integration with world financial markets limits the strength of the exchange rate channel of monetary transmission. The country lacks large and liquid secondary markets for debt instruments, and its stock market is both extremely small and very illiquid. This means that monetary policy effects on aggregate demand would tend to operate primarily through the bank lending channel. Yet the formal banking sector is small, and doesn't intermediate for a large share of the economy. Moreover, there is evidence both that the costs of financial intermediation are high and that the banking system may not be very competitive. The presence of all of these factors should tend to weaken the process of monetary transmission in Uganda.

In other LICs where similar conditions hold, the effects of monetary policy shocks measured using a VAR methodology similar to that employed in this paper have often not been consistent with theory or, if they have been, have frequently not proven to be statistically significant at any horizon.[8] According to the results in this paper, however, neither of these characteristics seems to hold in Uganda. A positive monetary policy shock has macroeconomic effects that are consistent with theory: it causes the bank lending rate to fall rather quickly, depreciates the exchange rate, and tends to increase the aggregate price level. The exception

[7] I have explored a third robustness test – including (the log of) M2 in the central bank's information set – i.e., expanding the VAR to six variables. Unfortunately, this turns out to put a serious strain on the available data and makes all of the impulse responses statistically insignificant over all horizons. There are two notable changes in the point estimates. The first is that the real-activity "puzzle" goes away, in the sense that the response of adjusted real imports to a monetary policy shock becomes positive (albeit quantitatively small and statistically insignificant) over all horizons. The second, unfortunately, is more problematic: the responses of the exchange rate and M2, while positive for the first few months, become negative for a prolonged period.

[8] See Mishra and Montiel (2013).

to theoretical consistency is with respect to the reaction of the proxy for real economic activity which, while it expands on impact as expected, then spends a prolonged period of time in negative territory. There is evidence, however, that this may be related to the quality of the proxy. While all of these results are encouraging, the impacts of monetary policy appear to be significantly more powerful on intermediate variables such as the bank lending rate and the exchange rate than on indicators of aggregate demand such as the price level or real activity. The effects on former, while estimated with precision over a non-negligible horizon, are quantitatively very small. The conclusion, then, is that while monetary policy seems to function as expected in Uganda, there is little evidence that it was able to exert powerful effects on aggregate demand over the sample period. Again, the small size of the formal financial sector is a likely explanation.

Do the results of this paper, in which the monetary base was interpreted as the monetary policy instrument, remain relevant under inflation targeting lite, which entailed a switch from the base to a market interest rate as the BOU's policy instrument? To address this question, we can decompose the monetary policy transmission mechanism in a bank-based economy like Uganda's into the following steps:

- From central bank actions to the behavior of commercial bank interest rates.
- From commercial bank interest rates to the spending behavior of commercial bank customers through interest rate effects as well as exchange rate effects.
- From the spending behavior of central bank customers to total aggregate demand in the Ugandan economy.

Regarding the first step, the explicit use of a policy interest rate and a transparent policy reaction function are likely to give more predictability to the path of market interest rates in Uganda, and for that reason increase the effectiveness of transmission from policy interest rates to bank rates. The reason is that if banks perceive a fixed cost to changing interest rates (in the form, e.g., of menu costs or information costs), they are less likely to adjust their interest rates when the future path of the interest rate is uncertain than when it is more predictable.[9] Thus the change in the monetary policy regime may strengthen transmission through this channel.

In turn, if a closer link between bank interest rates and the BOU's policy rate makes the future path of nominal bank interest rates themselves more predictable, the nonbank sector's response to changes in bank rates may also be strengthened (i.e., the interest rate elasticity of the Ugandan economy's IS curve may increase), essentially because current nominal interest

[9] See Cottarelli and Kourelis (1994).

rates may become better predictors of future nominal rates. If the IT regime also makes future inflation more stable and predictable, the same would apply to expected future real interest rates. At the same time, an entirely independent event – the rapidly increasing degree of Uganda's international financial integration – is likely to make market exchange rates more sensitive to central bank actions, and therefore to reinforce the strengthening of monetary transmission caused by the introduction of inflation targeting lite.

These considerations suggest that the recent past may be an imperfect guide to the strength of monetary transmission in Uganda over the near-term future. However, this conclusion needs to be tempered by the fact that Uganda's financial sector remains relatively small and will take time to grow, so even if transmission to bank customers is strengthened, the bank lending channel is likely to remain relatively weak in Uganda. Increased capital mobility – and therefore a strengthening of the exchange rate channel, which affects both bank customers and others in the economy who do not do business with banks – may have a larger impact on the strength of monetary transmission than the recent change in the monetary policy regime.

Appendix. Financial frictions, monopoly power, and monetary transmission

This appendix develops a simple model of bank lending behavior that explores the possible roles of financial frictions and bank monopoly power on the strength of monetary transmission.

Consider a representative LIC commercial bank that manages a portfolio consisting of loans (*L*), government securities (*B*), as well as reserves (*R*), and finances it by issuing deposits (*D*) and obtaining central bank credit (*C*). The bank's demand for central bank credit is therefore given by:

$$C = L + B + R - D \tag{1}$$

To capture the role of imperfect competition in the banking sector, assume that the bank has market power in both the loan and deposit markets, so it faces a demand for loans given by:

$$L = L(i_L),\ L' < 0, \tag{2}$$

and a supply of deposits:

$$D = D(i_D),\ D' > 0, \tag{3}$$

where i_L and i_D are respectively the loan and deposit rates set by the bank. The bank has no market power, however, in the market for government securities, where it faces the market interest rate i_B. Credit market frictions (asymmetric information and costly contract enforcement) make lending a costly activity and justify the existence of banks. To capture this phenomenon, costs of intermediation are taken to be an increasing and convex function of the volume of loans intermediated:

$$c = c(L), \text{ with } c' > 0,\ c'' > 0 \tag{4}$$

The more unfavorable the domestic institutional environment is for financial intermediation, the more rapidly these costs increase with the volume of funds being intermediated – i.e., when the institutional environment is very unfavorable, as in the case of LICs, we should expect $c'' >> 0$. The idea is that lending becomes more costly as banks expand beyond their traditional customers that they know well. This effect is stronger in countries with weak institutional settings.

The "lemons" problem associated with asymmetric information about loan quality makes bank loans illiquid, and the absence of a secondary market for government securities makes those instruments illiquid as well. The bank therefore values reserves because they provide the only available liquid buffer against unanticipated deposit withdrawals (for simplicity, I assume that there are no required reserves). This "liquidity premium," which I denote ρ, is a decreasing and convex function of the ratio of reserves to deposits, i.e.:

$$\rho = \rho(R/D), \text{ with } \rho' < 0 \text{ and } \rho'' > 0. \tag{5}$$

The central bank charges the interest rate i_C for credit extended to commercial banks, but rations this credit among individual commercial banks, so that our bank faces the constraint:

$$C \leq C_{bar}, \tag{6}$$

with C_{bar} denoting the maximum amount of central bank credit available to this bank.

Under these conditions, the bank's problem is to set its lending and deposit rates, and to choose its holdings of government securities and reserves, so as to maximize profits, subject to its balance sheet constraint (1) and the supply of central bank credit (6). In other words, its problem is to:

$$Max\ \pi\ (i_L, i_D, B, R) = i_L L(i_L) + i_B B + \rho(R/D)R - c(L) - i_D D(i_D) - i_C C$$

subject to (1) and (6), as well as to nonnegativity constraints on its balance sheet variables. I assume that the nonnegativity constraints are not binding, but that the central bank's credit constraint (6) is. Under these assumptions, the first-order conditions are given by:

$$L + i_L L' - c'L' - i_C L' - \lambda L' = 0 \quad (7a)$$

$$-\rho'(R/D)^2 D' - D - i_D D' + i_C D' + \lambda D' = 0 \quad (7b)$$

$$i_B - i_C - \lambda = 0 \quad (7c)$$

$$\rho - \rho'(R/D) - i_C - \lambda = 0 \quad (7d)$$

Notice from (7c) that for the central bank credit constraint to be binding (i.e., for $\lambda > 0$), we must have $i_B > i_C$. The intuition is straightforward: as long as the return on government securities exceeds the interest rate on bank credit, the bank would always prefer to borrow additional amounts from the central bank in order to purchase more government securities. I am assuming that this is the case. Notice also from (7c) that $i_C + \lambda = i_B$. Substituting this expression in (7d) yields the bank's demand for reserves as a function of its deposit base and the interest rate on government securities:

$$R = h(i_B)D, \text{ where } h' = 1/\rho'(1 - \eta) < 0.^{10} \quad (8)$$

From (7a) and (7c) we can express the optimal lending rate as:

$$i_L = (1 + 1/\xi_L)\ (i_B + c'(L)\ ), \quad (9)$$

where ξ_L is the elasticity of loan demand. This equation expresses the loan interest rate as a markup $(1 + 1/\xi_L)$ over the marginal cost of loanable funds, where the latter is given by the foregone return on government securities plus marginal intermediation costs. This markup is larger the less competitive the banking environment – i.e., the less elastic the demand for loans facing an individual bank. Finally, using (7c), (7d) and (8) in (7b), the deposit rate is given by:

$$i_D = (1 + 1/\boldsymbol{\xi_D})^{-1}\ [i_B\ (1 - h\ ) + \rho h], \quad (10)$$

where ξ_D is the deposit supply elasticity.

[10] η is the elasticity of the liquidity premium with respect to the reserve/deposit ratio. For an interior solution, we must have $0 < \eta < 1$, which implies $1/\rho'(1 - \eta) < 0$.

Our primary concern is with the "pass-through" from the interest rate on government securities, which is the policy rate determined by the central bank, to commercial banks' lending rates.[11] Assuming a constant loan demand elasticity, equation (9) and the loan demand equation (2) together determine the optimal lending rate and loan supply as a function of the interest rate on government securities and the elasticity of loan demand. Substituting (2) into (9) and differentiating, we can derive the "pass-through" coefficient:

$$di_L/di_B = \frac{(1 + 1/\xi_L)}{1 - c''L'(1 + 1/\xi_L)} > 0 \qquad (11)$$

The key point for our purposes is that this "pass-through" coefficient is a decreasing function of c'', the slope of the marginal intermediation-cost curve. What this means is that if a deficient institutional environment causes problems of asymmetric information and costly contract enforcement to generate a steeply rising cost of financial intermediation when banks try to expand their lending, banks are less likely to adjust their lending rates in response to changes in the central bank's policy rate. Moreover, since equations (2) and (9) imply that the lending rate depends only on i_B, any other central bank action, such as changes in the supply of credit to banks or in the discount rate, would also leave the lending rate unchanged so long as such actions do not change the policy rate i_B. Finally, it is easy to see that it is not just the strength of the pass-through effect that is at issue here, but also its reliability, since any factor that unexpectedly alters the shape of commercial banks' intermediation cost curve (including changes in the stability of the domestic macroeconomic environment, in the policy regime, or in the institutional framework governing financial intermediation) will also affect the extent of pass-through from policy to lending rates through c''.

[11] Notice that i_C does not serve as the policy rate. This follows from the assumption that the central bank credit constraint is binding i.e. it does not extend unlimited amounts of credit at this rate.

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