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Monetary Policy and the Macroeconomy: The Ethiopian Experience

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Abstract

Successful conduct of monetary policy is known to be critical for ensuring macroeconomic stability. The central banking system of Ethiopia has neither achieved stability in prices nor in the foreign exchange market in the recent years. However, it is unclear how monetary policy decisions translate into important macroeconomic outcomes in Ethiopia. This paper uses descriptive tools and econometric estimates from a structural vector autoregression model based on quarterly time series data for 2006-2020 to address this question. It is shown that reserve money, which is the central bank's operating target, is a weak predictor of macroeconomic goal variables. This observation, allied with the lack of central bank independence, transparency and communication with the public, can help explain the inefficacy of the monetary targeting regime. It is also found that the prevailing structure and development of the financial system is problematic for effective monetary transmission. The results imply that successful monetary policy requires a two-pronged effort: a short-run strategy aimed at revising the monetary policy framework, and a medium- to long-run strategy aimed at reforming the financial services sector.

Keywords: *Monetary policy, macroeconomic stability, Ethiopia*
JEL Classification: *E5, C32, N17*

1. Introduction

How is monetary policy determined and then transmitted to economic activities and prices in Ethiopia? There have been few attempts to explore this important macroeconomic question. The purpose of this paper is to provide empirical evidence.

Monetary policy actions have important effects on real economic activity and eventually inflation (e.g., Bernanke, 2020). Understanding the transmission process is thus pivotal to: (i) determine the stance of monetary policy at any time, and (ii) accurately appraise the timing and effect of policies on the economy, and set policy instruments accordingly (Boivin *et al*., 2010). And

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perennial debates abound about monetary policy transmission: from the Keynesian-monetarist debates (Mishkin, 2004, Ch. 26) through to alternative post-Keynesian and New Keynesian theories (Hannsgen, 2006; Rotheim, 2006) and finally to contemporary issues involving international spillovers of monetary policy (Curcuru *et al.*, 2018), its redistributive effects (Auclert, 2019), central bank information shocks (Jarociński and Karadi, 2020), and the merits of "unconventional" monetary policy instruments after financial and pandemic crises (Bernanke, 2020; Fratto*et al.*, 2021). These arguments are predominantly cast in the context of advanced economies, and to a lesser extent emerging markets, whereas monetary research in low-income Sub-Saharan Africa (SSA) is comparatively sparse. Yet the available analysis does not provide unambiguous evidence on monetary transmission in SSA (e.g., Mugume, 2011; Montiel *et al.*, 2012; Davoodi *et al.*, 2013; Berg *et al*, 2019; Aye *et al.*, 2020). But Mishra and Montiel's (2012) argue that these mixed findings could reflect reality or methodological choices, highlighting the need for country-specific studies that enable distinguishing between the two.

This paper presents an empirical perspective from Ethiopia. Recently, Melesse (2019) has compared business cycle fluctuations in Ethiopia under alternative interest rate and money growth rules, applying a modified version of open-economy dynamic stochastic general equilibrium (DSGE) model. His calibration and simulation exercises show that the model economy with money growth rule is substantially less powerful for the transmission of monetary policy shocks. However, he uses a monetary policy rule that "mimics" the behaviour of the central bank, and he does not attempt to link his findings to facts on the ground or potential causal factors. The advantage of the present study is that it uses the actual monetary policy framework as a reference point, employs country-specific data, and attempts to substantiate the model results with different monetary-financial facts. The context makes it an interesting case study. While being one of the least developed countries in the world, ranked in the bottom 20 on the United Nation's 2020 Human Development Index and heavily reliant on foreign aid, external borrowing and remittances, between 2006 and 2020 Ethiopia registered a 9.7% annual growth in real gross domestic product (GDP)—one of the fastest in the world (albeit from a very low base and government-led). Meanwhile, major macroeconomic distortions have recurred: very high unemployment rate (about 20% for the urban labour force), double-digit and variable inflation, unsustainable debt service, and acute shortages of foreign exchange. Then in 2019, Ethiopia's newly-introduced government unveiled its "Homegrown Economic Reform Plan," which aims to ensure private sector-led economy, boost financial inclusion and deepening, and promote macroeconomic stability (IMF, 2020a). In this light, monetary policy comes under closer scrutiny.

To evaluate how and to what extent monetary policy feeds through to macroeconomic goal variables, such as employment and inflation, the approach of this study is twofold. First, it describes the legal and institutional framework of the central bank; identifies prominent monetary-financial features of the economy; and reports basic facts like growth rates and (co)movements over time for the relevant variables. This exercise shows that the monetary decision-makers in Ethiopia have often failed to achieve the price level and foreign exchange objectives; the monetary and financial sectors, notwithstanding some progress of late, remain underdeveloped, with negative implications for the 'normal operation' of most transmission channels (as standard theories would have it); and there is apparent divergence between goals and targets of monetary policy. Second, it estimates a conventional structural vector autoregression (VAR) model that subsumes real output, price level, reserve/base money, lending interest rate, credit, and exchange rate as endogenous macroeconomic variables. The model controls for major exchange rate devaluations, data outliers, drought effects, potential structural breaks, and global economic conditions. The empirical application uses quarterly time series data from the central bank and international institutions for the period 2006-2020. The econometric results show that reserve money, i.e., the monetary authority's key policy indicator, does not have a statistically significant effect on real activity and prices. Domestic credit displays predictive power for goal variables through various metrics—as found by Khan (2010) for several SSA economies—while appearing unresponsive to changes in reserve money. These econometric results do seem to reflect factual conformity. So whether or not the Ethiopian central bank pursues monetary targeting seriously, it cannot, other things equal, influence inflation/unemployment predictably, and thereby maintain macroeconomic stability, using base money as a means of signalling monetary policy stance. This paper thus argues that monetary policy in Ethiopia evidently lacks potency and credibility. To enhance the macroeconomic relevance of monetary policy, which has been subservient to fiscal policy, a reconsideration of the monetary policy framework and financial development are put forward as critical factors.

The remainder of the paper is organized as follows. The next section reviews the theory. Section 3 presents a brief account of Ethiopia's monetary-financial system. It reports recent developments and association of the main variables of interest using simple summary statistics and charts. Section 4 outlines the econometric methodology. Next, Section 5 defines empirical model variables, presents the econometric results, and performs some sensitivity checks. Lastly, Section 6 concludes.

2. How Does Monetary Policy Affect the Macroeconomy?

This section briefly describes the main transmission mechanisms of monetary policy, i.e., the channels through which monetary policy filters the economy, omitting the details that can be found in the original references. The channels fall into two categories (see Boivin *et al.*, 2010): neoclassical and non-neoclassical. The neoclassical channels, which assume perfect financial markets, include interest rate, exchange rate, Tobin's q, and wealth channels. In the traditional Keynesian view of the interest rate channel, a monetary policy change causes changes in nominal and real short-term as well as long-term interest rates, which would affect the user cost of capital, thus, other things being equal, influencing investment spending and aggregate demand. Alternatively, the real interest rate changes would influence investment spending through their impact on the net present value (NPV) of projects (Hannsgen, 2006). But when domestic real interest rates change, real exchange rates can also change, bearing on net exports and hence aggregate output, giving rise to the exchange rate channel (Mishkin, 1995; Taylor, 1995). By the monetarist argument, Tobin's q channel results when the interest rate changes alter equity prices, affecting the market value of firms relative to the replacement cost of capital (i.e., the q), and thus investment spending. The wealth channel functions when monetary action-induced change in stock prices changes the financial wealth of consumers, influencing their consumption and aggregate output.

The non-neoclassical channels mainly comprise credit rationing channel, bank-based channels—via lending and bank capital—and balance-sheet channel. All of these entail frictions in credit markets, hence their common name the "credit view," which is actually "a set of factors that amplify and propagate conventional interest rate effects" (Bernanke and Gertler, 1995). The credit rationing channel occurs when monetary measures impact, through government intervention (Boivin *et al.*, 2010) or asymmetric information in loan markets (Stiglitz and Weiss, 1981), banks' credit supply and hence investment. In the bank lending channel, monetary policy affects banks' loan supply through their core deposits and cost of funds, altering the external finance premium facing bank-dependent borrowers, and ultimately real spending and activity. The bank capital channel operates when monetary action affects banks' capital through asset prices and their loan portfolios, thereby modifying their lending behaviour and economic activity. In the balance sheet channel, monetary policy, which changes asset prices or interest rates, affects borrowers' financial position and hence lending, investment and economic activity due to the impact on external finance premium (Bernanke and Gertler, 1995).

Finally, private-sector expectations play a prominent role in the monetary transmission process, so much so that some authors treat them as a separate transmission channel. In effect, expectations are embedded into the different transmission mechanisms discussed above—for example, predicted real rates of interest and return in the interest rate channel (Hannsgen, 2006), and expected future path of short-term interest rates in equity prices and exchange rates determination (Woodford, 2003). Woodford (2003) argues further that the most important task of a central bank is to manage expectations. To this end, transparency, effective communication and credibility in the central bank's policy actions/intentions are mentioned as critical factors, as are well-developed financial systems and more sophisticated market participants.

Even this brief overview of monetary policy transmission channels suggests that the actual macroeconomic impact of a nation's monetary policy is an empirical matter, depending, inter alia, upon the monetary policy framework, the financial system's degree of development (see the next section for further discussion with respect to Ethiopia), and the wider macroeconomic policy framework including fiscal policy (e.g., Tenreyro and Thwaites, 2016), which may have an amplifying or dampening effect.

3. The Monetary and Financial Sectors in Ethiopia

The present section highlights some salient features of the monetary-financial climate in Ethiopia. It is divided into three parts dealing with the monetary policy framework, an overview of the financial sector, and descriptive account of some key variables.

3.1. The Monetary Policy Framework

The National Bank of Ethiopia (NBE), founded in 1963, is the central bank of Ethiopia. The Establishment Proclamation of 2008 recognises the Bank as an "autonomous institution," but makes it "accountable to the Prime Minister of Ethiopia." The law mandates the Bank "to maintain stable prices and exchange rate, to foster a healthy financial system, and to [facilitate] rapid economic development." It also directs the Bank to keep "sufficient international reserve fund" for international transactions, and to "make advances to the government" with a limited constraint. To attain these multiple, sometimes conflicting, objectives set forth by Parliament, the Monetary Policy Committee (MPC) of the central bank—headed by the NBE Governor and including the Vice Governors and Directors as members—meets quarterly to make a proposal on the appropriate monetary policy stance. The final arbiter is the Board of Directors, which is composed of seven members: the Governor and Vice Governor of the Bank ex officio, the Chairman of the Board and the remaining four members as appointed by the government. In fact, the constitution, in force since 1994, gives the federal government statutory authority over the NBE and to formulate/execute monetary policy and regulate foreign exchange. So, in Ethiopia, the "monetary authority" is largely the government.

The NBE's 2009 Monetary Policy Framework states that the Bank's principal objective is "to maintain price and exchange rate stability." The Bank quantitatively defines "price stability" as single-digit annual headline inflation, and "sufficient international reserves" at a minimum of three months of imports. The IMF classifies the exchange rate regime of choice as de jure "managed float", and de facto "crawl-like"—an arrangement that seeks to exercise some control both on monetary policy and exchange rate stability, supported by capital controls. The NBE's monetary policy strategy is monetary targeting. The M2 monetary aggregate is the nominal anchor used as an intermediate target (assuming a stable demand for money), and its growth is envisaged to match nominal GDP growth. Reserve/base money—the sum of domestic currency in circulation and commercial bank deposits at the NBE—is the operating target. But the NBE avowedly uses both direct and indirect tools of monetary policy as it sees fit (NBE, 2009).

In practice, the NBE has conducted open market operations primarily through sales of Treasury bills, both to finance the federal government and to absorb excess liquidity in the banking system. Such market-based policy instruments aside, the NBE has also intervened directly or statutorily to exercise monetary control, through reserve and liquidity requirements, administrative allocation of foreign exchange, setting a floor for savings-deposit interest rates, bank credit ceilings, and directing credit to priority sectors. For example, during 2009-2011 the NBE imposed credit ceiling on banks, and during 2011–2019 it ordered private commercial banks to allocate funds worth 27% of total new loans disbursed to purchase 5-year NBE bills with a 3% interest rate, aiming to finance favoured development projects. Then to alleviate banking liquidity shortages and financial market stress caused by the COVID-19 shock, in March 2020, the NBE introduced an asset purchase program (or quantitative easing) worth about US$450 million, by redeeming the NBE bills from private banks.

Finally, while the NBE has also taken steps to upgrade its regulatory infrastructure (e.g., implementing an integrated national payment system in May 2011 and a web-based supervisory platform by end 2017), characteristically speaking, it falls well short of a modern central bank. It has often tolled the line of autocratic governments (1974-2018), exposing its policy to fiscal dominance and blurring the borderline with the Treasury. The Bank has sustained political pressures of various forms, not just fiscal. This includes political favouritism in staff recruitment, while a previous governor was accused of providing illegal loan guarantees to ruling party-affiliated businesses. Besides, relatively less attractive pay and working conditions have posed a challenge to the central bank in recruiting and retaining high calibre staff. The NBE is not known for its transparent, well-communicated, and timely policymaking either. For instance, the public rarely hears about when the MPC meets or details of its proposals, and committee members seldom speak in public. Such institutional culture, coupled with loosely-defined goals (targets), erodes the central bank's policy credibility and invalidates such modern tools of monetary policy as "forward guidance" to influence market expectations.

3.2. The Financial Sector

The transmission of monetary policy through the real economy depends critically on the structure and development of the financial system (e.g., BIS, 1995). The financial sector in Ethiopia, as in much of Africa, consists of both formal and informal financial intermediaries. The formal financial sector comprises the NBE, a development bank, commercial banks, microfinance institutions, savings and credit associations, insurance companies, and capital goods finance companies. Here, both private and public financial intermediaries co-exist, exclusive of foreign firms. As of end-December 2019, total assets of the financial system (excluding the NBE) were worth 60% of GDP. The financial system is dominated by the banking sector, which itself is highly concentrated, with the state-owned Commercial Bank of Ethiopia (CBE) holding about two-thirds of sector assets (IMF, 2020b). The informal financial sector, although difficult to quantify, includes mutual assistance associations, rotating credit and savings institutions, and the parallel foreign exchange market.

The formal financial sector—the sector directly amenable to monetary policy measures—has progressed since 1994 when the private sector was first allowed entry, though not to the extent that the IMF and the World Bank wished. Both commercial banks and nonbank financial institutions have expanded, including modernizing products/processes by the former. Nevertheless, by many measures the progress made so far remains modest. For example, according to a 2021 Global Findex report, the share of adults owning an account was 46% in Ethiopia, but 79% in neighbouring Kenya and 55% for the whole SSA. Of those adults who reported saving and borrowing money, only 23% and 5%, respectively, used the formal financial system. Furthermore, financial markets are at an early stage of development. Capital markets are virtually absent: there are no stock markets; corporate bonds are issued by a few public enterprises and regional governments to the CBE, government bonds occasionally for specific purposes. As for money markets, there is a primary market for Treasury bills with maturities of 28 to 364 days; and no secondary market exists. The interbank money market, introduced in 1998, remains largely inactive due to banks' excess reserves.

This notwithstanding, the government of Prime Minister Abiy Ahmed, succeeding the Ethiopian People's Revolutionary Democratic Front-led regime (1991-2018) known for its "gradualism" strategy (Alemayehu, 2011, Ch. 5), is already taking major steps to reform the financial sector. It started by lifting the "27-percent rule" mentioned earlier and allowed eligible microfinance institutions to acquire bank status. Then, in December 2019, competitive market-based Treasury-bill auctions began. In May 2021, the public telecommunications operator launched the country's first mobile money service, and in May 2023, the first foreign provider of a similar service was authorized. Another major step was taken when, in June 2021, Parliament passed a bill to establish the first capital market. Lastly, in September 2022, the Council of Minsters approved a draft policy to open up the banking sector—one of heretofore closed "strategic" sectors—to foreign competition. All in all, there is a promise of more sophisticated markets and new financial products.

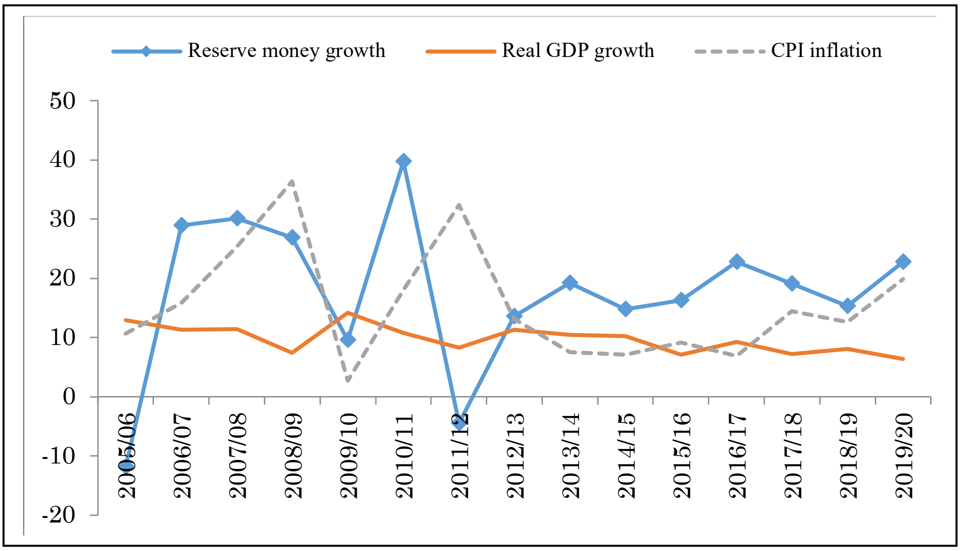
3.3. A Preliminary Look at the Basic Variables

This subsection is a summary of the behaviour of key variables in the period 2005/06-2019/20.[1] Several points stand out. First, Ethiopia appears to have pursued an easy-money policy during the period under analysis, gauging by the growth of reserve money—the NBE's primary monetary indicator—which, while greatly swinging up and down, averaged 18% per year (Figure

[1]The Ethiopian fiscal year runs from July 8 to July 7, so the data used in the empirical analysis reflect this.

1). This was helped by the NBE's direct financing of budget deficits, which, along with factors such as remittance inflows, contributed to high levels of excess reserves in the banking system. Money supply (M2, an intermediate-target variable) rose markedly, driven primarily by rapid domestic credit expansion; its yearly growth (24.3%) is slightly lower than that of nominal GDP (26%). But Ethiopia's economy had very low levels of monetization, with the M2/GDP ratio averaging 29% in the same period. Moreover, while both reserve money and M2 displayed high average growth rates, their movements over time were strikingly discrepant (Figure 2, top-left). For example, when the growth rates of reserve money turned negative, those of M2 were in double digits. So there are times when they tell a different story about the course of monetary policy.

Figure 1. Reserve money, output and price level



Note: CPI is consumer price index.
Source: Author's illustration.

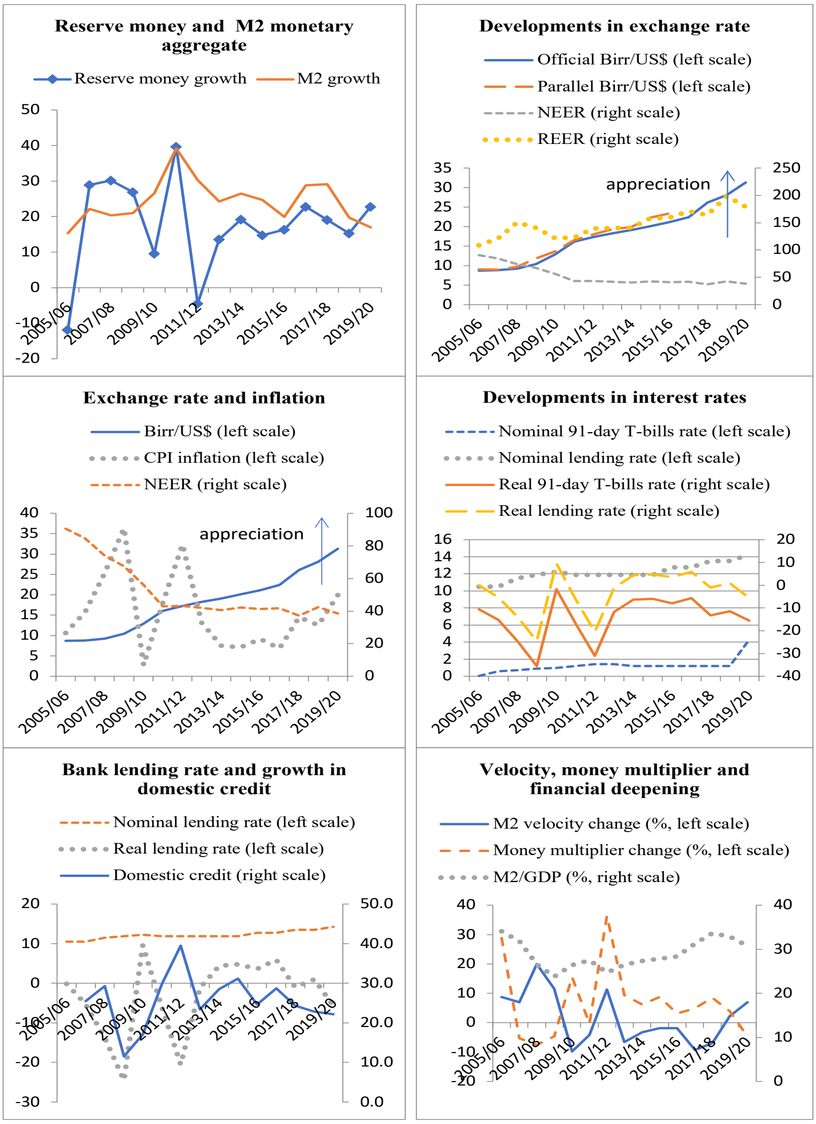
While Ethiopia reported high economic growth rates in a seemingly accommodative monetary environment, from Figure 1, no strong relationship between reserve money and real output can be identified. That is, increases (decreases) in reserve money growth did not consistently match higher (lower) real GDP growth over the sample period. Actually, the negative growth rates of reserve money in 2005/06 and 2011/12 were both followed by a real GDP growth rate of 11.3%. This probably reflects the primacy of other determinants of real output, such as the amount of rainfall affecting agricultural output (36% of GDP), but it does not say much about using reserve money as a policy guide.

Meanwhile, overall inflation—changes in consumer price index (CPI)—largely departed from the NBE's single-digit goal, averaging an annual rate of 15%; it has also been unstable (Figure 1). Sometimes monetary easing and inflation moved closely together as expected, other times they diverged significantly (e.g., the aforementioned negative reserve money growth rates were both followed by double-digit inflation). There is also no visible pass-through from official exchange rate movements to domestic prices (Figure 2, middle-left). But, for example, there were unprecedented inflation rates of 36.4% in 2008/09 and 32.4% in 2011/12, mainly due to major spikes in food prices (about 54% of CPI), which, in turn, came from drought-induced agricultural output shock. Hence, the NBE needs to carefully monitor "core inflation," a measure that excludes volatile food prices, to obtain the signal about underlying inflation pressures.

Regarding exchange rates, the Ethiopian birr was devalued against the U.S. dollar on average by 9.1%, while the nominal effective exchange rate (NEER) depreciated by 4.5% (Figure 2, top-right). But their year-to-year changes have been highly volatile: the mean percentage change in birr/US$ was 1.9% in 2005/06-2007/08, 20.6% in 2008/09-2010/11, 5.7% in 2011/12-2016/17, and 11.9% in 2017/18-2019/20. Similarly, the mean depreciations of NEER in the respective periods were 3.4%, 16.4%, 0.4%, and 2.0%. By contrast, the real effective exchange rate (REER) appreciated by 5% a year partly due to inflation differentials. In the meantime, excess demand for U.S. dollars caused by continued overvaluation of the birr (by 20-40% per IMF data), supported by exchange controls, led to the emergence of an illegal, parallel market. The parallel exchange rate premiums up until 2015/16—after which the NBE stopped reporting the parallel rate—were mostly modest with a median value of 5.3%. But, given persistent and widening current account deficits, increased exchange market pressure has been partly absorbed by a drawdown in foreign exchange reserves—which covered on average less than two months of prospective imports (again consulting IMF statistics), far lower than the NBE's goal of a three-month buffer. This has most recently resulted in strict foreign exchange rationing and the parallel market trading at a record premium of more than 100%.

Turning to interest rates, the short-term nominal rates have often been sticky in the sense that they do not change every quarter or even every year, with ex-post (actual) real rates closely tracking the inflation rate (Figure 2, middle-right). The notable exception is when the nominal average weighted yield for three-month Treasury bills rose sharply in 2019/20 following a policy shift towards competitive market-based Treasury-bill auctions. The rigidity of nominal commercial bank lending rates can be partly explained by insufficient competition in the banking sector. Lending rates averaged

Figure 2. Selected monetary and financial sector indicators



Notes: NEER is nominal effective exchange rate index; REER is real effective exchange rate index; CPI is consumer price index; T-bills rate is Treasury bills interest rate.
Source: Author’s illustration.

12.2% for the period, looking well above the minimum savings-deposit rates (an important part of bank funding costs) set by the NBE (with 3-7% range), but understandable when compared to the cost of funding from the central bank (a discount rate of 13%). Furthermore, there was a high incidence of negative real bank lending rates.

Finally, domestic credit offered by commercial banks registered quite substantial growth over the sample period (25.6% annually). This was driven primarily by considerable lending to public infrastructure projects, itself a result of "financial repression" by the government. However, public enterprises' credit from the dominant, state-owned CBE, apart from being unsustainable, has had the effect of crowding out private sector credit (IMF, 2013). On the other hand, while negative real lending rates might have contributed to robust credit growth, the relationship is not apparent from Figure 2 (bottom-left). Indeed, private demand for bank loans is normally strong and not that sensitive to loan rate changes, probably due to the scarcity of alternative domestic sources of finance.

Summarizing, the descriptive evidence presented above yields some troubling conclusions. For one thing, the NBE—as one of the least independent central banks in the world—has largely failed to accomplish its mandated mission, namely stability in inflation and the foreign exchange market. For another, the observed underdevelopment in Ethiopia's financial system does not square with efficient monetary transmission, impinging on the smooth functioning of some transmission channels, while rendering others totally irrelevant. To elaborate on this point, shallow money and capital markets, plus recurring excess bank liquidity and administratively-set deposit rate accompanied by the apparent inertia in nominal lending rates, suggest that the interest rate channel is likely to be weak. Ethiopia's exchange-rate policy with currency and capital restrictions, along with real interest rates usually in negative territory, impede the functioning of the exchange rate channel. And less sophisticated financial markets and their participants, as well as monetary policy credibility problems, rule out the expectations channel. Moreover, while a large financing gap makes the traditional bank lending channel potentially applicable, factors such as direct credit controls, highly concentrated banking sector, and nascent securities markets work in the opposite direction. Finally, reserve money as an instrument target looks dubious, given the large discrepancies and invisible patterns of association between its growth rates and those of M2 broad money. This view is reinforced by the instability of money velocity and multiplier, whose year-to-year changes show large fluctuations (Figure 2, bottom-right), which casts doubt on reserve money targeting. (In Section 5 further evidence is provided.)

4. Econometric Methodology

Model-based quantitative evaluation of the transmission mechanisms of monetary policy is a challenging task, even when high-frequency data and time-tested, economy-specific models are readily available. Notwithstanding, this paper now proceeds to apply the well-known VAR econometric technique[2] to Ethiopian data. In what follows, the specification and identification of the empirical model are discussed.

4.1. The VAR Model

Pioneered by Sims (1980), a VAR is a multivariate time series model that describes how economic variables evolve and interact with each other dynamically. The VAR model used in this paper considers both endogenous and exogenous economic variables—sometimes called VARX model—and its reduced form may be formally specified as (see, e.g., Lutkepohl, 2005):

$$X_t = \Phi(L)X_{t-1} + \Gamma(L)Z_t + \mu_t, \tag{1}$$

where the time subscript $t = 1, 2, ..., T$; X is an $(n \times 1)$ vector of n endogenous variables; Z is a $(k \times 1)$ vector of k exogenous variables; $\Phi(L)$ and $\Gamma(L)$, respectively, are $(n \times n)$ and $(n \times k)$ coefficient matrix polynomials in the lag operator L; μ_t is an $(n \times 1)$ vector of white noise reduced-form disturbances—or, in VAR model parlance, "innovations" through which perturbations to the system are introduced—with a positive definite covariance matrix $E[\mu_t \mu_t'] = \sum$. For the purposes of this paper, vector X contains six endogenous variables: real GDP (y), CPI (p), reserve money (m), simple-average bank lending interest rate (r), domestic loans made by banks (cr), and NEER (e). The choice of these variables is closely related to Davoodi *et al.* (2013), reflecting an (admittedly difficult) attempt to strike a balance between theory, data availability, model identifiability, and peculiarities of the Ethiopian monetary financial system. The vector Z comprises three exogenous variables: global commodity price index, U.S. federal funds rate—to proxy for global economic conditions and making the reasonable assumption that shocks to the Ethiopian economy have little effect on the rest of the world—and a one-zero dummy variable for drought.

Although the model (1) can be estimated consistently using ordinary least squares (OLS) equation by equation, components of the error vector μ_t—

[2]For examples of VAR applications, see Caldara and Herbst, 2019; Cesa-Bianchi *et al.*, 2020; Jarociński and Karadi, 2020.

serially uncorrelated—may be contemporaneously correlated, i.e., $\sum$ may not be diagonal. If so, there is no unique way to answer the questions of how the system's endogenous variables respond dynamically to exogenous shocks and which shocks are the primary causes of variability in them (Watson, 1994). A popular approach to this uniqueness problem is to model the instantaneous relations between the endogenous variables directly (Lutkepohl, 2005). Thus, we assume that (1) has an underlying structural model of the form

$$\Psi X_t = \Theta(L)X_{t-1} + \Lambda(L)Z_t + \varepsilon_t, \tag{2}$$

where Ψ is an $(n \times n)$ invertible matrix of contemporaneous coefficients; $\Theta(L)$ and $\Lambda(L)$ are matrices of polynomials in the lag operator; ε_t is a vector of structural innovations (exogenous shocks) with covariance matrix $E[\varepsilon_t \varepsilon_t{}'] = \Omega$, where, for a proper choice of Ψ, Ω is assumed to be a diagonal matrix. Combining (1) and (2) then yields

$$\Psi\Phi(L) = \Theta(L), \tag{3}$$
$$\Psi\Gamma(L) = \Lambda(L), \tag{4}$$
$$\Psi\mu_t = \varepsilon_t, \tag{5}$$
$$\Psi\sum\Psi' = \Omega. \tag{6}$$

But identifying the structural parameters typically requires that some restrictions be imposed on the elements of Ψ such that $\Psi\mu_t = \varepsilon_t$ has a diagonal covariance matrix. The first identifying restrictions usually normalize the diagonal elements of Ψ to unity, so that the n-th structural equation can be written with x_{nt} as the left-hand variable (Lutkepohl, 2017), with economic theory providing the remaining restrictions.

4.2. Identification Restrictions

Proper identification of monetary policy shocks is perhaps the most important as well as difficult part of the modelling exercise. Two structural VAR identification schemes are available: recursive and non-recursive. The first assumes a recursive structure of the contemporaneous relations between the endogenous variables (Amisano and Giannini, 1997; Lutkepohl, 2005). It is implemented through a Cholesky decomposition of the covariance matrix of reduced-form disturbances, $\sum$, with the contemporaneous coefficient matrix, Ψ becoming lower triangular with unit diagonal, yielding just enough identifying restrictions. This approach requires the Wold causal ordering of the endogenous variables, such that the first variable in X_t may have an instantaneous impact on all the other variables, the second variable may have an instantaneous impact on all the other variables except the first variable, and so on. The non-recursive (structural) identification, pioneered by

Bernanke (1986), Blanchard and Watson (1986) and Sims (1986), imposes economic theory restrictions on the impact/short-run effects of the shocks (i.e., Ψ), while relaxing the restrictive assumption of a lower triangular matrix and allowing contemporaneous feedback impacts between some variables.

Here a structural VAR model of the recursive type is adopted for two reasons. First, it is simple to use and probably the most common kind (Lutkepohl, 2017). Second, the particular recursive structure used appears to be reasonable from theoretical and/or institutional perspectives.[3] It can be summarized as a six-dimensional structural VAR system in innovation form (5), which links reduced-form residuals with underlying economic shocks:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ \psi_{21} & 1 & 0 & 0 & 0 & 0 \\ \psi_{31} & \psi_{32} & 1 & 0 & 0 & 0 \\ \psi_{41} & \psi_{42} & \psi_{43} & 1 & 0 & 0 \\ \psi_{51} & \psi_{52} & \psi_{53} & \psi_{54} & 1 & 0 \\ \psi_{61} & \psi_{62} & \psi_{63} & \psi_{64} & \psi_{65} & 1 \end{bmatrix} \begin{bmatrix} \mu_{yt} \\ \mu_{pt} \\ \mu_{mt} \\ \mu_{rt} \\ \mu_{crt} \\ \mu_{et} \end{bmatrix} = \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{pt} \\ \varepsilon_{mt} \\ \varepsilon_{rt} \\ \varepsilon_{crt} \\ \varepsilon_{et} \end{bmatrix}. \tag{7}$$

The identifying restrictions in (7) merit some explanation. First, as is customary, macroeconomic goal variables are ordered before financial market variables. It is particularly plausible that aggregate output and the price level react to policy shocks with long lags. Thus, several authors who adopt a non-recursive approach, too, maintain this assumption (e.g., Montiel *et al.*, 2012). So the first equation in (7) indicates that innovation in output, μ_{yt} within a quarter is entirely a structural shock, ε_{yt}; the second equation makes price level shock depend on output innovations on a quarterly basis. In the third equation, the NBE's presumed reaction function makes reserve money react contemporaneously to innovations in goal variables. And the fact that reserve money shock, ε_{mt}, is treated as a shock to monetary policy—as dictated by the NBE's official policy regime—means that the dynamic response of the economy to reserve money shock can be interpreted as reflecting structural response to monetary policy stance (Bernanke and Blinder, 1992). However, in principle changes in reserve/base money could reflect other factors than just policy decisions, potentially discombobulating inference about the effectiveness of monetary policy (see, e.g., Mishkin, 2004, Ch. 15). In any case, if reserve money is indeed a measure of policy, and the NBE is "purposeful and reasonably consistent in its policymaking," then reserve money "should be systematically related to important macroeconomic [goal] variables like

[3]The identification scheme is similar to that of Davoodi *et al.* (2013), who examined monetary transmission in the East African Community.

unemployment and inflation” (Bernanke and Blinder, 1992). Lastly in (7), the lending rate is allowed to respond instantly to innovations in goal variables and monetary policy; credit responds to contemporaneous innovations in all other variables except exchange rate; and exchange rate depends on current innovations in all other variables (given Ethiopia’s administered foreign exchange market, the plausibility of this (non)restriction is mainly theoretical).

As suggested by Lutkepohl (2017), the just-identified recursive model (7) is most preferably estimated by the method-of-moments method. However, the model can also be consistently estimated by maximum likelihood method.

5. Econometric Estimates

The present section is devoted to estimation results. The data, reduced-form estimates, Granger causality tests, impulse response functions (IRFs), forecast error variance decompositions (FEVDs), and robustness tests are discussed in turn.

5.1. Data

The empirical analysis uses quarterly time series data for the period 2005/06:1–2019/20:4. The variables are: real GDP, CPI, reserve money, commercial banks’ average lending interest rate, domestic credit supplied by banks, NEER, global commodity price index, U.S. federal funds rate, and a drought dummy. For Ethiopia, quarterly GDP data is not available. Nor is there a reliable related indicator—such as an industrial/agricultural production index—at the quarterly frequency. Therefore, quarterly estimate of real GDP was obtained after disaggregating annual nominal GDP and GDP deflator figures into quarterly figures using the “Denton-Cholette” temporal disaggregation method without an indicator.[4] The nominal GDP and GDP deflator data came from the NBE’s annual reports. The bank loan rate is chosen because it is market-determined (unlike, e.g., savings-deposit rate), and other short-term interest rates (such as Treasury-bill rate) are neither representative market rates nor reliable indicators of the direction of monetary policy. Credit is broadly measured to include credit to the public sector; it is thus an inexact representation of the variable emphasised by the credit channel theory, namely bank loans to the private sector, for which reliable data were not available. The NBE’s quarterly reports are sources for reserve money, bank lending rate, domestic loans, and NEER series. CPI was

[4]The temporal disaggregation exercise was conducted using the R package tempdisagg (written by Christoph Sax and Peter Steiner).

drawn from FAOSTAT database of the Food and Agriculture Organization of the United Nations, global commodity price index from the IMF's Primary Commodity Price System, the U.S. federal funds rate from FRED database of the Federal Reserve Bank of St. Louis, and drought data mainly from the Ethiopian Economics Association. All non-interest rate variables (excluding dummies) are transformed to natural logarithms. None of the series is seasonally adjusted.

5.2. Reduced-Form Estimates

Before a structural VAR analysis proceeds, the reduced-form model should be specified, estimated, and checked for its adequacy (Lutkepohl, 2001). We therefore set up a VAR in levels that consists of the six endogenous variables and the three exogenous variables mentioned above, a constant, two one-zero impulse dummies for serious outliers in the lending rate during 2005/06:1 to 2006/07:4 and in 2019/20, two one-zero impulse dummies for large devaluations in 2010/11:2 and 2017/18:2, and two one-zero dummies for potential structural breaks in 2008/09:2 for the price level and in 2013/14:2 for reserve money—both identified by the Quandt Likelihood Ratio (QLR) test for unknown break date.[5] The model was estimated using the maximum likelihood method, applying small-sample corrections to reported statistics. The optimal lag order of two was chosen for the VAR process on the basis of standard criteria: Akaike Information Criterion (AIC), Hannan-Quinn (HQ), and Schwarz Bayesian Information Criterion (SC) (see Appendix, Table A3). Then various misspecification tests were performed to evaluate the adequacy of the estimated VAR model. First, the residuals were checked to ascertain whether or not they are in line with the white noise assumption. The multivariate Lagrange multiplier (LM) test for residual autocorrelations up to two lags does not reject the null hypothesis of no residual autocorrelation for both lags at the 0.05 significance level (Appendix, Table A4). Single-equation and joint Jarque-Bera tests for nonnormality do indicate problems for the disturbances (Appendix, Table A5). But single-equation LM tests for autoregressive conditional heteroskedasticity (ARCH) effect in the residuals were conducted, and none of the equations indicate its presence (Appendix, Table A6). Moreover, the estimated VAR(2) process is dynamically stable (i.e.,

[5]The QLR test also identified additional three break dates for real GDP, domestic credit and exchange rate. But the case to control for potential structural break in real GDP here did not seem to be strong, given the series was temporally disaggregated. Furthermore, the potential break dates in the other two variables were not supported by visual inspection of the data series and, in addition, their potential impact was thought to be captured by the included outlier dummies. So, given the relatively small sample size and preference for greater parsimony, these additional break dates were left out.

stationary) since all roots of the determinant of the characteristic polynomial lie strictly outside the complex unit circle (or, equivalently, the modulus of each eigenvalue of the coefficient matrix in companion form is strictly inside the complex unit circle) (Appendix, Figure A1). Overall, the model diagnostics do not suggest serious violation of the assumptions behind the VAR model.

But to what extent does specification of the VAR in levels form make sense? This requires examination of integration and cointegration properties of the dataset. First, results from the Augmented Dickey-Fuller (ADF) and Phillips-Perron tests for unit roots in the variables of interest indicate that each series exhibits at least one unit root in their (log) levels (Appendix, Table A1). However, the first-differenced series are all stationary, or I(0), implying that none of them has more than one unit root (i.e., they are I(1)). Next, Johansen's two likelihood ratio test statistics for cointegration among the I(1) endogenous variables—trace statistic and maximum-eigenvalue statistic—both reject the null hypothesis of no cointegration at the 5% level, with the trace test result suggesting three cointegrating relations (Appendix, Table A7). Ideally, in this case, one would proceed with identification of the cointegrating relations and of the structural shocks within the framework of a structural vector error correction model (SVECM) (Lutkepohl, 2005). In the present application, however, it was thought best not to take this latter route for several reasons. First and foremost, it is well known that multivariate cointegration tests, such as Johansen's, are unlikely to yield reliable results in small samples (e.g., Stock, 1993). Second, even if the cointegrating rank was accurately determined, estimation of SVECM would not be feasible for such a limited sample size ($T = 60$) with a relatively large dimension ($n = 6$) (Ericsson, 1994). Third, a levels VAR system would allow consistent parameter estimation irrespective of the integration properties of the data (Bruggemann, 2003), and it is robust to cointegration of unknown form (Lutkepohl, 2011). Lastly, estimating a VAR in levels does not restrict the system's long-run behaviour by imposing cointegration restrictions (Bruggemann, 2003), while—unlike a VAR in first differences—not throwing away the information contained in that long-run behaviour (e.g., Copelman and Werner, 1995; Davoodi *et al.*, 2013). Hence, the levels VAR(2) model is maintained for subsequent analysis.

5.3. Granger Non-causality Tests

Granger (1969) devised a test for non-causality between variables, so a variable x_{1t} is said to "Granger-cause" a variable x_{2t} if the information in x_{1t} contributes to improving the forecasts of x_{2t}. This could be checked simply by OLS regression of x_{2t} on lagged values of both x_{1t} and x_{2t} and testing the null hypothesis that the estimated coefficients on the lagged values of x_{1t} are jointly zero. Then rejecting the null hypothesis means rejecting the hypothesis that x_{1t} does not Granger-cause x_{2t} or, equivalently, that x_{1t} has no information content for the prediction of x_{2t}. But Granger causality between some variables is expected of cointegrated data (Toda and Yamamoto, 1995). Table 1 reports the results of a Wald test for Granger non-causality performed for each equation of the reduced-form VAR(2) and each endogenous variable that is not the dependent variable in that equation. Each row of the table corresponds to a forecasted variable with statistical levels of significance for the hypothesis that there is no predictive content from each column variable. The results show that, contrary to expectations, reserve money exhibits predictive power in neither output nor price level equations. Only the price level is the most important predictive variable for output (statistically significant at the 5% level), while output contributes marginally to improving the forecasts of the price level. Domestic credit makes the most significant predictive contribution for the price level, while causation in the other direction also exists. Reserve money is a slightly significant predictor of lending rate (at the 10% level), while the lending rate is highly significant in forecasting reserve money, hinting perhaps at bi-directional causation. Finally, output has a significant predictive content for credit forecast, while both of these variables appear to play a significant role in predicting the exchange rate.

Table 1. Summary of Granger noncausality tests

	Predictors					
Prediction equation	Real GDP	Consumer price index	Reserve money	Bank lending rate	Domestic credit	Nominal effective exchange rate
Real GDP	–	0.032	0.991	0.953	0.460	0.432
Consumer price index	0.084	–	0.245	0.848	0.032	0.112
Reserve money	0.181	0.126	–	0.000	0.678	0.715
Bank lending rate	0.068	0.928	0.054	–	0.314	0.627
Domestic credit	0.005	0.015	0.710	0.277	–	0.370
Nominal effective exchange rate	0.004	0.565	0.697	0.120	0.046	–

Notes: Each value in the table refers to the level of significance (p-value) for the Wald test of exclusion (zero) restriction on all the lags of the column variable in an ordinary-least-squares (OLS) equation that forecasts the row variable. The Wald test has the small sample F(2, 36)-distribution. All variables except the lending rate are in log levels.
Source: Author's estimation.

In brief, the Granger-causality criterion suggests that reserve money is not a good predictor of macroeconomic outcome variables. Not only that the NBE's policy variable contains no useful information for improving predictions of real output and price level, neither are there hints at an indirect forecasting ability. Yet, there are well-known limitations of the Granger causality concept (see Lutkepohl, 2005), and the absence of Granger causality does not necessarily mean that there is no cause-and-effect relationship. It is argued that in the VAR context, cause-and-effect relationships can be better assessed by a structural modelling of the VAR system and interpreting the resulting IRFs and FEVDs.

5.4. Impulse Response Analysis

Since the crux of the structural VAR exercise is to estimate the dynamic response of the Ethiopian economy to monetary policy shocks, the functions of structural parameters such as IRFs and FEVDs, and not the parameters themselves, are our main focus. IRF traces out the dynamic response of each endogenous variable to an exogenous shock or innovation in itself or another endogenous variable in the VAR system. Here, we calculate IRFs based on the structural VAR (7). Figure 3 displays the resulting impulse responses of real GDP and CPI to a positive one-standard deviation innovation in reserve money (i.e., expansionary monetary policy shock) for a time horizon of twelve quarters (Appendix, Figure A2 has the full set of IRFs.). The point estimates of IRFs are displayed together with 95% confidence intervals (approximate two-standard error bands). The main findings may be summarized as follows.

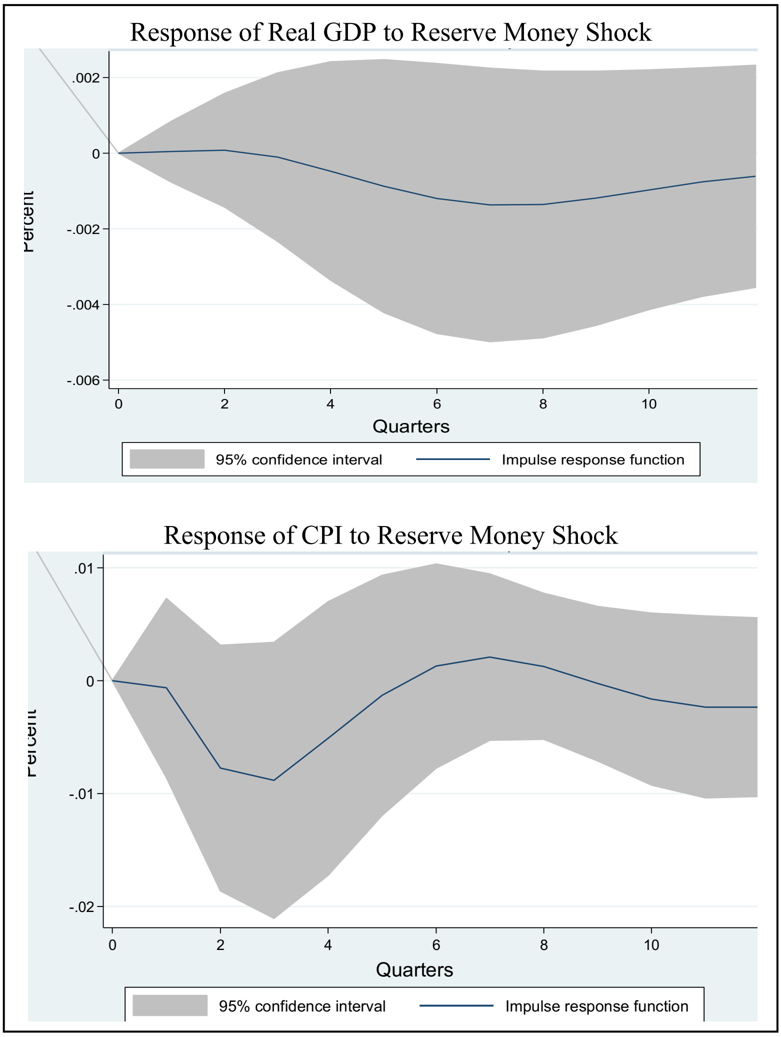
Although one would expect central bank policy instruments, to the extent that they are reliable, to have powerful effects on the economy, this relationship does not show up in the data. First, the response of real output to loose money—positive for the first two quarters and negative afterwards—is not statistically significant at any horizon.[6] The same is true for the effect of a monetary shock on the price level, which is counterintuitively negative over most of the forecast horizon, the so-called a "price puzzle."[7] Besides, the sensitivity of reserve money to perturbations in output and price level is not estimated precisely. But, as shown in Figure 4, unanticipated domestic credit expansion is passed forward to a statistically significant increase in output

[6]Notice that the impact responses of output and price level to a monetary policy shock, and that of reserve money to lending rate, credit, and exchange rate shocks are all zero by the identification assumption.

[7]Such puzzles are commonly found in the empirical literature, and they could be traced to the identification strategy, the sample period, the information set considered, or the details of model specification (Miranda-Agrippino and Ricco, 2021). Some authors include commodity price index in their VAR models in an attempt to resolve the price puzzle (e.g., Boivin and Giannoni, 2002).

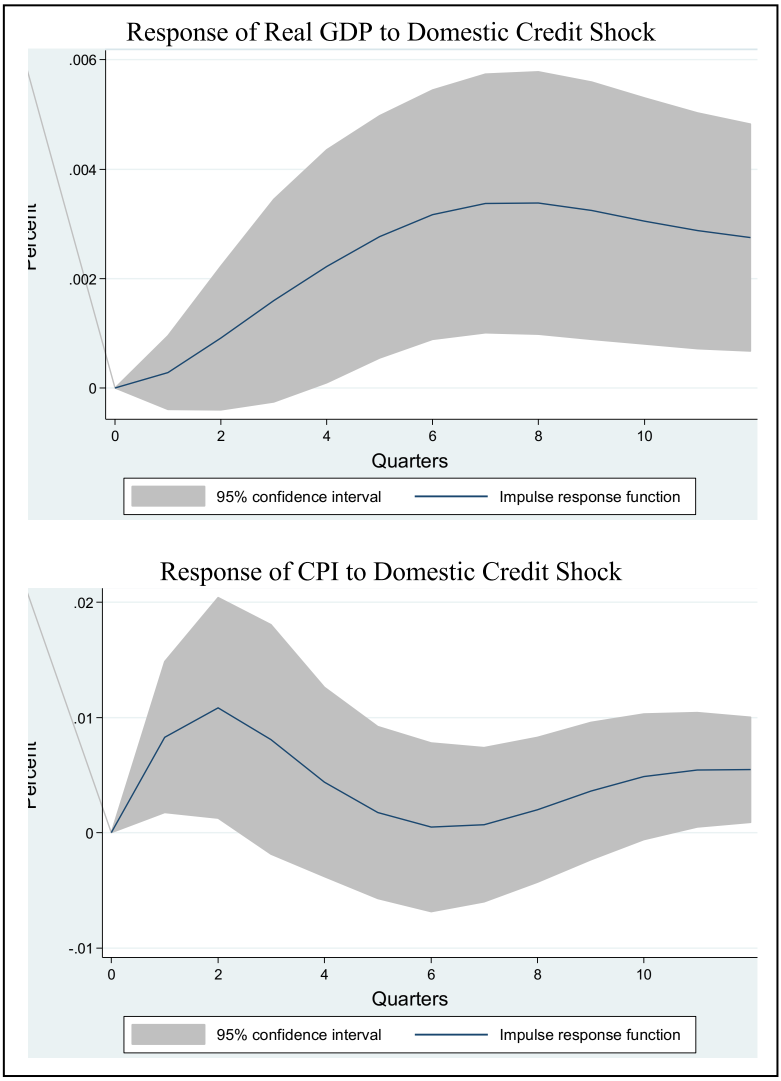
after a delay of three quarters, and the response peaks at the 8-quarter horizon. This result is plausible, given the fact that debt-financed public infrastructure investment has been a powerful driver of Ethiopia's economic growth in recent years. Impulse in

Figure 3. Impulse responses of output and price level to reserve money shock



Notes: The panels depict responses to positive one-standard deviation shocks. CPI is consumer price index.
Source: Author's estimation.

Figure 4. Impulse responses of output and price level to domestic credit shock



Notes: The panels depict responses to positive one-standard deviation shocks. CPI is consumer price index.
Source: Author's estimation.

credit also induces a persistently positive response from the price level, which is statistically significant at the first and last two quarters of the forecast horizon. These results appear to suggest that credit might be an important channel of monetary transmission, knowing that expansionary monetary policy augments reserves in the banking system, enhancing the ability of banks to supply credit. Nevertheless, the effect of monetary surprises on credit, though positive on impact and 2-4 quarters after the shock according to the point estimates, is not statistically different from zero. The effect of unforeseen monetary expansion on lending rate is significantly positive on impact and at 1-quarter horizon (a "liquidity puzzle"), while a lending rate innovation brings about a sustained rise in reserve money, though only statistically significant at the 2-5 quarter horizons. Furthermore, a lending rate shock fails to generate statistically and economically meaningful impact on domestic credit. Finally, we find no evidence for the exchange rate channel, not surprising in view of, among other things, administrative regulations in the foreign exchange market.

In a nutshell, the impulse response analysis does not allow rejection of the hypothesis that an expansionary monetary policy shock has no effect on output and price level. Where the link between financial conditions and economic outcomes was found, the link between monetary policy instruments and the financial conditions was absent. Put differently, there is neither direct nor indirect evidence for effective transmission of monetary policy.

5.5. Variance Decomposition

FEVD measures the fraction of the forecast error variance of an endogenous variable that is accounted for by shocks to itself and to other endogenous variables at a given forecast horizon. It thus helps to evaluate the relative contribution of monetary policy and other innovations for changes in goal variables such as output and price level over time. Table 2 gives the FEVDs of all six endogenous variables in the estimated equation (equation 7) at forecast horizons of four, eight, and twelve quarters. One striking finding that is consonant with the impulse response analysis, is that reserve money shocks account for small fractions (less than 10%) of the forecast error variances of output and the price level at any forecast horizon. In most cases, output is the most informative variable for forecasting price level, and vice versa. The next most important variable for forecasting both outcome variables is again domestic credit, whose innovations contribute 21.6% and 12.4% of the 12-quarter forecast error variance of output and price level, respectively. But for credit, as well as exchange rate, the proportions of the error variance attributable to monetary shocks are miniscule. Other findings that become apparent from Table 2 are: reserve money and the lending rate have more predictive power for each other than any other variable in the system; for exchange rate forecast at any horizon, output contains far more information than any other variable except the forecasted variable itself. Overall, the

FEVD results too suggest that monetary shocks are of minor importance to ultimate economic outcomes.

Table 2. Forecast error variance decomposition of the structural VAR model

		Shocks to					
Forecast error in	Forecast horizon	Real GDP	Consumer price index	Reserve money	Bank lending rate	Domestic credit	Nominal effective exchange rate
Real GDP	4	80.5	15.8	0.0	0.0	3.5	0.2
	8	48.3	31.4	1.7	0.5	14.7	3.4
	12	36.3	32.4	2.5	1.1	21.6	6.1
Consumer price	4	10.3	65.0	6.6	0.6	12.0	5.4
index	8	14.3	60.5	7.3	0.7	11.7	5.5
	12	16.6	58.4	6.5	0.8	12.4	5.2
Reserve money	4	0.3	5.8	77.1	15.6	0.9	0.3
	8	0.6	6.0	69.9	19.9	3.1	0.4
	12	1.9	7.8	66.6	19.4	3.8	0.5
Bank lending	4	2.6	0.8	31.5	62.4	1.8	0.8
rate	8	4.9	0.9	30.5	61.1	1.9	0.7
	12	5.0	1.2	30.5	60.7	1.9	0.8
Domestic credit	4	3.1	27.3	3.7	4.5	59.6	1.8
	8	3.6	33.1	3.0	7.0	49.3	4.1
	12	8.3	34.1	2.3	6.3	44.5	4.4
Nominal effective	4	23.1	5.1	5.2	8.0	7.5	51.1
exchange rate	8	26.7	7.7	7.0	7.8	7.5	43.3
	12	27.1	8.5	7.3	8.0	7.6	41.4

Notes: Entries in the table indicate percentages of the forecast error variance of the row variable accounted for by shocks to the column variable at the given forecast horizon. Forecast horizon refers to quarters. All variables except the lending rate are in log levels.
Source: Author’s estimation.

5.6. Robustness Tests

Most econometric estimates are model-specific in the sense that they depend on a given model. It is therefore desired to test whether the key assumptions of the model are supported by the data (which was demonstrated to be the case in sub-section 5.2), and if the estimates are robust to reasonable changes in the specification. In the literature, several concerns have been raised in relation to a VAR analysis (see Lutkepohl, 2005 for details). But, here, probably the most important is that the interpretation of a recursive structural VAR system critically depends on the ordering of variables. Now, it has already been noted that this ordering choice was not made arbitrarily in this study. Moreover, the correlation matrix of the reduced-form VAR residuals (Appendix, Table A8) suggests that contemporaneous correlation between shocks to different system variables is generally low, meaning that the ordering should not be a major concern. Still, it is common to try different orderings and then test the sensitivity of the estimated IRFs and FEVDs. In this exercise, we find that the main results reported in the preceding subsections remain virtually unaffected if we reordered the variables in the estimated model to place exchange rate before credit (as done by others; e.g., Copelman and Werner, 1995; Clements *et al.*, 2001), or even to arrange all variables in reverse.[8] If anything, in the latter case, the effect of credit on output becomes sharp and more pronounced over the entire forecast horizon, and reserve money becomes an even less informative variable for the price level. So the conclusions drawn in Section 5 are not sensitive to alternative orderings of the variables.

Another potential problem in model specification is omission of important variables from the information set. In this respect, a dummy variable meant to capture the effect of a change in government in April 2018 was considered as an additional control (exogenous) variable. However, an exclusion test—a joint test of significance of coefficients—did not reject the validity of excluding this additional variable from the estimated system (Appendix, Table A2). Likewise, to further look into the selection of interest rate in the empirical model, the latter was re-estimated using the three-month Treasury-bill rate instead of the bank lending rate. But, as would be expected from the discussion in Section 3, the use of the Treasury-bill rate did not improve the performance of the model (in terms of its desirable properties).

6. Conclusions

Lately, Ethiopia's economy has experienced both the good and the bad—rapid growth on the one hand, and high unemployment and unstable prices and foreign exchange market on the other. This paper sought to understand the link between monetary policy and macroeconomic outcomes in the country. The analysis proceeded from stylizing the relevant monetary, financial, and institutional facts on the ground to estimating a VAR system with its derived Granger causality, impulse responses, and variance decomposition. The

[8]These sensitivity results are available upon request from the author.

sample data were quarterly time series from 2006 to 2020. The empirical analysis indicates that there is unsteady relationship between the central bank's instrument target (reserve money) and macroeconomic goal variables (such as inflation). This means that hitting the monetary target will not produce the desired outcomes, which, coupled with the limited transparency of policy and accountability of the NBE, weakens base money as a guide to monetary policy (as argued explicitly by Mishkin, 2004). The analysis finds that domestic credit bears an instructive link with output and price level. So, inasmuch as monetary policy succeeds in affecting credit, the result suggests that it can also affect real economic activity. However, no strong correlation between reserve money and credit is found, hence providing no evidence for a credit channel. In short, whether the NBE pursues monetary targeting seriously or not (due, for example, to "game playing") matters very little for macroeconomic stability.

Although investigating the nature of the link between the key elements of monetary policy has been a critical first step in the analysis, an even more serious problem is identifying the underlying causes. Previous work indicated that conventional monetary transmission channels in developing economies could be impaired by, inter alia, low level of financial development, inferior quality of institutions, deficient monetary policy framework (Brandao-Marques *et al*., 2020), imperfect banking competition, capital and exchange controls, small formal financial sector relative to the size of economy (Mishra and Montiel, 2012), remittance inflows contributing to excess reserves in the banking system (Barajas *et al*., 2018), and primary goods production-inclined economic structure (Choi *et al*., 2022). The monetary-financial attributes of the Ethiopian economy reviewed in Section 3 suggest that all of these factors are probably behind the observed weakness in the responses of both financial and real variables to monetary impulses, although a more detailed analysis is needed.

Still, the empirical findings in this paper provide a number of important clues as to the kinds of measures that could be taken to improve the potency of monetary policy in Ethiopia. In the near term, they make the case for reform of the NBE's monetary policy framework. This is likely to involve: (a) refinements of the monetary policy regime to de-emphasize monetary targeting—which is shown not to be working—and/or to achieve clarity to goals/targets; and (b) changes to the legislative framework, here to mean the Bank's Establishment Proclamation, granting the Bank statutory independence, making it directly accountable to the public (i.e., the Parliament), tipping the balance of voting rights in the Board from government representatives to technocrats and requiring the chairman to come from the latter with the required expertise and integrity, increasing the central bank's operational autonomy, transparency and communication with the public, and specifying the constraints on direct monetary financing of the government. Restructuring the NBE as a technocratic institution (that it is supposed to be) would enable the central bank to function as claimed and gain public trust, better deal with political expedience, and thereby promote the success of its stabilization objectives. Over the longer term, one related challenge is to amend the constitution to increase the policymaking and executive power of the NBE. Another is to improve the structure and depth of the financial system by, for example, creating a competitive banking industry, developing financial markets with the requisite regulatory environment, enhancing the role of the private sector, and expanding the formal financial sector—some of which are being acted upon by the government. If realized, this would encourage market-based monetary management, and also enhance the percolation of monetary policy actions through the economy. Collectively, the above suggested reforms would also enable the NBE to consider alternative monetary policy strategies like inflation targeting.

But even then, as advanced economy experiences show, it may not be easy for the monetary authority to control economic outcomes like inflation, which may not be primarily a monetary phenomenon. That is, given the multiplicity of central bank objectives and of supply-side and demand-side factors that affect them (and not all domestic), monetary policy can only do so much and thus needs support from other policies/institutions to ensure macroeconomic stability. In this regard, a reasonable starting point is to move toward greater coordination with (the intimately-linked) fiscal policy. Now, at first sight, having a single monetary-fiscal authority—as is virtually the case in Ethiopia—may seem ideal for this purpose. But it can lead to an inferior policy mix in practice. For example, as the experience of Ethiopia itself shows, there is the danger of fiscal dominance. Thus, efficient monetary-fiscal coordination is generally expected where, first, the policies themselves are credible and operate within a region of stability, and then there are appropriate institutional and operational safeguards—including central bank independence (Laurens and de la Piedra, 1998; BIS, 2023). But the final message seems to be that, sound and credible monetary policy—one that shows consistency between central bank behaviour, goals and targets—would, at the very least, do its part.

We conclude by noting some methodological limitations of our analysis. First, econometric inferences about monetary transmission are almost always made under conditions of uncertainty, and the ones in the present paper are no exception. Second, data constraints have necessitated temporal disaggregation of GDP and use of an imperfect proxy for credit in the empirical model, and so future work can refine the analysis with sufficiently detailed and high-frequency data, if not change the main conclusions. Finally, the econometric analysis tested the dynamic response of the economy to expansionary monetary policy shocks. However, we can not rule out that contractionary shocks are more powerful than expansionary ones (Tenreyro and Thwaites, 2016).

Despite such caveats, this study does provide empirical insights into the challenges of conducting systematic monetary policy and thereby advancing a more stable economy in low-income SSA countries such as Ethiopia.

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Appendix

Table A1. Tests for unit root

Variable	ADF Statistic (lag)	Phillips-Perron Statistic
y	1.904 (3)	0.403
Δy	−3.565*** (2)	−2.871**
p	−2.427 (3)	−1.784
Δp	−3.433*** (2)	−4.464***
m	−2.531 (1)	−2.842
Δm	−8.041*** (0)	−8.103***
r	−1.628 (1)	−1.629
Δr	−7.630*** (0)	−7.651***
cr	−2.357 (1)	−2.236
Δcr	−8.189*** (0)	−8.353***
e	−1.726 (2)	−1.317
Δe	−4.017*** (1)	−5.435***

Notes: ADF denotes Augmented Dickey-Fuller test, with lag length selected based on the Schwarz Criterion (SC). Both ADF and Phillips-Perron tests have the null hypothesis of a unit root. The testing regressions include an intercept and a deterministic time trend for (log) variables, and only an intercept for the first-differenced series. Δ is the first difference operator. y is real GDP; p is consumer price index; m is reserve money; r is bank lending rate; cr is domestic credit; e is nominal effective exchange rate. All variables except the lending rate are in log levels. ***, **, and * denote level of statistical significance at 1%, 5%, and 10%, respectively.
Source: Author's estimation.

Table A2. Wald test for exclusion restriction

Variable	Distribution	Statistic	*p*-value
regime	F(6, 37)	1.26	0.29

Note: *regime* is a one-zero dummy variable to capture regime change since April 2018. The Wald test has the null hypothesis that the coefficients on the variable are jointly zero in the reduced-form VAR.
Source: Author's estimation.

Table A3. VAR lag order selection

Lag	AIC	HQ	SC
0	−32.41	−32.41	−32.41
1	−43.78	−42.28	−42.50
2	−45.39*	−44.40*	−42.83*

Notes: AIC is Akaike Information Criterion. HQ is Hannan-Quinn criterion. SC is Schwarz criterion. * indicates the order chosen so as to minimize the value of the criterion.
Source: Author's estimation.

Table A4. Lagrange multiplier test for autocorrelation

Lag	Distribution	Statistic	*p*-value
1	$\chi 2(36)$	45.62	0.13
2	$\chi 2(36)$	46.72	0.11

Note: The test has the null hypothesis of no autocorrelation at lag order.
Source: Author's estimation.

Table A5. Jarque-Bera test for nonnormality

Equation	Distribution	Statistic	*p*-value
y	$\chi 2(2)$	7.38	0.03
p	$\chi 2(2)$	9.43	0.01
m	$\chi 2(2)$	7.81	0.02
r	$\chi 2(2)$	9.56	0.01
cr	$\chi 2(2)$	8.38	0.02
e	$\chi 2(2)$	9.11	0.01
all	$\chi 2(12)$	51.67	0.00

Notes: Null hypothesis of the test is normally distributed disturbances. *y* is real GDP; *p* is consumer price index; *m* is reserve money; *r* is bank lending rate; *cr* is domestic credit; *e* is nominal effective exchange rate. All variables except the lending rate are in log levels.
Source: Author's estimation.

Table A6. Single-equation Lagrange multiplier test for ARCH

Equation	Asymptotic Distribution	Statistic	*p*-value
y	χ2(1)	0.04	0.84
p	χ2(1)	3.43	0.06
m	χ2(1)	0.77	0.38
r	χ2(1)	0.01	0.95
cr	χ2(1)	1.39	0.24
e	χ2(1)	0.40	0.53

Notes: ARCH is autoregressive conditional heteroscedasticity. The test has the null hypothesis of no ARCH effect of order one in the errors. *y* is real GDP; *p* is consumer price index; *m* is reserve money; *r* is bank lending rate; *cr* is domestic credit; *e* is nominal effective exchange rate. All variables except the lending rate are in log levels.
Source: Author's estimation.

Table A7. Johansen tests for cointegration

Test	Null hypothesis	Alternative	Statistic	5% critical value
Trace test	$H0$: $r = 0$	$H1$: $r > 0$	136.45	94.15
	H0: $r \leq 1$	$H1$: $r > 1$	78.69	68.52
	H0: $r \leq 2$	$H1$: $r > 2$	50.60	47.21
	H0: $r \leq 3$	$H1$: $r > 3$	28.09*	29.68
	H0: $r \leq 4$	$H1$: $r > 4$	11.40	15.41
	H0: $r \leq 5$	$H1$: $r > 5$	3.60	3.76
Maximum-eigenvalue test	$H0$: $r = 0$	$H1$: $r = 1$	57.76	39.37
	H0: $r \leq 1$	$H1$: $r = 2$	28.09	33.46
	H0: $r \leq 2$	$H1$: $r = 3$	22.50	27.07
	H0: $r \leq 3$	$H1$: $r = 4$	16.69	20.97
	H0: $r \leq 4$	$H1$: $r = 5$	7.81	14.07
	H0: $r \leq 5$	$H1$: $r = 6$	3.60	3.76

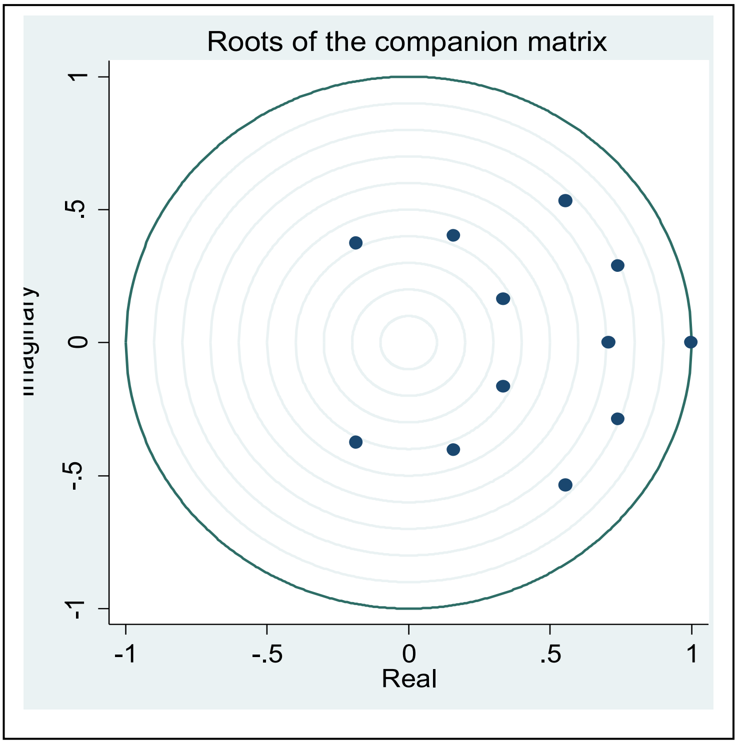
Notes: r denotes cointegrating rank (that is, the number of cointegrating relations). No. of observations = 58. Lag length = 2. Tests assume a linear deterministic trend in levels data (as a linear deterministic trend appears plausible for most of the (log) series).
Source: Author's estimation.

Table A8. Correlation matrix of reduced-form VAR residuals

	y	*p*	*m*	*r*	*cr*	*e*
y	1.00					
p	-0.05	1.00				
m	0.04	0.13	1.00			
r	0.18	-0.08	0.36	1.00		
cr	0.21	0.51	0.19	0.08	1.00	
e	-0.38	-0.11	-0.13	0.25	-0.04	1.00

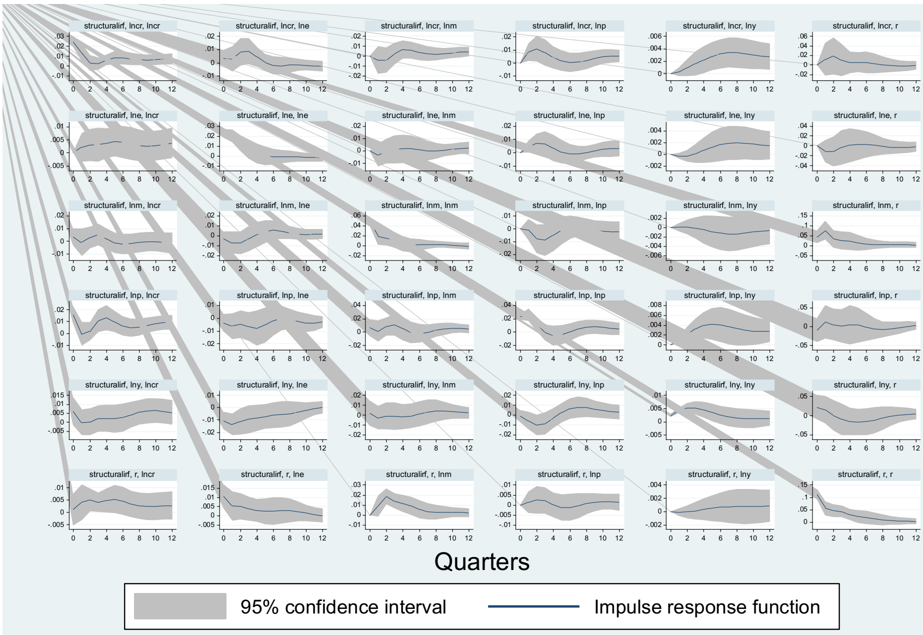
Notes: *y* is real GDP; *p* is consumer price index; *m* is reserve money; *r* is bank lending rate; *cr* is domestic credit; *e* is nominal effective exchange rate. All variables except the lending rate are in log levels.
Source: Author's estimation.

Figure A1. Stability condition of the VAR model



Note: Dots in the graph refer to the moduli of eigenvalues of the coefficient matrix in companion form.
Source: Author's estimation.

Figure A2. Impulse response functions for the recursive structural model



Notes: The panels depict responses to positive one-standard deviation shocks. Titles of individual graphs display the type of impulse response function (which is the same for all), the impulse variable, and the response variable, respectively. ln denotes natural logarithm. y is real GDP; p is consumer price index; m is reserve money; r is bank lending rate; cr is domestic credit; e is nominal effective exchange rate.
Source: Author's estimation.