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Price and liquidity puzzles of a monetary shock: Evidence from indebted African economies

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ABSTRACT

Price and liquidity puzzles have been identified as two major counterintuitive findings arising from monetary shocks. We investigate their presence in eleven African countries, using a dynamic stochastic general equilibrium model designed for indebted small open-economies. Our simulations reveal that the majority of African countries report a price puzzle whereas only three countries exhibit liquidity effect. In many of the sampled countries, a positive money growth shock drives interest rates up, but consumption and output fall in contrast to the conventional view. External debt increases in response to money growth shock, exchange rate appreciates and inflation falls. Money growth shocks are transmitted to the economy through the exchange rate channel when uncovered interest rate parity condition holds. Our findings therefore appear to suggest that monetary policy in Africa should prioritize foreign debt stabilization by reacting more to output gap than to inflation.

1. Introduction

Conventional economics posits that an expansionary monetary policy shock leads to a decrease in interest rates and an increase in inflation. However, empirical research has found evidence of a surprising increase in interest rate (the liquidity puzzle) and a surprising fall in prices (the price puzzle), after a positive monetary policy shock. These phenomena complicate the design and implementation of monetary policy because they generate perverse macro-dynamics.

Some authors, for example Sims (1992) and Hanson (2004), argue that the inclusion of commodity prices as an "information variable" in VAR models helps to reduce the price puzzle. On his part, Giordani (2004) argues that a price puzzle may be due to the omission of an accurate measure of output gap in the VAR. In this context, Zha (1997), Sims (1998), Christiano et al. (1999) (CEE), and Brissimis and Magginas (2006) argue that the presence of a price puzzle should serve as a specification test of a VAR model: if such an anomalous result is observed, then what one has labelled as "monetary policy" probably has not been correctly identified. A contrasting argument is provided by Rabanal (2007) who asserts that a shift in inflation in response to a monetary policy shock is not necessarily evidence of misspecification but arises from a worsening of credit conditions due to an increase in interest rates.

Fung and Kasumovich (1998) argue that the price and liquidity puzzles appear to depend critically on the recursive-causal restrictions used to identify monetary policy shocks. Along the same lines, Krusec (2010) shows that imposing long-run restrictions in the cointegrated structural VAR framework can resolve the price puzzle which is present when the Cholesky identification scheme is applied. His argument is that this solution works when not more than three variables are included in the system.

Unlike the authors above who used the VAR model, Belaygorod and Dueker (2009) extend Lubik and Schorfheide's (2004) DSGE model under indeterminacy. Belaygorod and Dueker (2009) note that the price puzzle might be a genuine phenomenon under indeterminacy, rather than a false finding to be exorcised through specification search and parameter restrictions. Recently, Ravn et al. (2010) posit that a price puzzle and an "inflation persistent puzzle" arise first, when variations in aggregate demand affect the price elasticity of demand facing producers and when producers set prices with a view to attract more future demand. These two situations give rise to a countercyclical mark-up.

Another explanation for the price puzzle is provided by Barth and Ramey (2001) who refer to the cost channel of monetary policy as an alternative explanation of an increase in inflation after a monetary

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tightening. However CEE (2005) conclude that the importance of the cost channel in the US is only minor. Furthermore, Henzel et al. (2009), posit that the cost channel in the Euro area is incapable of producing a price puzzle in an unrestricted regression, but its presence helps to generate an initially concave response of inflation to a monetary contraction. A more recent US based study by Tas (2011) shows that the expectation dynamics induced by information asymmetry between the central bank and the public can cause the price puzzle.

Regarding liquidity puzzles, studies by Bernanke and Blinder (1992), Christiano and Eichenbaum (1992) and Strongin (1995) provide strong empirical support of its presence. Eichenbaum and Evans (1995) and Grilli and Roubini (1995) extend this line of research to an open economy setting and find that expansionary monetary policy shocks are followed by sharp declines in the US interest rates and sharp depreciations in the US nominal and real exchange rates. Andrés et al. (2002), using a general equilibrium model with adjustment costs, revisit the liquidity effect and conclude that when capital accumulation is allowed, a liquidity effect follows. This is because the fall in real interest rates allows households to postpone consumption and rather increase output via increase in investment. However, Bilan (2005) concludes that the result of a monetary expansion is ambiguous because it depends on the characteristics of the economy (e.g., the speed and responsiveness of expectations).

A more recent study by Biscarri et al. (2010) demonstrates that a positive money supply shock by the US Federal Reserve Bank decreases interest rates, whereas a contractionary money supply shock increases interest rate, thus generating a sensible negative liquidity effect in the money market. Further, they find that the variance decomposition confirms that interest rate and M2 are mostly driven by money supply and money demand shocks across all periods. Another study by Kelly et al. (2011) investigates the role measurement error plays in the liquidity puzzle. They suggest that the traditional approach to solving the liquidity effect by using a narrowly defined monetary aggregate such as non-borrowed reserves may not be the best. They find that the broadest monetary aggregate exhibits stronger liquidity effects than narrow measures.

To establish the existence of liquidity effect and price puzzle in Africa, this paper makes use of a dynamic stochastic general equilibrium (DSGE) model derived by Muhanji and Ojah (2011). The model shares some of the basic small, open-economy features of models by Adolfson et al. (2007), Smets and Wouters (2003), Kose (2002), Senhadji (1997), McCallum and Nelson (1999) and Fuhrer (2000); but it includes the evolution of foreign debt.

Our study differs from the other studies in several distinctive ways. First, to the best of our knowledge, there is no study that provides evidence of a price and liquidity puzzle after monetary policy shock for African countries used in this study. Second, we apply a DSGE model to African countries, most of which are characterised by both incomplete and inefficient markets. Studies that currently populate the literature find existence of both price and liquidity puzzles in the Euro area and the USA. Third, our monetary reaction function is an integration of the Taylor's (1993) rule and McCallum's (1994) rule. We assume that monetary authorities control money supply[1] as in McCallum, but allow money supply to be driven by inflation and output as in Taylor. Fourth, the Phillips curve allows for the coexistence of forward-looking and backward-looking price setters as in Gali and Gertler (1999). Fifth and importantly, the model includes foreign debt and is estimated using the maximum likelihood method by applying the state space and the Kalman filter.

We find that an expansionary money growth shock leads to a simultaneous increase in interest rates, which generates a liquidity puzzle. The increase in domestic interest rates leads to an appreciation of the domestic currency and a fall in inflation. This generates a price puzzle. The increase in domestic interest rates and the currency appreciation discourages investors from borrowing domestically. Instead, they borrow from foreign markets, thus accumulating foreign debt.[2] This exchange rate channel of monetary transmission mechanism is in line with Aktas et al. (2010) who posit that a tighter monetary policy that is associated with higher real interest rates would increase debt service burdens and could actually lead to capital outflows and eventually to a depreciation of the domestic currency. Aktas et al. (2010) conclude that the price puzzle can emerge as a structural characteristic of emerging market economies that implement tight monetary policies. We argue that in economies that are financially vulnerable due to high foreign debt, it may be prudent for monetary policy to focus on the sources of foreign debt accumulation, such as excessive current account deficits and hence output and exchange rate fluctuations.

We also determine if the data exhibits a price and/or liquidity puzzle by computing the relative volatility and comovement of interest rates and inflation with money supply. We find countercyclical relationship between inflation and money supply as well as interest rates and money supply. This is an indication of the price and liquidity puzzle in the data.

The remainder of this paper is organised as follows. Section 2 describes the structural model. Section 3 presents the calibration and estimation of the model. Section 4 provides the impulse response functions for an expansionary monetary policy shock and Section 5 concludes the paper.

2. Outline of the model

2.1. Household's behaviour

As in Muhanji and Ojah (2011), the representative economy is populated by identical households. Households maximize an intertemporal utility function given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t U_t, \tag{1}$$

where β is the discount factor. The utility function has three arguments – domestic goods consumption, import goods consumption and money balances – over an infinite life horizon. The instantaneous utility function is separable in the consumption of domestic goods, imports, real money balances and labour. The utility depends positively on the consumption of domestic goods, C_t, relative to an external habit variable, H_t. Similarly, utility depends positively on the consumption of imports, C_{mt}, relative to an external habit variable, H_{mt}. Consumption appears in the utility function relative to a time-varying external habit variable along the lines of Fuhrer (2000) and Smets and Wouters (2003). Utility relates negatively to labour supply, L_t and positively to real cash balances, M_t / P_t. The utility function is therefore as follows:

$$U_t = e^{\xi_{ct}} \frac{1}{1-\sigma}\left[\frac{C_t}{H_t}\right]^{1-\sigma} + e^{\xi_{cmt}} \frac{1}{1-\theta}\left[\frac{C_{mt}}{H_{mt}}\right]^{1-\theta} + e^{\xi_{m_t}} \frac{1}{1-\omega}\left[\frac{M_t}{P_t}\right]^{1-\omega} - e^{\xi_{l_t}} \frac{1}{1+\vartheta}[L_t]^{1+\vartheta}, \tag{2}$$

where σ is the inverse of the intertemporal elasticity of substitution, θ represents the inverse of the elasticity of imports, ω represents the inverse of the elasticity of money holdings with respect to the interest rate and ϑ is the inverse of the intertemporal elasticity of labour supply. Eq. (2) has four preference shocks: ξ_{ct} represents a general shock to preferences that affects domestic goods; ξ_{cmt} represents a preference shock to imports; ξ_{m_t} is a preference shock to money demand and ξ_{l_t} is a labour supply shock which follows $\xi_{l_t} = \rho_l \xi_{l_{t-1}} + \xi_{l^*}$.

[1] This assumption is in line with the actual practices of monetary authorities in most of the sampled countries.

[2] Impulse responses show that external debt increases after an expansionary monetary policy.