



Monetary shocks and demand in a dollarized small open economy:
The case of Ecuador

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Abstract

The financial crisis Ecuador suffered in 1999 triggered the official dollarization of its economy which turned this country into the largest economy with the dollar as legal tender. This research uses a recursive Vector Autoregression and Bayesian Vector Autoregression model to examine the transmission of monetary shocks to private demand in the context of a dollarized small open economy analyzing the case of Ecuador. The empirical assessment of monetary shocks suggests the existence of an important relation of external monetary policies represented by the reer over the monetary base, deposits and consumption. Also, deposits are crucial to boost consumption rather than credit indicating the preference of households to consume through internal disposable resources. Additionally, the existence of liquidity puzzles under the two methodologies supported the suggestion of a special relationship between the response of the monetary price markets to monetary aggregates innovations as an aim of the financial system to capture resources due to the dollarization scheme.

Key words: Monetary Transmission Mechanism, Monetary Shocks, Developing Economies, VAR Models, Dollarization, Ecuador.

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1 Introduction

Monetary policy has been considered one of the most effective tools for macroeconomic stabilization to control output and inflation. There is broad evidence that money has the power to affect real variables and welfare of population as well as to generate business cycles (Mishkin, 2004). However, in developing economies, rather than a stabilization instrument, monetary policy has become the main source of macroeconomic fluctuations worsening external shocks (Mishra and Montiel, 2013). The evaluation of timing and effects of monetary policies through its different mechanisms is crucial and has been a constant question to monetary authorities (Mishkin, 1995). This question has been addressed mainly in the context of industrialized economies where monetary and financial institutions are well developed. In contrast, the evidence of monetary shocks in developing economies and the effectiveness of monetary policy instruments to affect the economy is minor.

To approach the question above, the dominant literature to evaluate the effect of monetary policies towards the economy lies on the monetary transmission mechanism which is applied to observe how changes over monetary conditions impact real variables as output or employment (Ireland, 2005). The analysis of the monetary transmission mechanism consists mostly of the empirical assessment in the monetary base management of each country through the Central's Bank monetary policy. Monetary shocks impact the economy through several channels. The most important are summarized in the interest rate and lending channel which are able to influence investments and demand decisions mainly (Ireland, 2005). In the context of the monetary transmission mechanism it is important to remark that for small open economies the results should be contrasted as the determination of monetary variables depends on external conditions (Mojon and Peersman, 2001). Small open economies constitute a special case as their financial systems are less developed. This arises from their dependence on external resources, external capital flows and uncertainty (Laxton and Pesenti, 2003). In this sense, an important question that has been raised in the assessment of monetary shocks is how this effect varies across degree of openness and the size of the country (Laxton and Pesenti, 2003).

Ecuador represents a particular case for the analysis of monetary transmission due to its fully dollarized monetary regime. The process that concluded with the complete dollarization of the economy started in 1998 when natural disasters impacted the productive sector generating losses of 13% of the Gross Domestic Product (GDP). As a result, the financial industry was severely affected. Additionally, wrong government decisions such as capital circulation taxes led depositors to take out their money from the financial system. Reduced confidence in the financial system gradually contributed to a conversion of assets and liabilities into foreign currency, mainly the dollar, being held away from the financial system. By the end of 1999, the conditions were unsustainable and the Central Bank, in its aim to save banks made an important monetary emission of 145% in order to insert liquidity to the financial system. Under these chaotic conditions, the depreciation of the national currency reached 200% and inflation reached 61% reducing the domestic demand. This setting unleashed the official dollarization of the economy in the year 2000 as an attempt to reduce the sizable inflation and eliminate the exchange risk and speculative pressures which turned Ecuador into the largest dollarized country (Hidalgo, 2005; Bogetic, 2000). Under dollarization, the role of monetary policy taken by the Central Bank is lost and several risks are accepted. First, the monetary authorities have less flexibility to face internal and external shocks. Second, the domestic economy becomes more sensitive to external shocks such as variations of foreign interest rates, capital inflows or outflows. This can be reflected on the allocation of resources of the banking system (Bogetic, 2000, p. 189). Third, the Central Bank can no longer act as a lender of last resort to tackle systematic crisis. Additionally, the use of the dollar as legal tender implies that money

supply is determined in dollars and it is sustained by the balance of payments (Hidalgo, 2005). As a result, the new role of the Central Bank consists of the management of legal reserves and liquidity funds to recirculate liquidity. The dollarization has been positive with an economic growth rate around 5% on average. However, the structure of the Ecuadorian economy remains highly exposed to international conditions since its productive scheme concentrates on commodities (ECLAC, 2016). Thus, further analysis of the implications of dollarization is needed to identify the weakness and potentialities of this monetary scheme.

The majority of research on the monetary transmission mechanism has been focused on industrialized economies. Meanwhile, the analysis from emerging small open economies has been little studied. The implementation of the dollar as official currency has been widely discussed in several Latin American countries. Therefore, the case of Ecuador provides the opportunity to analyze the implications of monetary shocks in a completely dollarized economy. Identifying the implications, timing and size of monetary shocks towards real variables is essential for monetary authorities. Hence, this research aims to determine the nature of the transmission process of monetary shocks to private demand in Ecuador as it represents a dollarized small open economy where the private sector has been important during crisis. For this purpose, it is necessary to answer the following questions. First, what is the effect of monetary shocks throughout the traditional channels of the monetary transmission mechanism. Second, how long does it take to real variables to respond to monetary shocks. Third, what is the relative importance of each of the components of the monetary transmission channels.

In order to approach the questions above the empirical analysis requires the application of macroeconometric models. The use of a Vector Autoregression (VAR) and Bayesian VAR models is proposed on a recursive reduced form basis which captures the ordering specification in the results. The use of reduced form VAR models is widely applied in the empirical assessment of the monetary transmission mechanism. The majority of research on industrialized economies has obtained consistent results with theory showing a relative importance of the interest rate channel (Mojon and Peersman, 2001; Cecchetti, 1995; Shahnazarian and Bjellerup, 2015; Bordon and Weber, 2010; Jannsen et al., 2015); meanwhile, in developing economies the existence of liquidity and price puzzles has been a recurrent outcome (Mishra and Montiel, 2013; Monhanty and Turner, 2008; Kim and Roubini, 2000; Acosta-Ormaechea and Coble, 2011).

The thesis is divided into three chapters. First, the literature review containing the topics related to monetary economics, monetary transmission mechanism, small open economies and dollarized economies. Later, the research methodology is presented enclosing the setting and research design, the model proposed and the data used. Thereafter, the results of the econometric models are shown. Finally, the conclusions and main implications of monetary shocks are outlined in the context of the Ecuadorian economy.

2 Literature Review

Regarding the literature review, the main theories that will be approached in this research are in the field of monetary economics and policy. First, the monetary economics theory is approached briefly contrasting the views of the classical and keynesian schools of thought. Second, the monetary transmission mechanism which represents the main reference for the development of this research is explained with its theoretical basis and the empirical assessment taking into account its recent developments. Finally, the role of monetary policy in the context of small open economies and dollarized economies is examined.

2.1 Monetary Economics

Monetary economics consists of the study of money and its role on the economy. The importance of money is grounded in its use as a method of payment, store of value and unit of account. To monetarists, the value of money is compounded by the inverse of the general price level, while for keynesians it is defined by the interest rate. In the context of open economies, it is essential to consider the foreign exchange market as a mechanism of adjustment to monetary disequilibrium. Money is considered as a special asset in balance sheets being able to influence other markets. For instance, changes in the quantity of money can increase the acquisition of other securities and goods, while a raise on the stocks of other goods are likely to remain longer. As a result, variations in the supply of money can produce an immediate effect over economic activity compared to other assets (Lewis and Mizen, 2000, p.3-18).

There is evidence that money has the power to affect real variables generating the business cycle. It has been observed that before recessions growth of monetary base falls, affecting the majority of households with fewer employment prospects (Mishkin, 2004, p.10). Due to the fact that money affects economic variables and population welfare, monetary policy has become crucial. The role of the Central Bank in the formulation of monetary policy is decisive, as it has the capacity to determine the supply of money but not its demand. Therefore, the behavior of financial markets and the demand for goods can be determined by the supply of high powered money. Thus, the value of money is defined by its substitutes rather than a value of itself.

Research into long term relationships between monetary indicators and economic variables has been focused on the capacity of inflation to influence output growth. McCandles and Weber in 1995 show that over 30 years in more than 110 countries this relationship is strong with a correlation coefficient higher than 0.90 depending on the money definition used. According to Walsh (2010), these results are consistent with research that considers different countries and covers other time periods. In countries where money growth is determined exogenously, the relationship between these variables is stronger. Nevertheless, this high correlation does not imply the existence of a causal relationship.

Despite the perceived importance of money, monetarists have argued that in the long run, money does not play a major role over the economy as real magnitudes are independent from the nominal. For the short run scenario, they recognize the non-neutrality of money emerging from nominal rigidities corrected in the long run to the "natural rates". In contrast, Keynes' theory of liquidity argued that interest rates are determined by the monetary system as money stock variations could affect its unit of account. Also, strong hold of wealth in money can lead to coordination failures, resulting in differentials between the demand and supply for goods and services. Consequently, neither money nor monetary policy is non-neutral defining the main differences between monetarists and keynesians (Lewis and Mizen, 2000). Below, the classical theory of money and the Keynes general theory of interest and money will be introduced to underline the role of money in the main schools of thought.

2.1.1 Classical theory of money

The classical approach is central in monetary theory and it is essential to understand how money overlaps the economy to explain the transmission of monetary policy through its direct and indirect channels (Lewis and Mizen, 2000, p.51-52). First, it is necessary to point out that classical models are built over the Walrasian system of general equilibrium. This system brings together demand and supply allowing relative prices to clear markets. The Barter model only considers goods,

however, we will go directly to the model with money as unit of account, mean of exchange and store of value. If we consider a Walras Law and introduce money as the n_{th} good, we obtain the following expression.

$$\sum_{i=1}^{n-1} p_i D_i + p_n D_n = p_n S_n + \sum_{i=1}^{n-1} p_i S_i \quad (1)$$

Where S_n and D_n are the supply and demand for money and p_n its relative price. The sum of the other supply and demand corresponds to the rest of goods that are not money. If we rearrange equation (1) it is possible to observe that the excess demand for money $p_n(D_n - S_n)$ it is equivalent to the excess of supply goods on the real side. Therefore, if the monetary side is in disequilibrium, the real sector will be as well. This implies that Say's law does not apply to monetary economies. As a result, for some suppliers the demand for their products may be insufficient while for others there is more demand than supply available. This is the result from a non equalized supply and demand for money. This has been observed by classical economists who have observed that hoarding of money causes oversupply of certain goods.

Nevertheless, Say's equality allows the possibility of achieving equilibrium in a temporary frame. The equilibrium conditions under a monetary economy are simultaneous for the value of money demanded to cover the purchases of goods and the supply of money is enough to cover the demand for goods. These conditions are crucial in allowing the possibility to reach balance in the demand and supply for goods and money. In addition, it is necessary to consider that the Walras general equilibrium is compounded by n -excess demand equations that represent the relative function of prices (Lewis and Mizen, 2000, p.52-59).

2.1.2 General Theory of interest and money

With a reflexive position to classical postulates, John Maynard (Keynes, 1973, p.88) criticizes the conception of the interest rate as an adjustment factor between the demand and supply of investable resources equalizing savings and investment. The critical position of Keynes was rooted in the existence of output demand constrained and the misinterpretation between accounting identities and causal relationships. For instance, spending must be equal to income, the supply creates its own demand and savings are invested instantaneously. Hence, the classical interest rates theory is stand alone without considering either income or liquidity preferences (Krugman, 2011).

The contribution of Keynes' work is grounded on the psychology behind private demand for the use of money and individuals' expectations of the future to conserve money as a liquid asset. This is known as the liquidity preference theory. Thus, individuals' preference between liquid and less liquid assets is determined by the interest rate rather than intertemporal consumption (Lewis and Mizen, 2000, p.100). This placed several restrictions over the effectiveness of the direct and indirect classical mechanism of transmission complementing theories where money is not neutral. He had not doubt of the importance of money due to three characteristics : (i) low carriage costs and high liquidity, (ii) zero elasticity of production and (iii) negligible elasticity of substitution. Here it is important to remark that money, unlike other assets, has no a single definite immediate response to economic forces and in order to clear its market the adjustment is faced in other goods ¹. A rising question to Keynes' theory consists in the motivation for agents to hold money. Three main aspects that influence the decision of holding money are identified: (i) transactions necessities; (ii) precautionary decisions to assure a proportion of total resources in cash; finally (iii) the speculative motive to increase profit in the future (Lewis and Mizen, 2000, p.100-105).

¹An excessive supply or demand of money can be transmitted to other markets.

The liquidity preference theory sets the interest rate as the rate of return that balances the capital market (Lewis and Mizen, 2000, p.112). To Keynes, the interest rate represents the price that brings to equilibrium the desire to hold wealth in cash from the uncertainty created by interest rates. Expectations play a major role on the keynesian liquidity preference theory being able to determine the interest rate even when the money supply remains unchanged. Consequently, the duration and level of acceptance of the interest rate will depend on the degree of confidence. Therefore, for Keynes policy will entail two dimensions which are the management of money and expectations (Tily, 2006, 661-662).

2.2 Monetary Transmission Mechanism

The trend towards stabilizing output through monetary rather than fiscal policy due to budget deficit concerns has increased. In this context the main role of the Central Bank has been focused on the promotion of long-run price stability through interest rates. In order to assess the effects of money on the economy and estimate the timing and impact of monetary policy, the *monetary transmission mechanism* framework was developed by Mishkin (1996).

The construction of the monetary transmission mechanism begins with the IS-LM frame characterized by equation (2) which explains the traditional interest rate channel. The first term ($M \uparrow$) shows an expansionary monetary policy that leads to a reduction of the real interest rate ($i \downarrow$) shortening the cost of capital and rising investment ($I \uparrow$). By doing so, aggregate demand and output increase ($Y \uparrow$). An important aspect of this mechanism is the use of the real interest rate due to its capacity to influence consumer and business decisions. Moreover, it is typically perceived that the real long-run interest rate rather than the short-run may cause a major impact over spending preferences.

$$M \uparrow \Rightarrow i_r \downarrow \Rightarrow I \uparrow \Rightarrow Y \uparrow \quad (2)$$

It is important to understand how changes in the short-term nominal interest rate driven by monetary policy can affect the real interest rate in the short and long run. In basic terms, this is caused by sticky prices where expansionary policy makes the nominal short-term interest rate fall, lowering the real rate as well. Therefore, lower interest rates lead to an increase in business investments, consumer durable expenditure and inventory investment that all together increase aggregate output. Under this framework, this effect can be reached even with nominal interest rates around zero through the channel in equation (3) where expected inflation (π^e) lowers the interest rate. However, many researchers have found evidence that the interest rate channel cannot capture the effect of monetary policy as its effect it is not representative. Therefore, the consideration of the credit channel under this scenario is more accurate (Mishkin, 1996, p.3-4).

$$M \uparrow \Rightarrow P^e \uparrow \Rightarrow \pi^e \uparrow \Rightarrow i_r \downarrow \Rightarrow I \uparrow \Rightarrow Y \uparrow \quad (3)$$

Monetarist critics have put forward alternative mechanisms², in response to the main criticism that the IS-LM frame focuses only on one asset price (interest rate). These alternative conceptions of the monetary mechanism consist of both relative asset prices and wealth. However, we continue to the exchange rate channel as it contains the power to provide additional effects from equilibrium requirements on the foreign exchange market. This implies that domestic currency depreciates up to a level that equalizes the risk adjustment return on different debt instruments denominated in

²Additional mechanisms, such as the equity prices, related to Tobin's q theory of investment and wealth effects are explained by Mishkin (1996).

two currencies (Ireland, 2005). This channel involves the impact of monetary policy on net exports (NX) and interest rate through the depreciation rate (E) expressed in equation (4) proposed by Mishkin (1996). Here, spending and investing decisions will decrease if interest rates are higher resulting in a higher value of the domestic currency which reduces foreign demand and total output (George et al., 1999).

$$M \uparrow \Rightarrow i_r \downarrow \Rightarrow E \downarrow \Rightarrow NX \uparrow \Rightarrow Y \uparrow \quad (4)$$

Finally, we consider the credit channel divided into the bank lending and balance sheet. Concerning to the bank lending channel, an expansionary monetary policy increases bank reserves and deposits, augmenting the amount of resources available to allocate loans as expressed in equation (5). Here the importance of the credit channel lies in the possibility of having greater impact over small firms that are dependent on external resources.

$$M \uparrow \Rightarrow \text{deposits} \uparrow \Rightarrow \text{loans} \uparrow \Rightarrow I \uparrow \Rightarrow Y \uparrow \quad (5)$$

Meanwhile, expansionary policy on the balance sheet channel increases equity prices (P_e). This situation leads to higher investment and aggregate demand (Y) due to a reduction in moral hazard and adverse selection. Simultaneously, this policy has the power to lower nominal rates improving firms' balance sheets by raising cash flows reducing adverse selection. This mechanism is drawn in equation (6). It is important to remark that this mechanism considers the effect produced by nominal rate rather than the real as above.

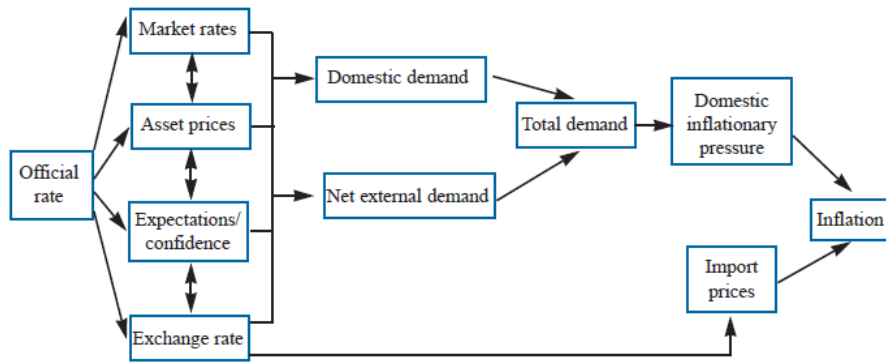
$$M \uparrow \Rightarrow i \downarrow \Rightarrow \text{cash} - \text{flow} \uparrow \Rightarrow \text{Adverse} - \text{selection} \downarrow \Rightarrow \text{lending} \uparrow \Rightarrow I \uparrow \Rightarrow Y \uparrow \quad (6)$$

Lastly, financial crises represent an extreme form of the credit channel generating asymmetric information that leads to an inefficient allocation of resources on productive investments. As a result, there is a reduction of the economic activity. According to Mishkin (1996, p.16) contractionary monetary policy can have the power to initiate a financial crisis. This is produced by the following process: (1) increase in interest rates; (2) fall in stock markets; (3) unanticipated decline in the price level; (4) augmentation of uncertainty; and (6) bank panics. Within all this process, the result is a deterioration in firms' balance sheets that reduces bank loans. As depositors are not in a position to differentiate between safe and risky banks, they rush to withdraw their money. This triggers a multiple contraction from depositors in their aim to protect their money and banks seeking to increase their reserves as a protection from depositors. The mechanism of transmission expressed by this channel is similar to that faced in Ecuador during 1999 which ended in the dollarization of the economy.

According to Mishkin (1996, p.18), it is important to be aware that the effects of the empirical analysis of traditional interest rate are minimal. Hence, the analysis with alternative variables can provide a more accurate identification. More precisely, the credit channel is considered the most important as there is sufficient cross sectional evidence that demonstrates the effect of credit market imperfections on spending decisions. Under this framework, the analysis is going to be conducted to the specific characteristics of the Ecuadorian economy as it constitutes a particular case where the transmission of monetary shocks is not well known. In practical terms, as Ireland (2005) describes, the transmission starts with changes to the monetary base (either reserves or currency). Traditionally, this process is undertaken by the Central Bank where a perfect substitute to the components of the monetary base cannot be found. However, this brings two implications to our research as in this case the amount of monetary base is not endogenously determined, it is expected that the transmission channels may present a different behavior.

The monetary transmission can be summarized by the flow chart in figure (1) developed by George et al. (1999). It can be observed that monetary policy affects aggregate demand and economic activity in different ways from a short term perspective. Meanwhile, in the long run this effect is observed principally in the price level. Under this scheme, monetary policy is produced by the official interest rate. Thus, the final impact over real variables depends on the anticipation and expectations before the policy. For simplicity, it is assumed that changes in the official interest rate cannot be reversed rapidly. The use of real interest rates is appropriate to agents that are not constrained on resources as they take into account the real rate over investing and saving decisions. However, for individuals with limited resources the nominal rate matters as it affects the current cash flow.

Figure 1: Monetary Transmission Mechanism



Source: George et al. (1999)

In order to observe the effect of monetary shocks to the private demand, it is necessary to analyze the transmission of monetary policy from financial markets to spending in figure (1) which implies the following reactions. First, new interest rates impact savings and debts altering disposable income. As a result, people will prefer to save money rather than consume. Also, the financial wealth of individuals varies as a response to changes in assets price. Changes produced through monetary shocks influence individuals' and firms' behavior. These are expected to generate movements in the aggregate level of spending compounded by the sum of private consumption, government spending and investment. In addition, if there is no affectation, households anticipation may impact confidence and expectations. As a result, monetary policy is intended to create direct costs for aggregate spending (George et al., 1999). Here we will focus on the private consumption as in the Ecuadorian case the loss of confidence of this sector led to the gradual dollarization of the economy.

The response to monetary policies may vary across countries, being faster in industrial economies. This may be determinated by several factors such as agents' confidence towards monetary policy, phase of the business cycle, world economy events and inflation expectations. These factors cannot be controlled by monetary authorities implying slow adjustments and uncertainty in the duration. As reported by George et al. (1999), the quantitative analysis and lags response to monetary policy in the Bank of England consists of the utilization of a macroeconometric model compounded by 20 endogenous variables and 30 exogenous. This model is developed on a long term basis with parameter restrictions to maintain theoretic consistency (Quinn, 2000).

So far, within the Bank of England (George et al., 1999) framework, the transmission mechanism considers the role of monetary policy through the establishment of interest rates rather than quantity of money. However, the traditional transmission mechanism (Mishkin, 1996; Lewis and

Mizen, 2000) depends in the effect of money supply towards interest rates, spending and price level. Under inflation targeting, money supply constitutes an instrument rather than a source to affect the real sector. Therefore, in some economies the use of monetary aggregates may be more accurate to understand the dynamics of saving and spending behavior. For instance, a change in money supply may reduce official interest rates. Later, commercial banks are able to diminish their rates and raise loans. These new loans will create more deposits³ in banks, expanding the broad money supply (M4). These dynamics may be only observed with monetary aggregates where there is evidence of aggregate fluctuations (Sims, 1992). However, in industrialized countries the relation between monetary aggregates and nominal GDP is not clear due to the complexity of their financial systems and inflation targeting (George et al., 1999).

The use of econometric tools contributed to observing the responses of economic variables to monetary aggregates movements. Sims (1992) determines that monetary aggregates are Granger causal to nominal income with the use of large multivariate models that included interest rates (nominal) capturing the variation of money stock. There is broad evidence across countries, time units and definition of variables that monetary policy (money stock or interest rates) may affect economy aggregates. Sims (1992) uses a Vector Autoregressive (VAR) model from his earlier frame (Sims, 1980) to estimate the response of the economy towards monetary innovations. The estimations were obtained from U.K, USA, Germany, France and Japan including: short-term interest rate, M1, Consumer Price Index (CPI), industrial production index, foreign exchange value and a commodity price index. The estimated orthogonalized impulse responses innovations showed a consistent dynamic with the IS-LM frame excluding the U.K. and Germany.

Afterwards, there have been several applications of VAR models to evaluate monetary transmission across different countries and policy objectives. A special application for this research may be the case of financial stability, as in the Ecuadorian context the financial system played a major role in monetary disequilibrium. Shahnazarian and Bjellerup (2015) use the traditional mechanism of monetary transmission to asses the linkage between the financial and real sector. They analyze the effect of the negative externalities caused by collective action over liquidity, demand and supply for credit through the stylized credit cycle. Depending on the channel the effect is delivered either by banks and/or borrowers as presented in figure (2).

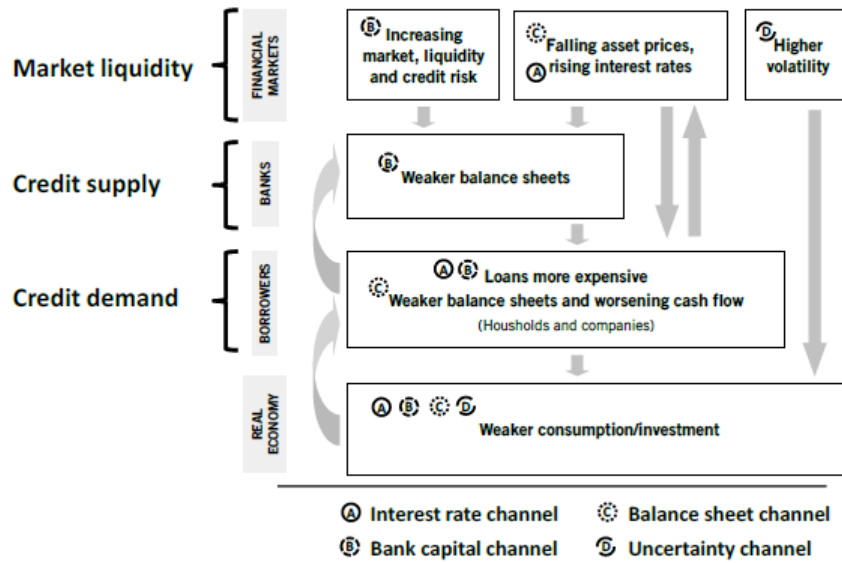
Shahnazarian and Bjellerup (2015), for the Swedish economy use the interest rate, CPI, GDP and financial indexes for each channel. Additionally, they use the foreign GDP and currency exchange rate as Sweden is a small open economy. The VAR models were restricted to be aligned with the mechanism functioning. However, alternative estimations as the Bayesian VAR (BVAR) were suggested to not impose restrictions (Shahnazarian and Bjellerup, 2015, p. 43). The Impulse Response Function (IRF) analysis showed consistent results with theory. Also, the GDP variance decomposition showed that financial indicators were crucial, accounting an important share of variance. With the development of impact simulations, financial stability policies were relevant to affect public finances and aggregate economy through lending rates and GDP. Similarly, Habermeier et al. (2015) find evidence that cyclical and structural macroeconomic stabilization may reduce the impact of financial crises. However, these results can be adjusted to country specific characteristics. For instance, structural conditions such as: likelihood of severe crises, large financial spillovers and identification of financial risks. The empirical approach compounded constant parameter, Markov switching (MSVAR) and threshold VAR models.

To Taylor (1995), the empirical assessment of the monetary transmission mechanism must measure financial market prices⁴ rather than quantities, as in advanced economies the interest

³We referred to this mechanism before as the credit channel.

⁴This is explained by the financial accelerator (Cecchetti, 1995) where small changes in the interest rates may

Figure 2: Monetary Transmission of credit cycle negative external effects



Source: Shahnazarian and Bjellerup (2015)

channel is the most representative (Bordon and Weber, 2010, p.5). Thus, monetary analysis must focus on exchange rates (bilateral), short and long term interest rates. Nevertheless, there is increasing criticism of the use of financial market prices, as their elasticities may not be significant. Generalized frameworks recognize the effect of monetary policies undertaken by monetary base movements translated to investment and output (Cecchetti, 1995). Chung et al. (2014) find evidence that global liquidity affects economic growth. Similarly, generalized crises play a major role in global liquidity affecting the composition of monetary aggregates in middle income countries.

The use of aggregate data to assess monetary transmission can be divided into three groups: forecast through monetary aggregates, the response timing to policy shocks and the behavior of interest rates. Specifically, in small open economies money growth is highly correlated with output variations with a lag response which depends in the variations of exchange rates. However, monetary aggregates may respond endogenously to real variables shocks and movements in money demand (Cecchetti, 1995, p. 12-17). Thus, Cecchetti (1995) applied a VAR to the U.S. economy with the federal fund rate as policy instrument added to CPI, unemployment, deposits, securities and loans. Similarly, Mojon and Peersman (2001) conduct a recursive VAR on 10 countries of the Europe Union prior its conformation. By dividing into three monetary regimes the results showed that after contractionary policy (positive deviation of interest rate) less output is produced. Exogenous variables such as Commodity Price Index, U.S. real GDP and interest rate to control external demand were considered. The endogenous variables included real GDP, CPI, short term nominal interest rate and real effective exchange rate (REER). Additionally, for small open economies regimes attached to the German economy (The Netherlands, Austria and Belgium), additional variables such as German GDP, CPI, reer and short term interest rate were included as endogenous. The policy shock is observed in the German interest rate innovation. Results were consistent with research including GDP, CPI and nominal interest rate for the G7 countries with a Structural VAR (SVAR) model with short and long run restrictions to aggregate demand and supply shocks (Gerlach and Smets, 1995).

have great impacts over investment likely to be present in the credit channel

In the same way, Bordon and Weber (2010) compare two monetary schemes (high and low dollarization) in a pre and post crisis context in Armenia. Two empirical frameworks were applied the traditional VAR and MSVAR. The latter is applied to model structural regime switches in order to identify the timing of policy shifts. This is used to study the effect of monetary policy across different regimes⁵. According to Bordon and Weber (2010), this frame can be applied to a vast number of emerging economies. The results presented that during dollarization monetary policy was less effective and worked mainly through the exchange rate channel. Bordon and Weber (2010) use the following endogenous in a recursive specification: real GDP, CPI, repo rate (Central Bank rate), M1 and nominal effective exchange rate. Exogenous variables as U.S. federal funds rate and oil prices to capture the effect of remittances were considered. These variables may be highly important for Ecuador as well as it is an oil producer country. The results showed that monetary policy effectiveness may vary across regimes.

Ozcelebi (2013) uses a recursive VAR and BVAR to identify the factors affecting firm performance with the monetary transmission mechanism setting. The identification considered a reaction of the monetary authority towards the state of the economy in the following order: real GDP, CPI inflation, inter-bank interest rate (monetary instrument), volume of credits and the revenue index of manufactures. The results showed that GDP boosts industrial activity in a similar way to the interest rate channel in the monetary transmission mechanism frame. Meanwhile, the effect of inflation was not relevant due to negative macroeconomic expectations. Similarly, Agha et al. (2005) develop for Pakistan four models to observe the transmission of industrial production towards treasury bills rate accounting the effect through each monetary transmission channel⁶. The results were consistent with the monetary transmission literature; however, the effects vanish after a short time period. The results were even more clear and direct under the bank lending channel where a decrease in the domestic demand was observed.

Turning to empirical evidence in Latin America, Sidaoui and Ramos-Francia (2008) assess the monetary policy in Mexico after the 1995 crisis when the inflation target had settled. They used a MSVAR to identify the structural breaks suffered. The endogenous variables of the model were reer, GDP, inflation core, inflation expectations and interest rate. Meanwhile, the exogenous variables to control the external conditions were the federal funds rate, U.S. growth and commodity prices. The results presented the increasing role of the interest rate channel due to strengthened financial conditions allowing monetary policy to be more effective in tackling inflation. On the other hand, the reer decreased its explanatory power. In addition, a standard VAR over these two periods with the following recursive structure was conducted: output, CPI, short term interest rate, M1, credit, securities and depreciation of nominal exchange rate. The results showed that after the crisis the response of economic activity to credit shocks is considerably higher than prior to the crisis. Similarly, the variance decomposition analysis presented the same behavior as the MSVAR. Likewise, Vargas (2007) analyzes the monetary transmission in Colombia. His findings show that after the crisis, responses to inflation during periods of stability are more sensitive. As a result, the interest rate channel has lost its relevance and the response to monetary shocks may be better explained by the credit channel and the macro state of the economy.

In Ecuador there is little research on monetary transmission. Lafuente (1996) develops a recursive VAR to assess the transmission mechanism between 1990-1995 computing Granger causality tests and variance decomposition. The identification consisted of the use of monetary emission, monetary base, M1, M2, credit, deposits, interest rates, CPI and economic activity. However, economic variables to capture the effects on small economies were not considered. In addition, the increasing

⁵The structural break was identified as the begin of the inflation targeting and dedollarization

⁶For instance, the specification for the interest rate channel was the following: Industrial production, prices, credit and interest rates

dollarization of the economy was not taken into account. However, important conclusions were obtained such as a negligible effect of interest rates to economic activity due to the ambiguous effect on moneylenders, meanwhile monetary aggregates and deposits are highly important to explain economic activity.

2.2.1 New developments

The scope of the analysis of monetary transmission has been growing. For instance, Jannsen et al. (2015), assess the role of monetary policy during financial crises applying a Panel BVAR for 20 economies. The model is organized to capture the effect towards GDP and CPI with the short term interest rate as policy instrument. The endogenous variables consisted of private credit, house prices, consumer confidence, stock prices and financial crises indicators. The results suggest that monetary policy impact over output and CPI inflation during financial crises is higher. Nevertheless, through the recovery period monetary policy instruments lose their effectiveness. These findings confirm the capacity of monetary policy to counterbalance the negative effects of financial crises. Romer and Romer (1990) evaluate the transmission mechanism under imperfections in the credit market with the policy instrument operating through the lending channel. They conclude that monetary policy is effective to operate through this channel due to deregulation of interest rates and banks' ability to accede to alternative sources of funding besides deposits. However, they considered that this channel may not be relevant in different institutional settings.

Mishkin (2007) update the mechanism of monetary transmission considering the relevance of housing market in economic activity and credit markets. The findings show that market housing and mortgages especially are crucial in the monetary transmission mechanism operating through consumers' transitory income. Therefore, variations in mortgages rates may reduce aggregate demand by a reduction of income implying augmented effects compared to the standard monetary transmission frame. In the same way, Boivin et al. (2010) develop a Dynamic Stochastic General Equilibrium model compared with empirical results from a Factor Augmented VAR on the evolution of the monetary mechanism. Their findings suggest that neoclassical channels such as interest rates have had little variation across the time. Also, they recognize the importance of regulation towards monetary policy transmission where real estate investment is linked to interest rates rather than credit availability. Finally, they argue that a trend towards inflation stabilization is being faced by a majority of countries affecting the variations of inflation and the subsequent output response.

Boivin and Giannoni (2009) for their part analyze monetary policy in the context of globalization and its influence over macroeconomic conditions in the U.S. and the effectiveness of monetary policy. An empirical framework with a FAVAR model including international indicators for the fifteen major U.S. trade partners was applied. The results obtained were not strong enough to conclude that globalization is gaining importance on its influence towards the U.S. economy except for long term interest rates and import/export prices. Regarding the mechanism of monetary transmission, the external forces do not seem to play an important role in monetary policy during 1980-2005. However, there is a reduction in the duration of the responses of monetary shocks due to global forces that may have recently increased.

2.3 Small open economies

In developing countries, fiscal policy interventions are considered pro-cyclical and aggravate negative shocks. As a result, an increasing trend to stabilization policies by independent central banks is appearing. However, in these economies association between monetary policy and real aggregates tends to be lower⁷. Thus, due to the structure of the financial system in these countries the lending channel is key to understanding the transmission mechanism. In low income countries there are several factors that may produce divergences to the analysis on high income such as underdeveloped financial markets for real estate, equities and securities, flawed connections with international markets and constant interventions of central banks to affect the exchange rate (Mishra and Montiel, 2013, p. 3-4).

For low income countries, monetary transmission does not only depend on the domestic policy as internal variations of monetary variables may be driven by external conditions. As a result, the VAR model may be integrated by a combination of exogenous policy and the internal response to contemporaneous innovations in other variables (Mishra and Montiel, 2013, p.6). Therefore, the aim of research would focus on obtaining the response towards exogenous monetary policy innovations which may incur in an "atheoretic" identification strategy⁸. Therefore, to construct the lending channel it is necessary to consider the stock of bank credit and the lending rate as endogenous. Later, the verification of statistical significance of the policy shock, for instance, a monetary contraction will lead to decrease in bank credit. Thereafter, the impact of this variation over output or prices will show the strength of the channel. In Latin American countries, the importance of transmission mechanisms may vary between money growth, nominal and real interest rate, expectations and credit channel (Monhanty and Turner, 2008, p.17). In emerging markets the credit channel is crucial due to the possibility of monetary authorities to control access to credit markets reflected in the supply of loans.

In Latin America results are diverse added to little research of specific country context where the amount of structural identification research is even lower. An structural approach for Trinidad and Tobago between 1970 and 1994 considered six variables: Government spending, deposits, loans, nominal GDP, price level and required reserves (instrument). The results suggests that a contractionary policy reduced the amount of credit and produced slower growth and inflation (Mishra and Montiel, 2013). Similarly, Monhanty and Turner (2008) undertake an empirical approach for emerging economies under the VAR methodology using Industrial output, CPI, reer and nominal interest rate obtaining similar results.

Kim and Roubini (2000) use a SVAR to identify the role of structural innovations of monetary shocks applied to small economies with a non-recursive approach. The identification consisted of short term interest rate (policy variable), a monetary aggregate, CPI, industrial production, oil prices, federal funds rate and the foreign exchange rate to U.S. dollars. Oil prices and federal fund rates are considered to isolate exogenous monetary policy shifts. For instance, negative oil supply variations have inflationary pressures while domestic policy can react to the federal rate. The identification and variables were able to avoid the existence of liquidity and price puzzles which is a recurrent outcome in the estimation of monetary transmission when analyzing non-industrialized economies. Similarly, Parrado (2001) uses a non recursive SVAR with GDP, CPI, domestic rate,

⁷The analysis of monetary policy shocks in advanced or emerging economies consists on the estimation of impulse response functions within the VAR methodology (Mishra and Montiel, 2013)

⁸In VAR models, the Cholesky decomposition among the reduced form innovations is recursive. This implies that the order of constructing the VAR model will reflect the process of the mechanism of transmission. However, several research consider the monetary policy instrument at the end of the identification arguing that is a response of policy makers to innovations in real sector

monetary aggregates and reer. Additionally, oil prices, U.S. federal fund rates and the country risk premium are included in the model as exogenous. The objective is to control the effects of foreign monetary policy or a sudden stop of capital inflows associated to risk premium and foreign rates.

2.4 Dollarized economies

Around the world more than 60 economies have formed a monetary union or adopted a large country currency. In the year 2000, Ecuador adopted a full dollarization scheme after a considerable depreciation of the Sucre resulting from speculative pressures, bringing eight banks to insolvency and closing (Alesina and Barro, 2001; Bogetic, 2000). Later, the money of depositors of the entire financial system was frozen unleashing a severe financial crisis that raised general distrust in the Sucre and being replaced gradually by U.S. dollars. Finally, by January, 9th 2000 the official dollarization of the economy was announced, turning Ecuador in the largest country with the dollar as legal tender.

Dollarization implied the loss of a monetary policy instrument and a complete monetary union adopting a foreign currency. Thus, monetary supply is determined in dollars and it is sustained by the balance of payments (Hidalgo, 2005). The new role of the Central Bank consists in the management of legal reserves and liquidity funds to recirculate the excess of liquidity between financial institutions. In contrast, under flexible exchange regime monetary policy works through two channels: (i) controlling money supply through interest rates and liquidity; (ii) monetary policy affects prices and aggregate demand by altering exchange rates (Quispe, 2000). Thus, the majority of research attempts to observe the effect of certain monetary policy stance. However for the Ecuadorian case this is not possible as money supply is determined by exogenous forces such as U.S. monetary policy, commodity prices, capital flows among other components of the balance of payments. The conditions of full dollarization such as in Ecuador have not been studied deeply in the mechanism transmission literature. Doing this may help to evaluate the benefits and costs of dollarization.

There may be positive and negative factors behind the conformation of dollarization. Traditionally, the elements of support are: reduction of transaction costs and establishment of an independent monetary authority. To Calvo (2002) the size of a country plays a major role in the adoption of dollarization process due to imperfect information of the financial institutions and macroeconomic environment. Alesina and Barro (2001) summarizes the benefits of dollarization as increased trade among countries and reduction of inflationary bias from discretionary policies. For developing countries, the uncertainty raised by fixed exchange regimes is eliminated by the adoption of a foreign currency which may counterbalance weak internal conditions committed to price stability. Thus, absence of currency risk may lower domestic interest rates and prices converging to the anchor country. Also, it may reduce pressure on the financial system to hold reserves divided on domestic and foreign currency as an insurance. This concern will dissipate with larger liquidity and better allocation of resources (Goldfajn and Olivares, 2001; Bogetic, 2000).

On the cost side, we can remark the loss of a monetary policy that may ease the adjustment to shocks. This cost may be higher if the correlation between the business cycle with the anchor country is low. This is derived from different preferences and policies towards price stability. In addition, the adopting country will lose the ability to print money which closes the door of lender of last resort⁹ (Alesina and Barro, 2001, p. 383). However, to Calvo (2006), monetary policy in emerging markets adopting a lender of last resort role increase the reer by the constant provision

⁹Calvo (2002) argues that alternatives under the dollarization scheme to the lender of last resort can be made as the creation of stabilization funds or contingent credit lines

of liquidity. This may cause precautionary behavior of private agents based on deposit withdraws with more volatile interest rates negatively impacting credit. Under dollarization, changes in external conditions such as interest rates, capital inflows or outflows are reflected in the allocation of resources of the banking system (Bogetic, 2000, p. 189). In the case of full dollarization in Panama, shocks are in essence non-monetary, but banks have played a major role in the adjustment process by counter cyclical credit allocation.

Alesina and Barro (2001) assess monetary integration of several Latin American countries, where they find evidence that for the Ecuadorian case the U.S. represents the best anchor. In the same way, (Calvo, 2002, p.4-5) states that the variance of U.S. variables such as interest rates or business cycle may account for a 50% of variation in the international reserves and reer in Latin American countries. This implies that the performance of domestic policy loses its power and the contagion risk imported from the anchor country increases. Goldfajn and Olivares (2001) identify that dollarization increases GDP volatility as fiscal policy is not completely counter cyclical and countries run the risk of being attached to monetary policy driven in the anchor country.

Goldfajn and Olivares (2001) analyze dollarization in Panama considering the effect of external shocks (Latin American Market Bond Index) towards, GDP, interest rates and reer and compare it with Costa Rica and Argentina. The main conclusions were that dollarization does not imply fiscal discipline and that the elimination of risk currency is not followed by lower spreads. Also, the degree of dollarization is not reflected in less output volatility; indeed it may increase it. However, a full dollarization may reduce inflationary pressures and interest rates. The case of Panama may not be generalized as it is not clear whether it is a result either of dollarization or financial globalization. Quispe (2000) analyzes Peru, one of the countries with the largest amount of its economy dollarized (60% broad money) resulting from elevated inflation that led to the dollarization of households' assets. This weakened monetary policy as the demand for domestic currency¹⁰ is highly volatile from devaluation expectations. Similarly, Acosta-Ormaechea and Coble (2011) analyze the mechanism transmission for Chile, Peru, New Zealand and Uruguay with different levels of dollarization and inflation target. The empirical analysis consisted of the use of a VAR model to observe the sequence of the effect of monetary policy towards output and inflation. The results indicate that for Peru and Uruguay the interest rate channel is weak, while the exchange rate channel may be more important in explaining inflationary pressures.

3 Research Methodology

In order to evaluate the transmission of monetary shocks to the private demand, in dollarized small open economies, the methodological framework presented hereafter comprises the following topics: research setting, research questions, econometric models, data and the research design proposed.

3.1 Setting

The particular context of Ecuador is considered in this research as it entails the conditions of an small open economy with exogenous monetary policy emerging from its fully dollarized monetary scheme. As previously mentioned, existing analysis of the monetary transmission in developing economies and especially in the Latin American region is limited. Thus, the necessity to measure the effects and duration of monetary shocks taking the case of Ecuador as a reference is essential

¹⁰Monetary base or cash holding accounts an important variance of inflation rather than less liquid monetary aggregates (Quispe, 2000)

to provide us the opportunity to assess the implications of formal dollarization. This is important as this has been a recurrent topic discussed in the region by many countries considering the possibility of using the dollar as legal tender. Finally, the research process could be able to show us the significance of monetary transmission and the impact of monetary shocks on the welfare and stability of the domestic economy.

3.2 Research Design

In order to quantify the effect of monetary shocks towards private demand, the research questions projected to this purpose are presented in the context of a quantitative research. A correlational research method is proposed through the utilization of econometric models as it allow us to quantify the relations between the variables. At first, an application of a time series Vector Autoregression (VAR) model is besought. Second, the estimation of the Granger causality tests is conducted. Then, the Impulse Response Functions (IRF) are obtained. Following, the forecast error variance decomposition analysis is computed. Finally, the BVAR model is presented to contrast the results from the standard VAR. Specifically, this research wants to address the following general and specific questions to evaluate the transmission of monetary shocks towards private demand in a dollarized small open economy.

G: What is the nature of transmission of monetary shocks to private demand in Ecuador in the period 1994-2015?

- What is the effect of monetary shocks towards private demand through the traditional monetary transmission components in Ecuador?
- How long does it take for each of the variables of the channel to operate from monetary shocks to the real economy?
- What is the relative importance of each element of the monetary transmission mechanism in a dollarized economy?

3.3 Model

As we observed in the literature review VAR models allow us to address the research questions proposed. First, we will begin with the standard application of the VAR models with a recursive Cholesky decomposition specification. The monetary instrument is placed first as the more exogenous variable and captures its contemporaneous effect towards the most endogenous variable of the system that is the private demand. The VAR model is one of the most useful models to analyze multivariate time series and is an extension of the univariate autoregressive model. Also, it is useful to approach structural inference and policy analysis by Granger causality tests, impulse response functions and the error variance decomposition (Zivot and Wang, 2006, p. 383). According to Hamilton(1994, p. 257), the VAR representation denoted in equation (7) is a generalization of a VAR(p) model with pth -order aimed to capture the interactions between a vector y_t with $(n \times 1)$ dimension equal to $Y_t = (y_{1t}, y_{2t}, \dots, y_{nt})'$.

$$Y_t = c + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \dots + \Phi_p Y_{t-p} + \varepsilon_t \quad (7)$$

Where, c represents a $(n \times 1)$ vector of constants; and Φ a $(n \times n)$ matrix of autoregressive coefficients for $j = 1, 2, \dots, p$. Meanwhile, ε_t is a $(n \times 1)$ vector generalization of white noise

serially uncorrelated. Once the stationary conditions of the var model are verified, each variable is regressed on a constant and a p number of lags of its own values and the other variables of the y_t vector. Thus, each regression will have the same explanatory variables. Using the lag operator, a VAR model can be rewritten:

$$\Phi(L)Y_t = c + \varepsilon_t \quad (8)$$

The specification for our recursive VAR considering exogenous variables to control for external innovations (Mojon and Peersman, 2001; Bordon and Weber, 2010; Sidaoui and Ramos-Francia, 2008; Parrado, 2001) takes the following representation:

$$Y_t = \Phi(L)Y_{t-1} + \Pi E_t + \varepsilon_t \quad (9)$$

The exogenous variables placed in the $(n \times 1)$ matrix E_t comprises oil world prices (*Oil*), commodity prices for non fuel products (*CPI**) and the U.S. federal funds rate (*Fr*) intended to isolate foreign monetary policy shocks. We assume that these variables are able to affect the other endogenous variables (Bordon and Weber, 2010) of the model Y_t but they do not receive a contemporaneous effect from them. The vector containing the exogenous variables has the following form:

$$E_t = [Oil, P_{co}, E_{pes}, E_{sol}, Fr]'$$

On their part, the endogenous variables presented in (Y_t) matrix are developed in their recursive representation to capture the transmission of the lending channel considering (Mishkin, 1995) some variations to fit the Ecuadorian economy. First, we placed the Real Effective Exchange Rate (*reer*) as the exogenous monetary policy instrument which drives the effect of monetary policy (Sidaoui and Ramos-Francia, 2008). This identification is assuming that the *reer* is not affected by contemporaneous innovations from the rest of the variables. Thereafter, we placed the monetary base (M_{base}); the level of the deposits (*dep*); the Consumer Price Index *CPI*, the interest rate (TBD) (i_r); the amount of deposits; the credit allocated by private banks (*cred*) and finally the level of private consumption (*Cons*) following the traditional representation of the monetary transmission by Mishkin (1996) and some considerations to dollarized small open economies (Boivin and Giannoni, 2009; Mishkin, 1995; Ozcelebi, 2013; Monhanty and Turner, 2008; Quispe, 2000; Mojon and Peersman, 2001).

$$Y_t = [reer, M_{base}, CPI, i_r, dep, cred, Cons]'$$

To estimate the VAR model and the projection parameters Φ_j of the vector Y_t , it is necessary that the error ε_t is uncorrelated with $Y_{t-1}, \dots, Y_{t-p}$ to keep the consistency of the n OLS regressions. Additionally, an assumption that the p lags are sufficient to summarize all the possible dynamics between the elements of Y_t is needed (Hamilton, 1994, p.261). At first, the Granger causality tests will be conducted to determine if an observed series y Granger causes another series x (Zivot and Wang, 2006; Hamilton, 1994). This test consists in the implementation of an autoregressive lag length p estimation as in equation (10) estimated by OLS where the F-test ($H_0 : \beta_1 = \beta_2 = \beta_p$) is obtained.

$$x_t = c_1 + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \alpha_p x_{t-p} + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_p y_{t-p} + \mu_t \quad (10)$$

Thereafter, the sum squared residuals of the bivariate series RSS_1 is compared with the univariate series x_t sum squared residuals equivalent to RSS_0 . Then the S test value is obtained to determine whether a series Granger causes another. If we obtain an S value higher than the 5% critical value for a $\chi^2(p)$ variable we reject the null hypothesis that y does not Granger cause x .

The impulse response function allow us to outline the working and timing of the responses towards monetary shocks. This technique is intended to capture the response or reaction of the variables

in the dynamic system towards innovations on the errors or an external change. First, we consider a VAR(p) model on the Wold decomposition form equivalent to:

$$Y_t = \mu + \varepsilon_t + \varphi_1 \varepsilon_{t-1} + \varphi_2 \varepsilon_{t-2} + \dots \quad (11)$$

The φ_s term shows the effect of one unit increase in the j th variable's innovation at date t (ε_{jt}) for the value of the i th variable at time $t+s$ (y_{it+s}), holding the rest of variables constant at all dates. However, this specification is based on the assumption of the occurrence of a shock only in one variable at time. This may be appropriate if shocks among variables are independent. Therefore, for this research we will obtain the orthogonalized IRF to capture the non independence of variables implying that a shock in a variable may be accompanied by a shock in another. Hence, the Cholesky decomposition is equal to $\Omega = PP'$; where P is a lower triangular matrix. Applied to a VAR, the orthogonalized impulse response consists in rewriting the model to have the disturbances of the equations uncorrelated based on a decomposition of a white noise variance matrix. Afterwards, the VAR(p) model is transformed to obtain a lower triangular matrix with zero diagonal capturing the instantaneous effects of the variables. Hence, the model takes a recursive identification where the researcher specifies the instantaneous ordering of variables as the first variable is able to impact the rest of variables and so on. For instance, variable y_{it} does not have an instantaneous impact over y_{jt} for $j < i$. The matrix of innovations which contains the instantaneous effects is obtained as a response to one standard deviation innovation ε_{it} to the system (Zivot and Wang, 2006).

Finally, the estimation of the variance decomposition can be computed after the VAR model is fitted. This estimator is intended to capture the portion of the forecast error variance in $Y_{i,T+h}$ resulting from the μ_j disturbance. The mean squared error¹¹ for this forecast estimation considering orthogonalized disturbances will be equal to:

$$MSE(\hat{y}_{t+s/t}) = \Omega + \varphi_1 \Omega \varphi_1' + \varphi_2 \Omega \varphi_2' + \dots + \varphi_{s-1} \Omega \varphi_{s-1}', \quad (12)$$

$$\text{Where } \begin{cases} \Omega = E(\varepsilon_t \varepsilon_t'), \\ \varepsilon_t = a_1 \mu_1 + a_2 \mu_2 + \dots + a_n \mu_n \end{cases}$$

Here a_j represents the j th column of the lower triangular matrix presented in the IRF. If we take the expectations of Ω , we can obtain the general equation (12) to compute the variance decomposition which permit us to calculate the portion of the total variance of y_t accounted to the disturbance μ_t by letting the factor s be large. The MSE of the s-period ahead forecast is equal to:

$$MSE(\hat{y}_{t+s/t}) = \sum_{j=1}^n \{ \text{Var}(\mu_{jt}) \cdot [a_j a_j' + \varphi_1 a_j a_j' \varphi_1' + \varphi_2 a_j a_j' \varphi_2' + \dots + \varphi_{s-1} a_j a_j' \varphi_{s-1}'] \} \quad (13)$$

The standard VAR presented above in its aim to provide insights into general representations does not impose restrictions. As a result, this level of generalization implies a large number of parameters, suggesting an over-parametrization that may be critical as the length of the majority of macroeconomic series is limited. The Bayesian VAR has several advantages in its application and allows us to overcome this problems with the use of prior information about the model structure or possible values for the parameters by shrinking the model parameters removing the over-parametrization issue (Zivot and Wang, 2006; Bańbura et al., 2008; Koop and Korobilis, 2010). The shrinkage of BVAR models counterbalances the lack of restrictions and results may

¹¹In first place, the mean squared error is defined as $MSE(\hat{y}_{t+s/t}) = E[(y_{t+st} - \hat{y}_{t+s/t})(y_{t+st} - \hat{y}_{t+s/t})']$ as in (Hamilton, 1994, p.323)

be consistent even with large numbers of variables (Bańbura et al., 2008; Koop and Korobilis, 2010). In the standard VAR, the vector of parameters estimated θ is considered as an unknown but fixed number. In Bayesian statistics θ is regarded as a random variable being its inference made on probability statements made by the analyst and its uncertainty. The information that the researcher has about θ before observing the data is contained in a *prior density* $f(\theta)$. This probability statements are made up after the θ estimation, and are rooted in the posterior density of y and θ which can be rewritten in the Bayes' Law form $f(\theta | y) = \frac{f(y, \theta)}{f(y)}$.

From equation (7) we can rewrite a VAR(p) process. Where, y_t is a $M \times 1$ vector containing time series observations, ε_t and a_0 are $M \times 1$ vectors containing errors and intercepts respectively, while A_j is a $M \times M$ matrix of coefficients. Also, additional exogenous variables or more deterministic terms can be added in the expression below, but for simplicity are excluded.

$$y_t = a_0 + \sum_{j=1}^p A_j y_{t-j} + \varepsilon_t \quad (14)$$

Equation (14) is written in terms of a matrix-variate Normal distribution. This is achieved through the use of a $MT \times 1$ vector y that stacks all the T observations on the first dependent variable; then all the T observations on the second dependent variable and so on. This is possible if a $T \times M$ matrix Y is set which stacks all the T observations on each dependent variable in columns next to one another. Meanwhile, the variables E and ε represent the stacking of the errors equivalent to y and Y . Hence, we define $x_t = (1, y'_{t-1}, \dots, y'_{t-p})$ and the matrix representation of X with a $T \times K$ dimension is the following if $K = 1 + Mp$:

$$X = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_T \end{bmatrix}$$

Finally, if $A = (a_0, A_1, \dots, A_p)'$ it is possible to define $\alpha = \text{vec}(A)$ as a $KM \times 1$ vector that stacks all the VAR coefficients (intercepts included) into a vector into the two following representations:

$$Y = XA + E \quad (15)$$

or

$$y = (I_M \otimes X)\alpha + \varepsilon \quad (16)$$

Where, $\varepsilon \sim N(0, \Sigma \otimes I_T)$. If the likelihood function is interpreted as a function of the parameters, then it is possible that the distribution function of the parameters is made up by two parts. First, one distribution for α given Σ . Second, the term Σ^{-1} has a different distribution, an Inverse Wishart distribution in the case of Koop and Korobilis (2010).

Regarding the prior distributions, there are several factors that may influence the selection criteria and can be summarized into three. First, as VAR models are not parsimonious prior information allows the researcher to improve the estimation of impulse response functions and forecasts. Second, priors used in VAR models differ in their objective for analytic purposes prediction or inference. Third, the priors may differ in their ability to handle outgoings from the unrestricted VAR, which would permit to have different explanatory variables, change parameters over time, allow heterokedastic structures among others. The Sims & Zha prior will be used in this research and will be briefly explained below.

The *Sims & Zha* prior is estimated by a multivariate regression to obtain the full parameters of the system which allows a more general specification. The mean prior is taken in a conditional form equivalent to the Minnesota prior having the same dimension ($M \times pM$) as in equation (15). Meanwhile, the prior for the conditional covariance of the parameters Ψ is more complicated and it is defined on the beliefs and facts of the series modeled (Brandt and Freeman, 2006). These beliefs are contained in the regression coefficients where the variance of each of this coefficients is determined through the hyperparameters to set the prior scale. The overall coefficients' covariances are scaled by the value of error variances coming from m univariate AR(p) OLS regressions for each variable on its own lagged values. The *Sims & Zha* prior hyperparameters definitions are presented in table (1).

Table 1: Sims and Zha reference prior hyperparameters

<i>Parameter</i>	<i>Range</i>	<i>Interpretation</i>
λ_0	[0,1]	Overall scale of the error covariance matrix
λ_1	> 0	Standard deviation around A_1 (persistence)
λ_2	$= 1$	Weight of own lag versus other lags
λ_3	> 0	Lag decay
λ_4	≥ 0	Scale of standard deviation of intercept
λ_5	≥ 0	Scale of standard deviation of exogenous variable coefficients
μ_5	≥ 0	Sum of coefficients/Cointegration (long-term trends)
μ_6	≥ 0	Initial observations/dummy observation (impacts of initial conditions)
v	> 0	Prior degrees of freedom

Source: Brandt and Freeman (2006)

The VAR reduced form of the *Sims & Zha* prior can be written in a matrix form by stacking the variables of each equation into columns.

$$\underset{T \times m}{Y} = \underset{T \times (mp+1)}{X} \underset{(mp+1) \times T}{\beta} + \underset{T \times m}{U}$$

In the expression above β corresponds to the coefficients of each equation stacked from the elements of the first coefficient of Φ_1 , the only exogenous variable included in this frame is the constant but it may be extended to more variables. Here Brandt and Freeman (2006) assume that the prior has a normal inverse Wishart distribution conditional structure that is multivariate. This is required for the model parameters in order to construct the reduced form BVAR with the *Sims & Zha*. With the use of this prior, it is possible to estimate the coefficients for the reduced form in the expression above with the following estimators:

$$\hat{\beta} = (\bar{\Psi}^{-1} + X'X)^{-1}(\Psi^{-1}\bar{\beta} + X'Y) \quad (17)$$

$$\hat{\Sigma} = T^{-1}(Y'Y - \hat{\beta}(X'X + \Psi^{-1})\hat{\beta} + \bar{\beta}'\Psi^{-1}\bar{\beta} + \bar{S}) \quad (18)$$

Where the normal-inverse Wishart prior for the coefficient is equal to:

$$\beta \mid \Sigma \sim N(\bar{\beta}, \bar{\Psi}) \quad \text{and} \quad \Sigma \sim IW(\bar{S}, v) \quad (19)$$

This equation by equation formulation of the prior has the form of $\beta \mid \Sigma \sim N((I \mid 0), M)$, where M is diagonal matrix of the prior beliefs about the parameters variance. As a result, the unconditional prior is correlated across equations. This implies that the prior account reciprocity among variables which may be important to the analysis of a variety of datasets (Brandt and Freeman, 2006).

3.4 Data

The data was obtained from different sources and was intended to cover the longest available period for all the series. However, some variables such as the real interest rate were not used and replaced by the deposit rate as the amount of missing data was considerable. The data for oil prices in USD dollars, commodity price index corresponding to non-fuel products, real effective exchange rate based on the consumer price index and household consumption in million USD dollars (private demand) was obtained from the International Financial Survey (IFS) developed by the International Monetary Fund. The effective federal funds rate expressed in percentage was obtained from the Federal Reserve Bank of St. Louis. The Consumer Price index was taken from the Macrobond database. Finally, the monetary aggregates, total liquidity, credits and deposits were obtained from the Central Bank of Ecuador national statistics web page and are expressed in USD dollars. These series are on a basis of quarterly periodicity for the 1994-2015 period as it represents the longest available period of reliable and continuous information.

4 Results

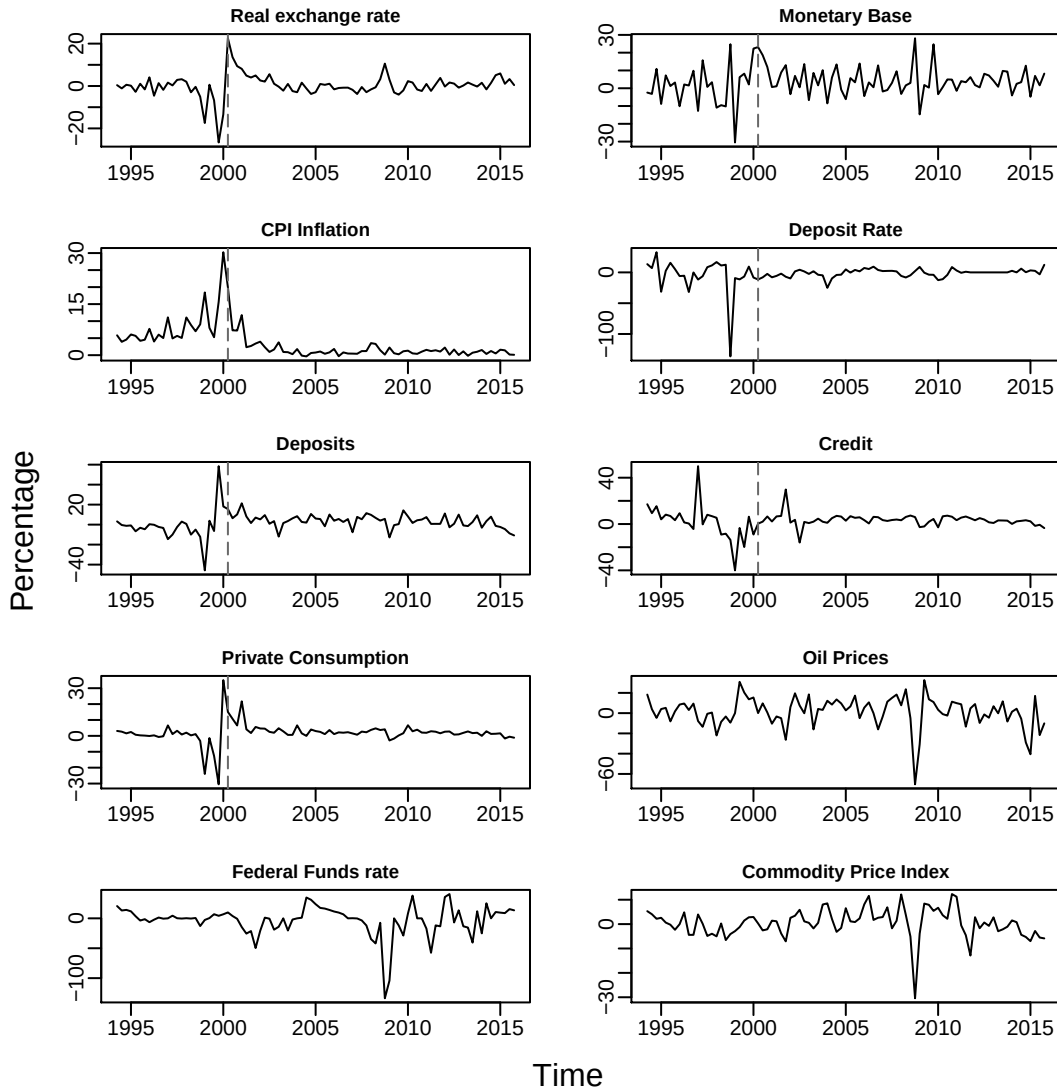
Once the theoretical and methodological elements to assess the effect of monetary shocks over private demand are outlined, this section will provide the main results obtained from the VAR and BVAR models. However, a brief analysis with the descriptive statistics of the variables used in the models will be introduced. Later, the preliminary conditions to approach the econometric analysis entailing the stationarity tests and lag order selection are shown. Finally, the Granger causality, the impulse response function and variance decomposition is presented.

Regarding the endogenous variables at levels from figure (A.6) we can observe that before dollarization the reer followed a stable process until the financial crisis falling around 40 points. On its part, the deposit rate remained high before dollarization, however, under the new currency it dropped from around 50% to 7% on average. Similarly, the CPI follows an increasing pattern which was steeper around the crisis. The monetary variables such as monetary base, deposits and credit, faced a considerable increase since dollarization. The monetary base passed from 764 USD million dollars in 1994 to 16,000 in 2016 showing a considerable reduction by 2009. In the same way, deposits followed an increasing trend which has been decreasing since 2014. Despite deposits were diminishing before 2000, the level of credit increased considerably and especially between 1995 and 1999. Finally, household consumption during dollarization has been increasing with its highest level in 2015 with 15,700 USD million dollars. Similarly to the rest of the endogenous variables, the lowest level of consumption was faced during the crisis with 1,700 USD million dollars.

The exogenous variables such as oil and commodity prices present a similar pattern where the biggest break is presented in 2009 coinciding with the international crisis. Similarly, the federal funds rate suffered two important reductions in 2002 and 2009 being stable since then in a level close to zero reflecting the effort of monetary authorities to boost the U.S. economy. From the plots of the variables at levels it is possible to observe that the majority of series follow an increasing trend. As a result, it is likely that these series are not stationary; indeed this suggests the presence of unit roots as their shape is similar to a random walk process. For this reason, all the variables were transformed on growth rates with the use of the logarithmic difference.

From figure (3) it is possible to appreciate the impact of the crisis. Also, we will contrast the plots with the summary descriptive statistics in table (A.2). First, the reer presented a considerable

Figure 3: Log Difference of Variables



drop in the crisis falling around 20% related with the severe depreciation suffered from the bailouts to the financial system. The reer grows on average 0.22% relatively stable, however, its coefficient of variance is the highest as it consists of the most exogenous variable of the system. Nevertheless, before dollarization this rate was -1.75% and under dollarization it became 1%. The monetary base displayed a similar behavior, but it is determined with less volatility. Before dollarization, it was growing at 1.8% with a coefficient of variance equal to 7.14. Meanwhile, since the year 2000 this growth rate is higher with 4.25% on average with lower variance (1.75). Regarding CPI inflation, during the crisis it increased to 30% arisen from the aim of the Central Bank to save commercial banks. On average inflation is really low with 1.75%, however, it may be the result of dollarization as under national currency inflation was 6.04% on average. On its part, the deposit rate has presented a great difference among the two monetary regimes with a growth rate of -0.83% under dollarization, and which under the former currency was -5.21%. One interesting shift is observed on deposits as before 2000 the average growth rate was -1.01%, but after dollarization it became positive with 3.53% being higher than credit which may be related with higher confidence. However, overall the growth of credit is higher than the deposits with 2.98% and 2.22% respectively. Similar to deposits under dollarization, consumption increased considerably with less volatility growing 1.95% on average. On their part, it is possible to observe that the global crisis affected

considerably the exogenous variables. In summary, there is a high volatility of external conditions such as the reer, oil and commodity prices and more stability and higher growth rates of the endogenous variables comparing dollarization with the national currency.

The statistics and graphics do not allow us to observe the impact of monetary aggregates towards the economy. Thus, the econometric models will provide us this information, but certain conditions such as the stationarity of the series are needed. As stated earlier, the variables at their levels are considered to follow a random walk process, but at their log first differences it is highly probable that they have a stationary pattern. Therefore, the augmented dickey fuller test presented in table (A.3) was conducted where the null hypothesis of non stationarity is proven. As we observed graphically the variables on their levels contain a unit root and the null hypothesis was not rejected for any variable. Nevertheless, for the log differences it is possible all the variables are stationary with a 99% of confidence which implies that our variables are difference stationary. After, the lag order selection was conducted, but after the Granger causality tests a second model was proposed excluding credit and CPI inflation. The optimal lag selection for model 1 and 2 was estimated in 6 and 4 lags respectively through the majority of selection criteria.

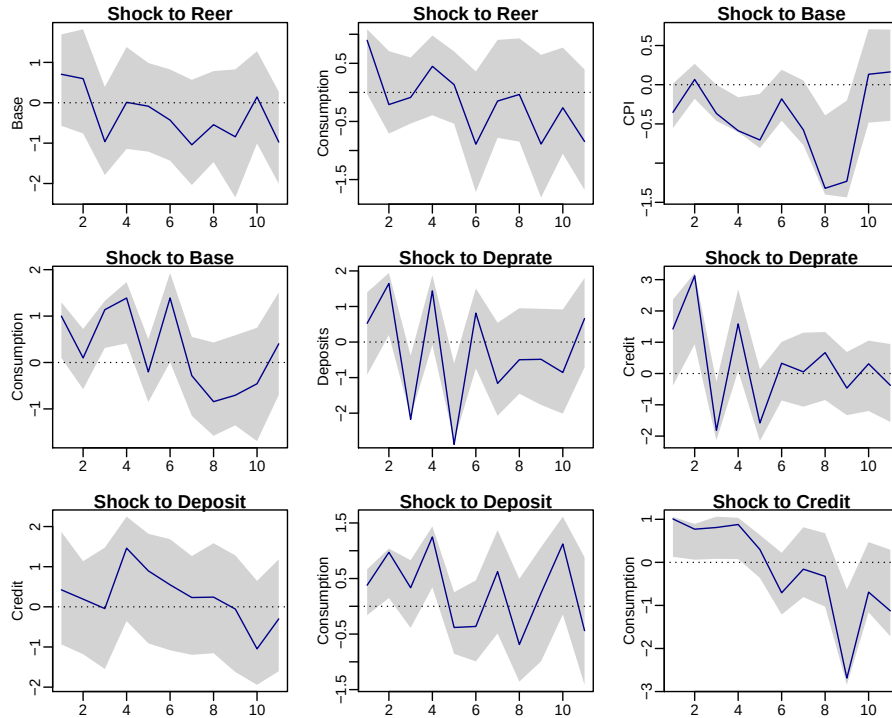
The multivariate and bi-variate Granger causality tests for the variables in log differences are presented in table (A.6) and (A.5) respectively with a forecast horizon of 3 and 6 lags. Important conclusions can be obtained from these tests which provided the possibility of reformulating the benchmark model in section (3.3). First, all the variables used in the benchmark model Granger cause the reer. However, this effect it is not mutual as the reer Granger causes the Monetary Base, CPI and consumption. These results are surprising as they imply that the external monetary market prices (reer) do not affect the domestic money market price (deposit rate) directly, but it does monetary aggregates as expected on the model 1 specification. According to these results, in a six lags perspective the majority of variables Granger cause the monetary base, but within a reduced horizon only the reer and deposits Granger cause the monetary base. It is striking that credit does not Granger cause the monetary base which may be explained by the permanence of credit on less liquid forms accounted in other monetary aggregates or the preference for credit to investment rather than consumption. On the other hand, the monetary base Granger causes the majority of variables excluding the deposit rate and credit. Regarding CPI inflation all the variables with exception of the credit are Granger causing it, this may be explained by the fact that credit is not useful to explain monetary base.

Turning to the last variables of the benchmark specification, surprisingly the deposit rate is not Granger caused by any other variable of the system. However, we maintain this variable in model 2 as Granger causes monetary base, consumption and deposits. Similarly, deposits are Granger caused by all the variables while on the inverse direction, deposits do not Granger cause deposit rate and credit. This result suggests that model 1 must not consider credit as it is not caused by deposits nor is it Granger causing consumption. This implies that private consumption is based on the preference of household resources between consumption and savings due to the elevated interest rates for consumption in Ecuador (around 15%). Finally, consumption is Granger caused by all the variables with exception of credit on the 3 lags horizon, while it does not Granger causes credit. As a result, in model 2 credit was excluded as it is not Granger caused by deposits and does not determine consumption. Also, CPI was removed as it is not Granger causing the deposit rate nor deposits and we end up with a model similar to the credit channel proposed by Mishkin (1996) putting more importance on deposits and considering the reer as the monetary instrument as Boivin et al. (2010). Also, we consider monetary aggregates as it is proven that in emerging countries and dollarized economies play a major role (Monhanty and Turner, 2008; Bogetic, 2000). Finally, in the multivariate Granger causality test we considered three scenarios for the two models where in all the cases the null hypothesis was rejected. The reer and monetary

base Granger cause all the variables jointly. Also, all the variables Granger cause consumption. Consequently, the Granger tests provided us a first insight into the mechanism and the direction of Granger causality.

To complement this analysis, the IRF were obtained. The IRF accounts the response of each variable to a one standard deviation shock presented in one period. Selected variables are plotted in figure (4) for model 1 and figure (5) for model 2. Meanwhile, all the variables are presented in figure (A.7) and (A.8) respectively. As explained before, the decomposition of shocks was obtained by the Cholesky decomposition which implies that the ordering of the variables presents a recursive transmission of the shock. Thus, the first variable (reer) is considered to have a contemporaneous effect on all the following variables. In contrast, the least endogenous variable (consumption) is assumed to be responding to monetary innovations, but it is not able to have contemporaneous effect over the rest of variables.

Figure 4: IRF - Model 1



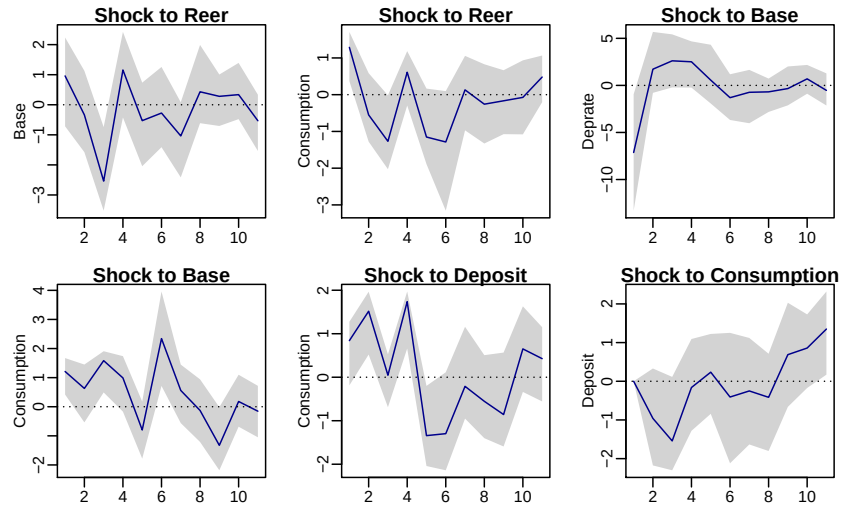
Overall, IRF for model 1 presents consistent results. First, as expected a shock to the reer¹² implies a monetary base reduction until the 7th quarter that may reflect a loss of competitiveness. Consequently, competitors may increase trade and money supply is reduced through the balance of payments. However, a positive impact maintaining the same volume of trade implies that more dollars are needed to buy domestic products raising domestic money supply. The response of consumption from a reer shock as expected reflects lower consumption for 6 quarters, then a short recovery is faced for 2 quarters and again presents a decreasing trend. Also, it is interesting that a reer shock does not considerably affect the deposit rate until the 7th quarter when it reflects a negative response as expected. It is possible that this delay may weaken the importance of this channel. It is striking that the price response to monetary base shocks is negative for eight quarters. This may be the result of dollarization as under this monetary scheme growth of monetary base is determined by economic conditions rather than discretionary policies. Also, it may be the result of

¹²A positive shock towards the reer implies that exports become more expensive while imports get cheaper.

fewer pressures over the re-circulation of current monetary base as there is more liquidity. Under this model, it is difficult to determine the existence of a liquidity puzzle as at the second quarter the deposit rate increases, but after this horizon starts a decreasing trend. Thus, inconsistencies identified in other developing countries remain (Mishra and Montiel, 2013; Kim and Roubini, 2000; Parrado, 2001). Additionally, a shock to monetary base as expected increases consumption for six quarters at which point starts a decreasing trend.

Concerning the response to a CPI shock, the results show a consistent behavior, which, in the majority of cases, is negative for about four quarters diminishing consumption, credit and deposit and increasing monetary base from the seventh quarter. For its part, shocks to the deposit rate imply certain volatility with a positive response at first. The response of deposits and credit to deposit rate innovations are stabilized after the 6th quarter. However, at this time horizon innovations on the deposit rate drive the biggest negative impact for consumption. Later, a shock to deposits increases credit up to the 4th quarter and after this point follows a decreasing trend. Meanwhile, a shock to the deposits increases consumption until the 4th quarter; then a negative period is faced; later an increasing trend up to the 10th quarter is experienced. Also, it is striking that the response towards credit innovations on its majority it is negative even for consumption. Finally, from model 1 the response from CPI to consumption innovations shows the highest impact on the fifth quarter lasting for one period. Also a shock on consumption receives a negative initial response from deposit which is consistent with our expectations, however, after the fourth quarter a positive increase in deposits is showed. Meanwhile its impact over credit is quite similar but on a smaller scale.

Figure 5: IRF - Model 2



In relation to the results of model 2 a shock to the reer implies a decrease of the monetary base, however, the lasting of this shock is lower as after the 3rd quarter monetary base increases and stabilizes. Similarly, as previously stated, a shock on the reer triggers a negative impact on consumption up to the 6th quarter which starts to change subsequently. Also, we can observe that a shock to the reer implies lower volatility of the response coming from the deposit rate. Similarly to before, in this model the presence of the liquidity puzzle remains, nevertheless, the volatility of the response of the deposit rate towards innovations of the monetary base is lower. Concerning the response of consumption to a monetary base shock, it shows an overall positive outcome, but with lowered volatility to the previous case. Also, it is interesting that the response from deposits to an increase on the monetary base is not translated into deposits. This suggests the preference of

consuming the higher liquidity rather than saving it. With respect of the responses to deposit rate innovations there is less variance compared to the previous model. It is surprising that the response of deposit to a shock in this variable follows a negative pattern for four quarters. This may be related to uncertainty from the lending channel during financial crises explained by Mishkin (1995) where highest interest rates imply more uncertainty which is affecting the willingness of depositors to place their savings in the banking system translated to consumption with a lag of 2 quarters. It is likely that the deposit rate is able to capture the effect towards other variables as it may be related to other interest rates as the real interest rate that was the base for the original mechanism of monetary transmission.

In respect of the response to deposit impulses, it seems interesting that there was an increase of the deposit rate until the 6th quarter at which point it started to decrease to its initial level. Additionally, a shock to deposits increases consumption for four quarters and then experiences one severe drop and a posterior recovery. The positive effect of deposit implies a rise of the disposable resources of households expressed on savings. Finally, we can observe that consumption innovations are associated with high variability of deposits during eight quarters, however, at this point deposits start to increase. The same effect is presented by the deposit rate and monetary base. Here we have observed that divergences with model 1 are minimal and the main conclusions outlined with model 1 remain with a different timing in some cases. Also, we can confirm that in the case of Ecuador, despite some results not being consistent with our expectations (such as the response of deposits towards innovations on the deposit rate), it is interesting to observe that the monetary variables suggested by the research such as deposits are helpful to explain variations on the demand.

Finally, having observed the trajectories and the timing of responses to shocks, the forecast variance decomposition analysis allows us to identify the amount of the forecast error variance that each variable is explaining by an exogenous shock to the rest of the variables of the system. The variance decomposition for both models is presented in table (A.7). First, it is unexpected that credit accounts for the majority of the variance in a shock that occurs to the reer with the 43.6% in a 4 quarters horizon, while the variance from the reer is considered low with 17% at the same term. The second model notwithstanding, the effect of the reer is high as expected, accounting at the first quarter the 53.2% of the variance decreasing up to 23.6% on the fourth quarter ahead. Second, a shock towards the monetary base is explained mainly by its own variance at the first quarter with the 66.4% followed by deposits with 19.6%. Later, in the fourth quarter, the effect of a shock in the monetary base is driven by its own variance on 38.1%, while the relative importance of deposit rate increases to 34.5%. Concerning the second model, this dynamic remains similar, but up to the fourth quarter the deposit rate accounts the majority of the variance of the monetary base with 49% followed by the monetary base with 33% and deposits 10.6%. Furthermore, the variables that most affect the variance of CPI are centered on credit and the deposit rate accounting the 31% and 47.6% of the variance up to the fourth quarter. Surprisingly, consumption has little effect on the variations of CPI contributing with 4.4% of its variance.

In relation to the variance of shock to the deposit rate for model 1 it is mainly explained by its own movements with 78.5%, followed by credit with 10.1% and deposits with 5.6% considering four quarters ahead. Regarding model 2, the outcome remains as the deposit rate accounts 89.8% of its variance and deposits 4.9%. These results suggest some independence of the deposit rate coinciding with the Granger causality tests. However, the deposits is one of the variables that its forecast error variance depends on its values with 54.6%, the deposit rate with the 28.4% and the consumption with 6%. If the analysis is conducted under the model 2 the contribution of the deposit rate it is lowered to 17.1%; while its effect itself is enhanced to 65.5%. Astonishingly, deposits are not useful to explain the forecast error variance of credit shocks as it only accounts for 2.3% of variance, while

the deposit rate explains the 12.9% and credit itself the 69.6%. Finally, it is interesting that at the first quarter ahead under model 1 the variance of consumption shocks is totally explained by itself, however, after the second quarter this importance falls heavily. Nevertheless, on the fourth quarter ahead deposit rate becomes more relevant accounting 56.7% of the variance, followed by the monetary base with 12.2% and deposits with 11.9%. The second model 2 is slightly different with the previous order of importance as in the fourth quarter the forecast error variance of a shock on consumption the deposit rate accounts for 33.6% of the variance, 30.3% consumption and 17.2% of the monetary base. In summary, the monetary base and deposit are highly important in explaining the innovations of consumption, where surprisingly CPI has little effect. This may be explained by the low effect of CPI on the reer. Also, we can conclude that credit is not essential to consumption dynamic in Ecuador.

From the standard VAR models important conclusions can be drawn. However, this methodology can contain several limitations. Therefore, a Bayesian analysis was proposed to contrast the results from the standard VAR. In order to obtain the optimal specification of the BVAR, an evaluation of the prior hyperparameters was conducted. The process consisted of identifying the hyperparameters values that best fit a reduced form BVAR to the real values. For this purpose a 4 period ahead forecast that reduces the root mean squared error was selected and it is presented in table (A.8). Thus, 16 different models for each specification were constructed. In brief, the hyperparameters with the best fit power are summarized on the following beliefs: the tightness of the sample and prior is high ($\lambda_0 = 0.9$); tightness of the prior around AR(1) parameters is low ($\lambda_1 = 0.1$); the decay for the lagged values of the variables shrinks harmonically ($\lambda_3 = 1$); tightness around the intercept is low ($\lambda_4 = 0.10$); tightness around exogenous variable coefficients is moderate ($\lambda_5 = 0.5$); finally, the beliefs of hyperparameters for difference stationary process and a common trend were set on zero ($\mu_4 = \mu_5 = 0$) as we used log difference series. Under this specification the reduced form BVAR models were fitted and the IRF were obtained through Monte Carlo simulations using the Cholesky decomposition of contemporaneous innovations of the error covariance matrix. In addition, 5000 draws of simulations were conducted to construct the IRF error bands. Within each simulation, the coefficient of each sample was obtained and summarized by the Markov Chain Monte Carlo algorithm to construct the error bands as explained by *Sims & Zha* prior methodology (Brandt and Freeman, 2006).

The Bayesian IRF are presented in figure (A.9) and (A.10) for model 1 and 2 respectively. The results for model 1 present some differences with the standard VAR observed on trajectories, size and duration. First, it is surprising that shocks to the reer have a bigger impact and for some variables causes non convergence. This may arise from the relative exogeneity of the reer from domestic actions which favors its propagation over time implying the impossibility response of internal actions to disseminate the impact. This outcome is shown by a positive response of the reer, monetary base, credit and consumption. The response of monetary base obtained shows a different behavior that may be explained by the fact that an increase of export prices maintaining the same volume implies that the country is receiving more liquidity. Consequently, this implies that the loss of competitiveness is not critical. Also, imports become cheaper which means that fewer dollars leave the economy. Concerning the response of CPI to a shock on the reer as expected prices increase to the third quarter when they stabilize. Similarly, the deposit rate and deposits follow a similar pattern with a positive response to a reer shock increasing until the fifth and eighth quarter respectively. Nevertheless, IRF results for model 2 get rid of the reer non converging shock. This indicates that CPI nor credit do not allow the effective adjustment of internal variables as inflation may be imported from the anchor country. Thus, dollarized economies may have a distorted response towards monetary shocks due to the impossibility of affecting inflation. In the second model the response of monetary base to a reer shock increases until the third quarter and

thereafter returns to its initial value. As mentioned above, this may reflect the underlying dynamic of responses to reer shocks suggesting that the volume of trade remains unchanged until the third quarter, but after this point a loss of competitiveness may explain the reduction on the monetary base. In the same way, the deposit rate and deposits grow considerably up to the fourth and fifth quarter respectively originated from an increase of the monetary base as expected. Consequently, the liquidity of the economy is higher and banks, in their aim to increase their resources, raise the deposit rate which explains the permanence of the liquidity puzzle on the BVAR model and its persistence for dollarized economies. Finally, evaluating the role of the reer over consumption at first shows a negative response, nevertheless, at the third quarter it follows an increasing direction for one quarter and then stabilizes around its initial value. The results of the two models under the Bayesian analysis can be considered similar, but with less volatility.

It is interesting that the deposits response for monetary base innovations is negative until the second quarter when some variability presents to finally be balanced around the eighth quarter in both specifications. In relation of the response of consumption to monetary base shocks. In the BVAR, the effect is clearer raising consumption considerably until the second quarter and stabilizing after the sixth quarter. With respect to the CPI shocks, as presented before the response of credit and consumption remains with a negative reaction. Also, the deposit rate increased in the light of inflationary shocks. Concerning deposit rate innovations, the results in both models suggest the same effect presented earlier over deposits. Nonetheless, it is astonishing that an increase in the deposit rate implies a negative reaction from deposits. In contrast, the response of monetary base and consumption is positive which can be associated with the impact of the deposit rate that lowers deposits and they are moved onto consumption. With respect to deposits shocks, the response from the majority of variables is negligible, but the main interest lies in its effect on consumption which as expected increases it for about 4 quarters and stabilizes after the sixth quarter. With these results we can observe the importance of deposits to affect consumption being crucial over this decision as the response to a shock in credit from this variable is negligible. Finally, we analyze the effect of a shock in consumption which shows little impact on the rest of the variables suggesting little positive response from the monetary base until the second quarter, meanwhile, deposits increase up to the second quarter.

5 Conclusions

This research addressed the effect of monetary shocks and their transmission to private demand; analyzing the case of Ecuador as it represents a dollarized small open economy. The literature review outlined the importance of monetary policy and the possibility of establishing a model that includes the main components of the traditional lending channel with some variations specific to the context of Ecuador. During the research process we observed that dollarization contributed to more stability expressed on higher and more stable (less variance) growth for the reer, monetary base, deposit rate, deposits, credit and consumption. Meanwhile, the inflationary pressures reduced. However, when considering the entire period of analysis, the reer accounts the highest volatility. Nevertheless, the econometric analysis that provided the insights of monetary shocks transmission can be summarized in three findings.

First, the Granger causality tests showed that the reer is essential in monetary transmission, given that it is being Granger caused by all the variables. However, the reer did not granger cause the deposit rate, which demonstrates the incapacity of external market prices to affect the domestic revealing its working mechanism through monetary aggregates. In addition, the reer and deposits are essential in the monetary base determination in a short and medium term perspective. Also, it

is interesting that the deposit rate is not Granger caused by any other variable while consumption, monetary base and deposits are. Finally, it is astonishing that deposits do not granger cause credit and credit does not Granger cause consumption. This suggests that credit is not instantaneously translated into consumption; this let us assume that credit is preferred for investments remaining longer in less liquid forms. These results imply that, under dollarization and especially in the Ecuadorian case, credit is not essential for the transmission of monetary shocks, but deposits innovations affect demand and this implies the preference of consumption rooted on savings rather than loans.

Second, it is concluded that reer innovations are crucial for monetary base determination and this is summarized by a positive response at first followed by a reduction between six and eight quarters. Under the VAR model the response of monetary base towards reer innovations suggests a negative response indicating loss of competitiveness. However, the BVAR on the benchmark model presents a propagation effect arisen from the relative exogeneity of reer denoting the importance of external shocks to the supply of money under dollarization. In addition, external monetary shocks on the reer are translated into less consumption for three to six quarters by reducing domestic liquidity. Also, positive monetary base innovations raise consumption for 4 to 6 quarters reflecting the importance of monetary aggregates under dollarization as its size impact is larger compared to the reer. Additionally, monetary base shocks raise deposits considerably and consumption for around five quarters. However, the existence of liquidity puzzles under the VAR and BVAR models remains. This can be explained through the response of banks to monetary innovations with higher interest rates to capture the new available resources. Nevertheless, further analysis on the existence of liquidity puzzles under fully dollarized economies is suggested. Also, it is interesting that monetary base shocks reduce deposits indicating that higher liquidity in dollarized economies is not immediately translated onto savings. In this sense, it is astonishing that deposit rate innovations lead to less deposits denoting uncertainty on financial markets increasing the preference of individuals to hold liquidity or consume rather than save. Finally, credit it is not effective to boost consumption, but the increase of deposits is more relevant to raise consumption for around a year. Thus, the increase of disposable resources reflected on savings expresses the preference of households to root consumption on their own sources rather than on external sources provided by financial institutions. Consequently, monetary policy towards a better re-circulation through the credit channel must be reconsidered by the Central Bank through its official rates.

Third, the importance of each component of the transmission channel of monetary transmission can be summarized in the following findings with the variance decomposition. Under the benchmark model, credit accounts the largest amount of reer variance, but without taking into account credit and CPI the reer shows a high degree of independence from the rest of the endogenous variables. The most important variables to determine the monetary base are the deposit rate and deposits reflecting the importance of money price markets and monetary aggregates to determine money supply in dollarized economies. Similarly, the deposit rate indicates a high degree of independence as it itself accounts for 78% of its own variance, followed by credit and deposits. Surprisingly, for the determination of CPI, consumption accounts for only a little of its variance with 4%. Regarding deposits, the importance of deposit rate and consumption is confirmed accounting the majority of the variance. This suggests the importance of banks' deposit rates and the possibility of monetary authorities to control deposits through domestic rates. Finally, the variance of consumption which represents our main variable of interest is explained principally by the deposit rate, followed by the monetary base and finally deposits. This outlines the importance of monetary variables to influence private demand through the main traditional components of monetary transmission such as the interest rate and the lending channel where surprisingly credit is excluded.

Finally, further analysis on structural identifications to overcome the existence of liquidity puzzles

and the relation between deposits, credit and consumption is suggested. Furthermore, alternative specifications with the use of different policy instruments and aggregate output may be important in order to analyze the effect of monetary shocks in dollarized economies.

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