MSc Dissertation Title:

Analysis of the Effectiveness of Monetary Policy in sub-Saharan Africa Developing Countries: the Case of Mozambique

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ABSTRACT

The Macroeconomic policy framework in Sub-Saharan Africa developing countries under the IMF support places special emphasis on monetary policy as a stabilization tool. This dissertation discusses the appropriateness of such approach by analyzing the case of Mozambique. Specifically, the paper looks to the structure of the country's financial sector and its linkages with the real economy, and to quantitatively complement such analysis a Vector Error-Correction Model (VECM) is estimated. The evidence shows that besides the embryonic financial system, a fragile relationship between the country's economic activity and the financial sector makes the conduit of monetary policy very weak. Further, the VECM shows that the predominant tightening stance that characterizes the monetary policy framework in this country may have some negative impacts in the economy in the long-run. These results, that offer a point of inference to other SSA countries with similar economic structure and monetary framework, imply that macroeconomic policy should be rethought in Mozambique.

Contents

1. INTRODUCTION

The employment of different instruments to achieve stability and long-term growth is the nucleus of macroeconomic management in any economy. The Sub-Saharan African (SSA) Low Income Countries (LICs), under the International Monetary Fund (IMF) assistance, place special emphasis on monetary policy as a tool to reach such intents (see table 1). The trusted mechanism behind this approach - as in the classical monetary policy transmission mechanisms in advanced economies – is that monetary authorities should manage money growth and policy interest rates to impact credit conditions in the economy (and the aggregate demand) to reach programmed targets of single digit inflation and pre-determined levels of net external reserves (IMF 2010, IMF 2012a).

Table 1: Summary of macroeconomic policy strategy and recommendations for 2012 in Selected SSA countries under the IMF Policy Support Instrument

	Macroeconomic strategy	Monetary policy goals
Benin	Stability by prudent monetary and fiscal policies and balance of payment and fiscal account managements	In the medium term return to the West Africa Economic and Monetary Union (WAEMU) inflation convergence criterion of 3%
Burundi	Compensate budget support decline by tax and revenues reform to finance infrastructure and monetary tightening	Reduce inflation from two digit to single digit (medium term target 6.4% 2015)
Ethiopia	Monetary and fiscal prudent policies to keep inflation in single digit, fiscal pro-poor spending, mobilization of domestic savings	Single digit inflation
Ghana	Growth recover followed by prudent monetary policies, creation of fiscal space for investment in infrastructure and debt sustainability	Low inflation and exchange rate stability.
Kenya	Maintenance of tight monetary policy to hold expectations of low inflation, reduction of the external account deficit and fiscal discipline	Lower inflation and external account pressure by controlling net domestic and foreign assets
Malawi	Imperative liberalization of the exchange rate accompanied by monetary and fiscal tightening	Inflation control
Mozambique	Prudent Monetary and fiscal policies with limited use of domestic credit, investment in infrastructure and maintenance of debt sustainability	Single digit inflation (mean term goal of 7%) money growth control, safeguard of international reserves. Long-run movement to inflation target.
Rwanda	Monetary policy management of Net Domestic Assets (NDA), Net Foreign Assets (NFA) and reserve money to avoid erosion of the growth gains. Fiscal consolidation by increasing revenues	Inflation control (5% target for 2016) through money control, improvement of liquidity forecast, reforms towards a fully market determined exchange rate regime.
Tanzania	Monetary policy tightening, expansion of public infrastructure and management of debt sustainability	single digit inflation (target 5% by 2014) and management of exchange rate volatility
Uganda	Use of monetary policy to anchor inflation expectations, fiscal expansion with focus on infra-structure, safeguard of debt position	Disinflation (single digit target of 5% by 2017), exchange rate strengthening, track money growth and NDA

Source: Arab News (2012), IMF (2012c), IMF (2012d), IMF (2012e), IMF (2012f), IMF (2012g), IMF (2012h), IMF (2012i), IMF (2012j), IMF (2012k), IMF (2012l), IMF (2012m), TE(2011)

However, the reality casts doubts regarding the real effectiveness of such approach. With very few exceptions, the required financial sector development and linkages between the financial sector and the real economy that is fundamental for effective monetary policy are absent from SSA countries. For example, only 5% of the adult population uses credit from formal financial institutions in SSA and the level of financial development, calculated as the ratio of financial system deposits and GDP, is 0.3, which is the lowest compared to other regions (Beck and Al-Hussain 2010, World Bank 2012:8).[1] Further, the main focus on prices stability and the predominant tightening stance that is clear from table 1 seems to pay no attention to the costs that such approach may imply in terms of output growth and presumably to employment creation and economic diversification that are more in accordance with many SSA countries' needs.

This dissertation discusses the effectiveness of the monetary policy approach of SSA countries and if there are costs from the predominant tightening stance required to meet the inflation targets. Considering that the transmission of monetary policy occurs through the financial system, the purpose of this thesis is to shows that the channels of monetary policy transmission are very weak in these countries to cement so much trust in this policy tool.

To achieve an in-depth analytical framework, the problem is discussed based on a single case analysis of Mozambique. This country offers good insights to evaluate monetary policy performance under IMF support for being pointed to as an example of success in terms of implementation of the recommended macroeconomic policies (IMF 2012b). Moreover, Mozambique's financial and economic structures are very similar to other SSA countries, making it a representative case (see Mirsha et al. 2010:35 for details).

So, two hypotheses are discussed:

(i) Mozambique's financial and economic structures block the effectiveness of monetary policy as a stabilization tool. That is, because of the financial system underdevelopment and its weak linkage with the economic activity, the effective conduit of monetary policy actions from operational variables to the targets (output and prices) fails to take place.

[1] For example, for South Asia, Middle East and North Africa and Europe, this ratio is respectively, 0.6, 0.7 and 1.

(ii) The tightening monetary stance required to reach the agreed inflation targets, besides taking the risk of being ineffective, imply long-run[2] negative impacts in terms of output growth.

To achieve the proposed goals, this paper carries out two main exercises. It starts by characterizing the Mozambique financial sector and its relation with the economic activity (section 4) that provides previous inferences about the effectiveness of monetary policy.

Then, it proceeds with a formal econometric analysis (section 5). Specifically, a Vector Error-Correction Model (VECM) is employed to analyze the short-run transmission of monetary policy through a Vector Autoregressive (VAR) that as suggested by Sims (1980) is an effective technique to overcome endogeneity problems that normally surround macroeconomic modeling approaches. Further, it provides the long-run effects of monetary policy through an error-correction mechanism, which is especially important for the second hypothesis.

Although country specific, this study is a valuable contribution to clarify the mechanism of transmission of monetary policy in the SSA environment that is still a "black box" (term borrowed from Bernanke and Gertler (1995:27)). That is especially fundamental if trust is to be cemented in this policy as a stabilization tool. So, this study offers a complete set of tools to evaluate different monetary policy channels by looking to the link between monetary policy operational variables and the financial sector, and between this and the real economy.

Further, this study is methodologically advantageous relative to existing studies for three reasons. (i) It not only looks to the econometric relationship among monetary and aggregate demand variables as commonly done. But, it looks behind the factors that determine such relationship by analyzing Mozambique's economic and financial features before completing it with a quantitative econometric analysis. So, it combines two types of analyses, instead of using one or another that would carry the "danger of a single story" (TEDTalks 2009). (ii) It uses a

[2] The long-run effects are used in an econometric sense. They express the cointegrating relationships among variables, such that even with short-run deviation from such relation caused by shocks, the variables always return to it. So, not necessarily means extending the monetary policy impact to a long period of time, but they express the "main" relationship to which variables always return even after short-run disequilibrium (see Gujarati and Porter 2009 for details).

VECM that considers both the short and long-run relationships between variables that are cointegrated. (iii) Two VECM are estimated by alternating the monetary operational variables between the monetary base and the Treasury bill rate. This also allows comparing which variables is more suitable for monetary policy for the case of Mozambique.

The remainder of the paper is organized as follows. Section 2 discusses the theoretically identified monetary policy transmission mechanisms along with the existent empirical evidence for SSA countries. Section 3 portrays Mozambique's monetary policy framework. Sections 4 and 5, as aforementioned, provide the main body of the work by presenting the characteristics of Mozambique's economy and a formal econometric analysis. Section 6 provides the conclusions that confirm the hypotheses in analysis.

A caveat before proceeding. This analysis has a clear focus on the relationship among monetary policy variables and the final targets, through the financial system. So, the intention is not to discuss structural factors, such as exogenous and political shocks that may have a degree of influence on it. This will be part of a future research.

2. LITERATURE REVIEW

2.1 Monetary Policy Transmission Mechanisms

In general, the framework behind the transmission of monetary policy actions to the real economy consists of: (i) a final macroeconomic target, typically price stability and/or employment depending on the central bank; (ii) An intermediate target (normally broad monetary aggregates and medium/long-term interest rates) with a predictable and stable relationship with the final target and that are partially controllable by the monetary authorities through an operational variable (generally the short-term interest rate and/or money reserve), the latter under complete control of central banks through their instruments.[3] From this, five main channels can be drawn to explain how the process effectively occurs.

Thornton (1802) identified the *interest rate channel*. Essentially, in a monetary expansion, for example through an open market purchase, the raise of reserves in the commercial banks' balance sheet reduces the interbank interest rate. Considering arbitrage linkages, the interest rate of short-term securities also falls as banks will transfer resources to short-term securities until equilibrium is reached between interbank rates and the return in securities. With price stickiness, the real short-term interest rate also reduces, causing changes in inter-temporal consumption and investment in inventories (Keynes 1936). Under rational expectations (New-Keynesian models), the reduction in short-term securities return leads to long-term interest rate adjustments affecting the cost of capital that is behind firms' investment decisions as well as households consumption of durable goods (Woodford 2003, Blanchard 2008).

Linked with the *q Tobin* ratio (Tobin 1969) and the permanent income theory the interest rate channel is extended to *asset* and *wealth channels* (Ando-Modigliani 1963). For example, an interest rate reduction, induced by monetary actions, increases the firms' *q Tobin*[4]. So, equity values increase, improving firms' access to funds to finance investment projects. Along with that

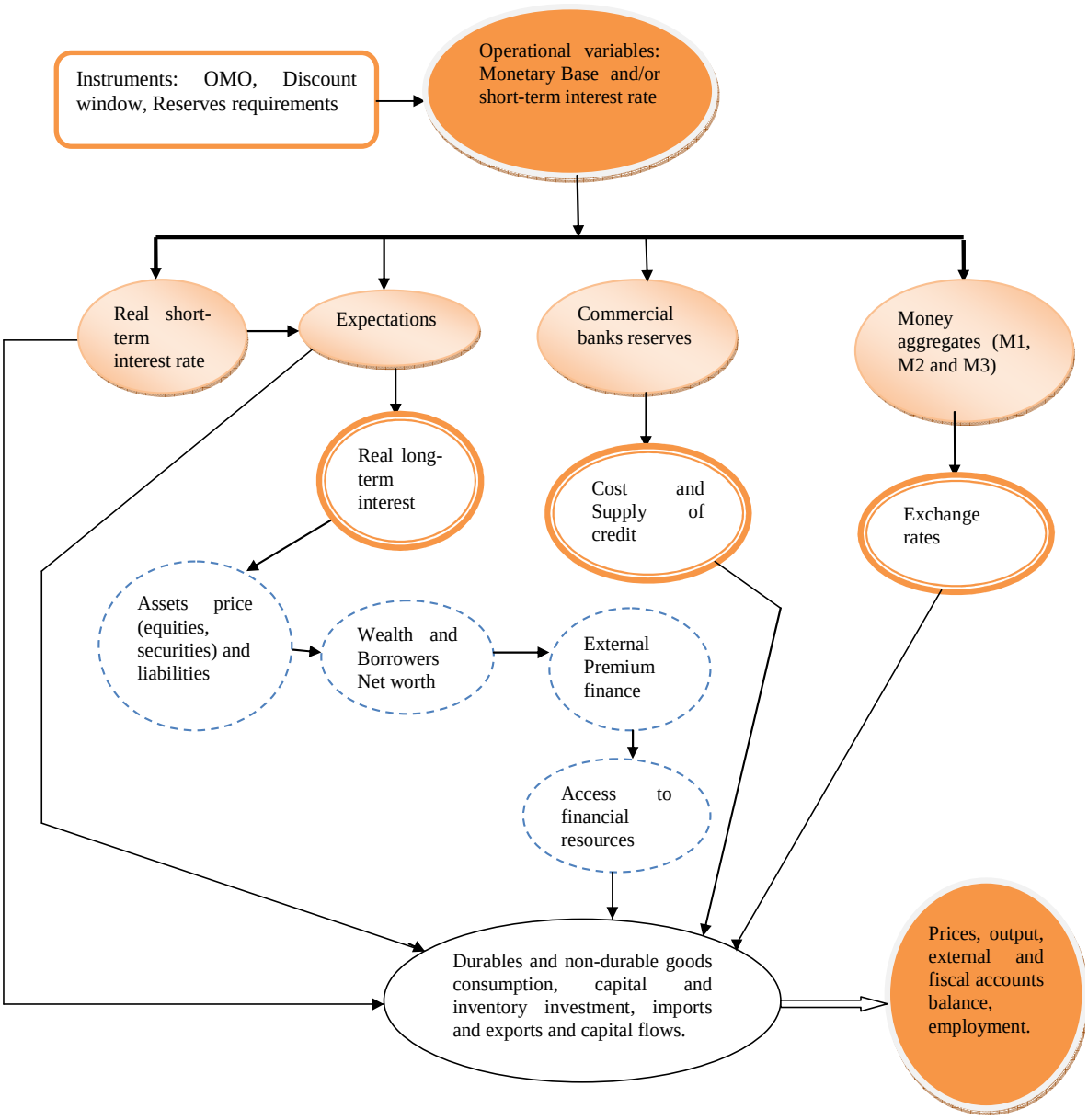
[3] The main used instruments are the open market operation (OMO), minimum reserve requirements and the discount window. These are indirect instruments that were upgraded since 1970, with the downgrading of the direct instruments such as credit ceiling.
[4] The stock market value of a firm over its physical capital reposition costs.

households' financial wealth (that may include equities) rises and so the permanent income, leading to spending increase.

Based on considerations of the market frictions literature (Stiglitz and Weiss 1981), the *credit channel* was identified. Bernanke and Gertler (1995) argued that asymmetric information between borrowers and lenders causes agency costs and thus a premium, which agents have to pay for using external finance (i.e. issuing debt) instead of internal finance (e.g. use of retained profits). So, monetary policy shocks, besides changing the interest rates, endogenously change the external finance premium that amplifies the shocks through two "sub-channels": (i) a *balance sheet*, where an interest rate fall, for example, raises the borrowers' access to finance, by shrinking the external premium finance through improvement of the assets side of the balance sheet while reducing liabilities. (ii) And a *lending channel* where banks' credit supply and costs are affected by monetary actions (for example an OMO purchase). So, access to resources to finance spending is affected (Bernanke *et al.* 1999).

Further, the *exchange rate channel* is derived from the liberalization of the exchange rate market. A loose policy that reduces the interest rate diminishes the attractiveness of deposits and other financial investments in domestic currency relative to foreign currency, which leads to capital outflows (Dornbusch 1976). As a result, the domestic currency depreciates, with effects on exports and imports demand that changes the aggregate demand. The effects direction depends on the imports and exports elasticity to exchange rate as stated in the Marshall-Lerner-condition (Caves *et al.* 2007).

Figure 1: Monetary Policy transmission mechanisms



Source: Author's construction based on the discussed theory

The described channels show that the financial system is the central conduit of monetary actions. Thus, developed financial systems with perfect liquidity and arbitrage linkages between different interest rates and instruments are fundamental for policy effectiveness. Further, a strong sensitive relation between aggregate demand components and the financial system is another requirement,

besides floating exchange rates, integration in foreign capital markets and central bank independence.

Such a scenario is distant from the reality in most SSA countries. These countries present embryonic financial structures, inexistent or hardly developed capital markets, and exchange rate market interventions. Weeks (2010:1) reports that in the SSA only 11 countries have bond markets, which are still rudimentary, and for about 17 central banks' independence is absent due to integration in common monetary areas. Mishra and Montiel (2012:35) show that SSA countries present the lowest indexes levels of financial development compared to other LICs in terms of bank sector structure. These issues cast doubts on the effectiveness of monetary policy in the SSA environment and stimulate the curiosity to look at what the empirical evidence has found.

2.2 Empirical Evidence from SSA Countries

Different from advanced economies, the monetary policy transmission mechanism in SSA countries is still a black box with recent ongoing decoding attempts. The small, but increasing number of empirical studies has relied on VAR models as a methodological approach. In general, the conclusions presented are mixed, with results leaving more paradoxes and enquiries than clarifications.

Cheng (2006) found that monetary policy shocks effectively affect prices and exchange rates in Kenya through the interest rate channel, but have no effect in output. Specifically, through a VAR (composed by output, Consumer Price Index (CPI), M3, repo interest rate and nominal exchange rate) he observes that a positive shock in the policy interest rate results in a fall in prices and nominal exchange rate appreciation that persists for more than 12 months. And, using variance decomposition he shows that monetary policy explains, respectively, 1/3 and 1/5 of prices and exchange rate fluctuations. Equally, Peiris and Lledó (2008) found that shocks in the money base explain changes in prices, but not in output and exchange rates in Mozambique.

Divergent from the above, other studies find the lending transmission channel to output or other aggregate demand components, but not to prices. Uanguta and Ikhide (2002) analyzed how the

changes in the South Africa Reserve Bank (SARB) repo interest rate[5] are transmitted to the Namibian economy and found that lending rates and private investment were sensitive to this operational variable. Ngalawa and Viegi (2011) found significant effects of the monetary aggregates on output, but no effect on prices and exchange rates in Malawi.

Other surveys, besides finding no statistically significant transmission of monetary policy also have theoretically ambiguous results. Mangani (2011) found no predictive effect of money supply on prices for Malawi, and that the only variable able to explain prices was the exchange rate, but the latter was completely unresponsive to the monetary policy stance. Further, he found an ambiguous negative relationship between money supply and the broad monetary aggregates, with the latter reducing under expansionary shocks. He suggests that a credit channel should be surveyed. Similarly, Rungo and Manjate (2011) found no effect of monetary policy operational variables in prices and output for Mozambique. They also found ambiguous results, that is, monetary expansionary shocks caused the nominal exchange rate appreciation and price fall. They suggest the credit channel is worth being investigated for the Mozambique case and justify that the results may be linked with an accommodative policy stance and data span limitations. However, using higher frequency data (monthly data from 2000 to 2010) with more degrees of freedom and including lending rates to capture the lending channel Montiel *et al.* (2012) also found no significant effect of reserve money shocks on prices and output. Moreover, ambiguous effects in the exchange rate and lending rate were found, which tended to appreciate and increase, respectively, under positive shocks in the money reserve that is equivalent to a monetary expansion.

From another perspective, studies argue that the monetary policy stance based on the IMF financial programming has real effects on the economy but it unnecessarily too restrictive, resulting in needless real economic costs. Abradu-Otoo et al. (2003) report for Ghana, through a VECM, that interest rate raise in a tight monetary policy lead to temporary increases in inflation before it starts to fall, at the expense of a fall in output that lasts for 3 to 4 years. More, they show that allowing credit growth impulses GDP growth, reduces inflation and depreciates the exchange rate. According to the authors this occurs because interest rates act as a cost for firms,

[5] The SARB is considered because Namibia's currency is pegged to the South African rand.

such that higher interest rates increase costs and lead to higher prices. They also found an exchange rate puzzle. Epstein and Heintz (2006) complement this analysis. They simulate a monetary expansion of 5% in the money supply for 5 years and show that output could increase by 25% with only 1.2% inflation increase. So they conclude that, contrary to the restrictive monetary stance characteristic of financial programming with focus on inflation, significant higher economic growth, and then employment creation could be achieved with low inflationary sacrifices.

In general, the evidence suggests that efforts are still required to clarify the transmission of monetary policy in SSA countries. The empirical conclusions transit between partial effects on output or prices (that is a paradox) to no effects and/or ambiguous effects. Further, some studies present data span and methodological problems that may undermine their credibility. For example, Ngalawa and Viegi (2011) wrongly chose the interest rate as operational variables for Malawi's case, when actually it is the monetary base. Uangute and Ikhide (2002), in the analysis of the Namibian aggregate demand response to the SARB repo rate, erroneously considered the latter as endogenous to Namibia's' macroeconomics variables, which is implausible (Mishra *et al.* 2010).

Further, these studies are limited for only using econometric quantitative analysis. They do not assess the financial and real economy frameworks of the cases they analyze that are fundamental to understand not only if, but also why the monetary policy transmission may or not effectively occur. This exercise also provides a point of departure to understand what needs to be improved.

Additionally, with exception of Abradu-Otoo et al. (2003), these studies tend to lose information for not providing a long-run relationship between the variables when cointegration exists among them. Moreover, only Montiel *et al.* (2012) correctly include the possibility that in cases of a flatter supply curve, monetary effects may be felt in output levels rather than in prices.

Considering these gaps, the following sections continue with the analysis of monetary policy transmission in SSA environment. But, to achieve a deep analysis, from this point the focus is turned to the Mozambique case.

3. MONETARY POLICY FRAMEWORK IN MOZAMBIQUE

The monetary policy in Mozambique, as in many developing countries, is based on the IMF financial programming model. In simple terms, monetary and fiscal identities are conjugated with the balance of payments to define the objectives of the monetary policy, which are single digit inflation and a stable exchange rate. In this sense, it is up to monetary policy to target the net domestic assets (NDA) and net foreign assets (NFA) (Easterly 2002, BM 2007a).

Specifically, based on the law 1/92, from 3rd January, the Bank of Mozambique (BM) Medium term strategy (BM 2007a) states that the role of monetary policy in Mozambique consists of:

(i) Determination of the operating and intermediate targets that are, respectively, the monetary base and the money supply. When determining the monetary base the Central Bank must consider its balance sheet. So, the monetary base must equal to the NFA and NDA that are the Central Bank assets.

$$MoB = NFA + NDA$$

The money supply is represented by the broad monetary aggregate (M3), which is the amount of money and coins in circulation, plus the total amount of deposits in foreign and domestic currency (ibid). The monetary actions are transmitted from the MBa to M3 through the money multiplier mechanism (see Mishkin 2012 for details):

$$M3 = m * MoB$$

(ii) Prices Control. Based on a monetary view of inflation, money supply is expected to determine prices through the quantitative money theory.

$$M3 * V = P * Y$$

Where, P, V *and* Y are respectively prices, money velocity and output. As formulated by Fischer (1911) the latter two are constant, so money changes determine the price level.

(iii) Controlling credit/money demand. The money demand is considered important in determining the demand of goods (in an IS-LM model fashion (Hicks 1937)) and thus

> the price level. In this sense, the short-term interest rate, specially, of the treasury bills emitted by the Central Bank in Mozambique are also used as instruments of monetary policy, under expectations that it influences aggregate demand and thus prices.

Considering this, the BM uses indirect instruments to reach the operational targets. The OMO are mainly used, but also employed are reserve requirements, repo and reverse operations and the discount window (BM 2012). These instruments are called to meet the NDA and NFA goals. The former determines the amount of credit that can be created by the central bank allowing to control inflation, while the latter determines the external reserves accumulation. So, if the level of NFA is below the target, monetary policy will be restrictive relatively to the NDA. The same stance is assumed if inflation is above the objective (Blejer *et al.* 2002, Epstein and Heintz 2006).

Several criticisms have been pointed to this approach. The practically exclusive focus on inflation and exchange rate leaves aside other important things such as output growth and employment (Chang 2010:51). Therefore, it only defines the criteria for monetary policy tightening, that is in case of high inflation and/or low external reserves, but it does not refer to the need of expansionary interventions under slow growth or low employment, for example. Other pointed flaws are related to the model mechanics, such as, the assumption of constant money velocity, stable relationship between credit and money supply, no long-run impact of monetary policy and identities consistency problems. Further, it is said that the framework is inappropriate to the economic conjecture that characterises SSA countries as Mozambique for requiring developed financial systems (Easterly 2002, Fine and Hailu 2002, Epstein and Heintz 2006). It is to this last point that the following chapter turns.

4. OVERVIEW OF MOZAMBIQUE'S FINANCIAL STRUCTURE AND THE LINKAGES WITH THE ECONOMIC ACTIVITY

Since it is clear that the financial sector is the main conduit of monetary policy, this section gathers information about Mozambique financial sector and its relationship with the economic activity to make previous inferences about this policy effectiveness.

4.1. The Financial Structure

Mozambique's financial system is dominated by the commercial banking sector. The capital market (i.e. for equities and bonds) is barely developed. The total value of securities traded represents only 5.6% of GDP, from which 3.7% are public bonds. Commercial banks control more than 99% of total credit and deposits in the system (Tables 2&3).

Tables 2&3: Credit institutions in Mozambique and the financial system size and depth

Credit Institutions (2010)	
Banks	16
Cooperatives	7
Micro banks	6
Leasing institutions	0
Microcredit	118
Commercial Banks credit /Financial system credit	99.1%
Commercial Banks deposits/Financial system deposits	99.1%

Financial System Size and depth (2011)	
M2/GDP	28.4%
Deposits/GDP	33.4%
Credit /GDP	25.6%
Total securities traded	5.6%
Total Public Bonds/GDP	3.7%
Total Private Bonds/GDP	1.9%

Source: Data on the number of credit institutions was obtained from the Bank of Mozambique (BM) 2010 Annual Report that is the last available in their website (www.bancomoc.co.mz). The data on financial system size and depth is from the World Bank most recent financial database (http://databank.worldbank.org/ddp/home.do). This justifies the years' differences.

The total of deposits and credit in the financial sector is about 33% and 26% of the GDP, respectively. Related to these indicators, Mozambique financial sector performs well if compared to the LICs and SSA regional average (table4).

The bond market was created in 1999. At the moment, it has in total 5 public bonds and 13 private bonds, which, respectively, totalize about 7,376 and of 3,710 million Meticals[6] (BVM

[6] Metical is Mozambique's national currency. The values respectively equals to 246 and 123 million USD (BM August mean exchange rate from www.bancomoc.mz).

2012). The stock market capitalization is about 7% of the GDP. That is very low compared to SSA and LICs mean (table4).

The dominance of the bank sector and the negligible role of the financial markets shown by the low values of the securities traded and the stock exchange (table 2&3) clearly suggest that the credit lending channel is the main candidate for monetary policy transmission mechanisms. This is reinforced by the practically insignificant role of the non-financial institutions (NFI) (see BM 2010).

On the other hand, a very limited part of the population is effectively covered by commercial bank services. From the 43% of the adult population that is reported to use credit, only 6% have access to formal loans, the remaining 37% uses informal credit sources such as family members and/or informal lenders (World Bank 2012). Also low is the proportion of the population with formal savings (table4). Thus, even if the monetary policy actions affect the credit supply and lending rates, the transmission to consumption and investment spending that will affect the aggregate demand may be limited.

Table 4: Mozambique Financial Development in a comparative perspective (Selected Indicators) (2011)

	Mozambique	SSA-LICs	SSA	LICs
Breadth and depth of the financial sector				
Deposit Banks/GDP*	29%	24%	30%	26%
Domestic credit from the banking sector/GDP	26%	22%	25%	26%
Domestic credit to private sector/GDP)	25%	18%	20%	20%
Money and quasi money (M2)/GDP	28%	28%	30%	34%
Other financial Institutions assets/GDP*	1%	8%	29%	7%
Bonds and stock Market capitalization				
Stock Market total value traded/GDP	1%	1%	4%	3%
Stock Market capitalization	7%	43%	46%	33%
Access to Financial services by adult population (15 +) (2012 data)				
Account at a formal financial Institution	40%	-	24%	24%
Use of formal credit	6%	-	5%	11%
Use of informal credit	37%	-	45%	37%
Formal Savings	18%	-	14%	12%
Total savings	43%	-	40%	30%

Source: Calculation by the author based on: Beck and Al-Hussain (2010), World dataBank (2012); *World Bank (2012)*
*Means that (due to availability) the data is from 2009 and not 2011.

Bank sector Structure

Besides being dominant, the bank sector presents considerable degrees of concentration. The 3 largest commercial banks hold about 82% of the share of total banks assets in Mozambique. That is high even compared with Tanzania and Zambia that have almost the same economic development level (Table5).

Furthermore, there are only 3 commercial banks branches per 100 thousand inhabitants. This is below the average of SSA countries and very distant from 9 in South Africa. Besides the indicators in table5, the BM (2011) shows that commercial banks own more than 72% of the 574 branches and 50% of such branches are owned by the 5 largest banks. Further, 41% of these branches are in the 3 largest provinces (see appendix 2).

Table 5: The bank Sector Structure

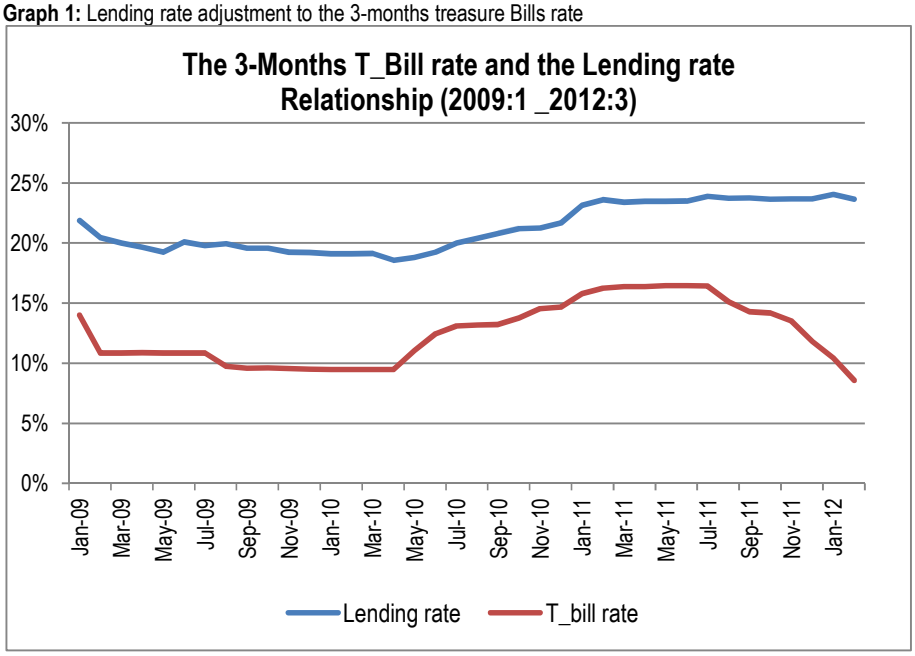
	Year	Kenya	Mozambique	South Africa	Tanzania	Uganda	Zambia	LICs	SSA
Real interest rate	2011	2.7%	7.2%	0.9%	5.9%	16.2%	4.7%	11.2%	7.8%
Interest rate spread (lending rate minus deposit rate)	2010	10%	7%	3%	8%	12%	14%	15%	12%
Risk premium on lending (prime rate minus treasury bill rate)	2011	6.0%	4.0%	4.0%	9.0%	7.0%	9.0%	14.8%	9.2%
Bank concentration	2009	n/d	82%	n/d	47%	58%	74%	73%	-
Commercial bank branches (per 100,000 adults)	2009	4.4	2.9	9.4	1.8	2.3	-	2.9	5.4

Source: *World dataBank (2012), World Bank 2012, KPMG (2009)*
n/d- no data

These indications of concentration may explain the high real interest rates. After Uganda, Mozambique has the highest interest rate relatively to other SSA countries in the table although it is below the SSA average.

Under concentration, stickiness of the lending rates response to policy rate changes is quite unavoidable. For example, under expansionary policies, banks tend be slower to adjust lending rates down, because they face a less elastic demand for loans, making the cost of adjustment higher than the cost of keeping the lending rate different from the market rate (Cottarelli and Kourelis 1994). This maladjustment of lending rates relative to the policy rate is clearly shown in the graph 1.

Graph 1: Lending rate adjustment to the 3-months treasure Bills rate



Source: Elaborated by the author based on data from the BM Website: www.bancomoc.co.mz

From July to August 2009, the T-Bill rate drop from 11% to 10% is not immediately responded by the lending rate. Only 4 months later the latter falls from 20% to 19%. Such disparity is more accentuated from July 2011, where there is significant drop of the T-Bill rate from 16% to 9% in March 2012, but the lending rate is completely irresponsive to such drop and slightly increases, thus raising the spread among the rates. It can also be seen that when the T_Bill rate increases the lending rate immediately adjusts to the former (from March 2010 to January 2011), meaning that the rigidity is present when the rates should be adjusted downward. This is probably because, with no competitive financial structure, thus less elastic demand there will be few alternatives to banks' loans, so banks have no significant losses from keeping their interest rate above of the market rate.

Distribution of banks financial assets

Besides high real interest rates, banks' reserves have been above the minimum requirement as shown below (table6). The excess of liquidity may undermine the effectiveness of monetary

policy because it hinders the regulation of the money supply through the money multiplier (Nissanke and Aryeetey 1998:118-127). Likewise, Saxegaard (2006) shows quantitatively that for the Central Africa Economic and Monetary Community, Nigeria and Uganda that excess liquidity weakens the capacity to influence aggregate demand behaviour in the economy through monetary policy.

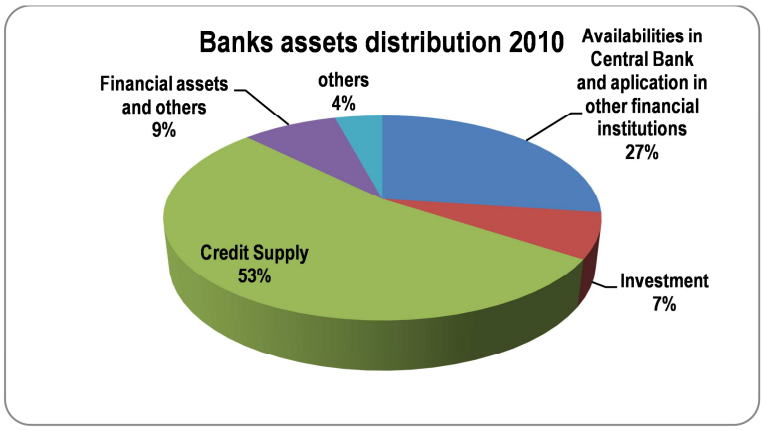
Further, financial assets, risk free public and private bonds and investment in other financial institutions, are one of the main preferences of the commercial banks that in 2010 invested about 34% of the total assets in such instruments (graph2**)**. This suggests that, as said by Mishra et al. (2010), the lack of competition makes banks more likely substitute loans to the private sector for securities in case of major availability of reserves, lowering the private sector access to finance.

Table 6: Banks reserves

	Required Reserves	Actual Reserves
Jan/07- Dec07	10.2%	12.5%
Jan/08- Dec/08	9.0%	10.8%
Jan/09-Dec/09	8.0%	9.5%
Jan/10-Dec/10	8.8%	9.4%
Jan/11-Nov/11	9.0%	10.1%
Dec/11-Feb/12	8.5%	9.8%

Source: Author's calculations based on data from the BM website: www.bancomoc.mz and BM reports (2007b, 2008, 2009, 2010)

Graphs 2: Banks assets distribution



Source: Idem

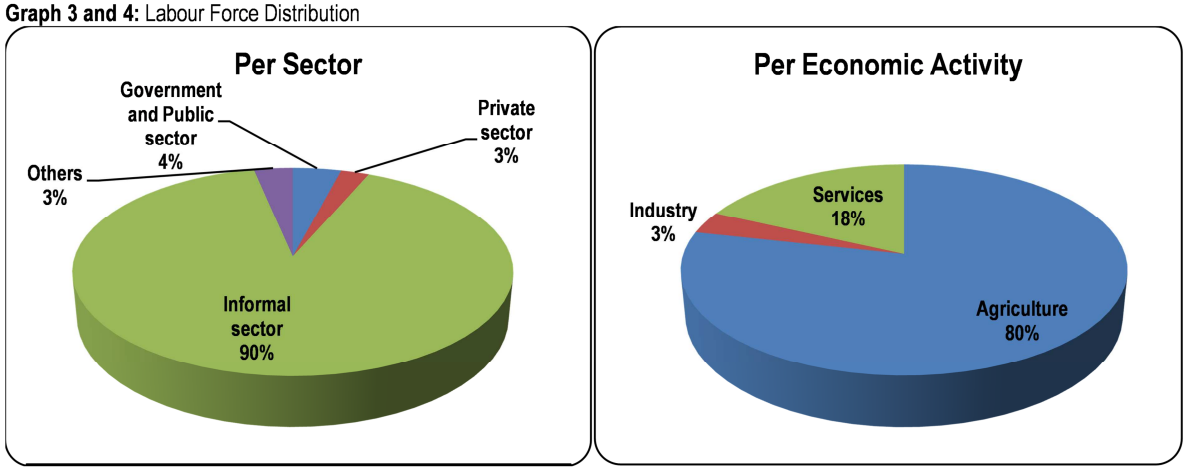
4.2. The Economic Activity[7]

Besides the low coverage and development, the financial sector seems to present a weak linkage with the real economy. The proportion of the informal economy and the private investment dynamics suggest that its influence in the economic activity may be limited.

The size of the informal sector

The proportion of total labour force in the informal sector gives the best indicative measure of the informal sector. So, this makes about 90% of Mozambique labour force, of which the majority is in the agricultural sector. Thus, a considerable part of the economic activity cannot be financed through bank credit for not presenting the requirements to overcome collateral and moral hazard problems.

Graph 3 and 4: Labour Force Distribution



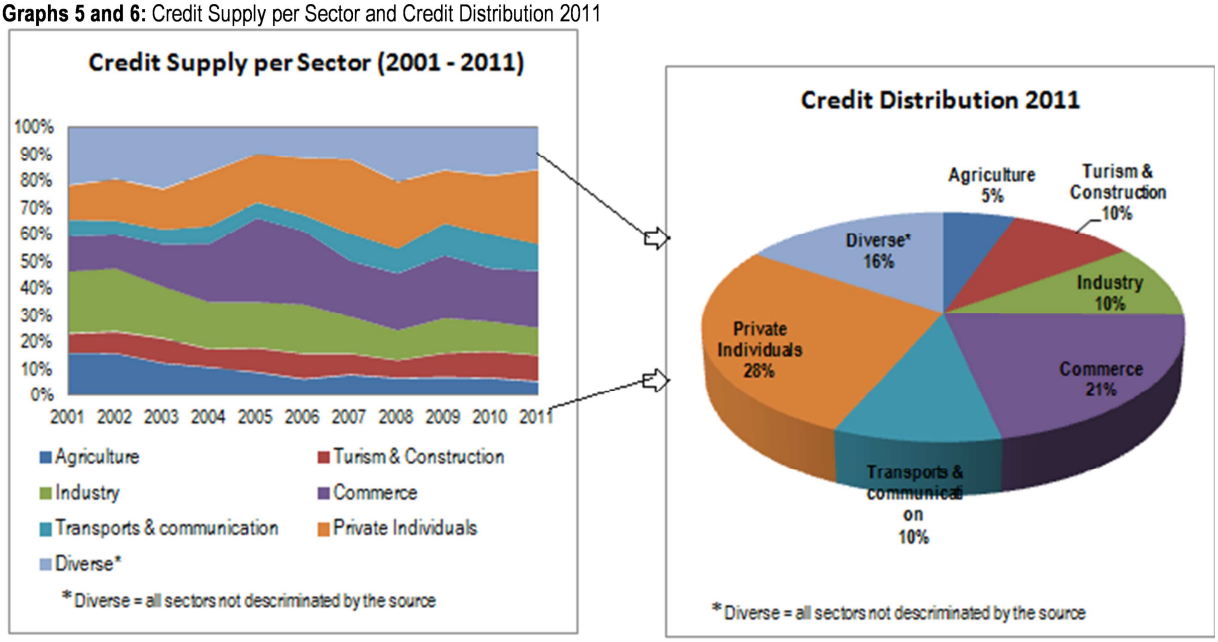
Source: National Statistics Institute (2006), UNDP Mozambique (2012)

This is probably the reason why the agricultural sector although responding for a considerable part of the economic activity receives the smaller proportion of total credit. Further, it can be seen that the majority (almost 30%) of credit is allocated to private individuals (graphs5&6). Considering that only 6% of the adult population effectively receives credit (table4), it can be concluded that variations in the biggest proportion of credit supply is likely to influence only 6% of the population in terms of their individual spending. And if considered the limitation in terms

[7] This sub-section points to specific factors of Mozambique economy that may influence the monetary policy transmission.

of inter-sectoral distribution and linkages among sectors due to the extractive nature of the economy clearly shown in Castel-Branco (2010), the spillovers effects are presumably limited.

Graphs 5 and 6: Credit Supply per Sector and Credit Distribution 2011



Source: Elaborate by the author based on data from BM Website: www.bancomoc.mz

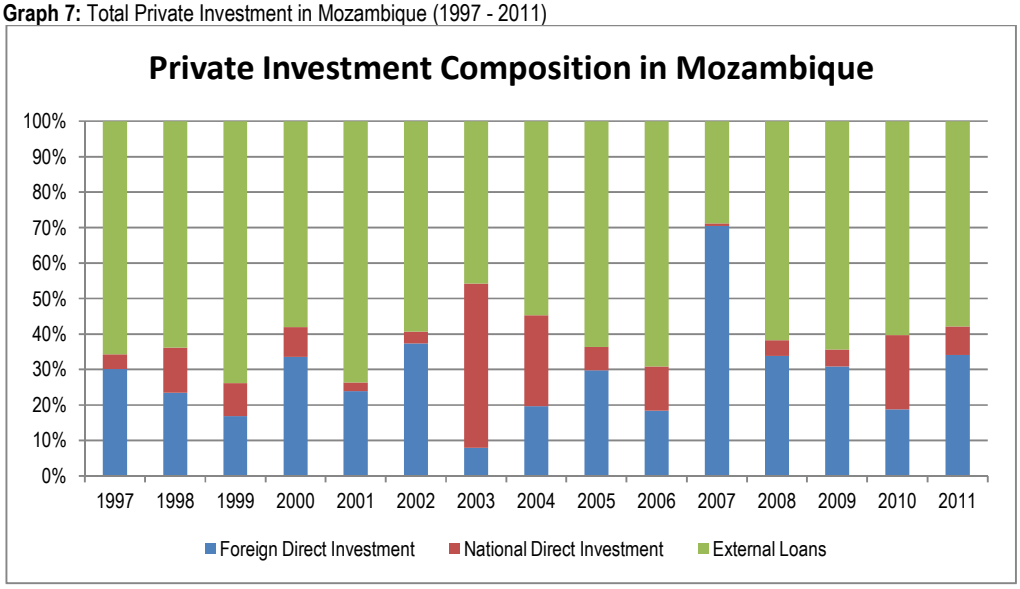
Private Investment

More than 90% of private investment in Mozambique is financed through external capital inflows (FDI), that is, it does not depend on private credit from domestic commercial banks (graph7). Domestic private investment is about 8% of the total share of investment, and according to *World Economic Forum* (2011:268) limited access to credit by national enterprises is the main problem faced (appendix1). So, this indicates that a significant part of the 8% of private investment may not be targeted by credit supply.

Again, this is a manifestation of what Castel-Branco and Ossemane (2010) called *extractive economic structure*, that is, the economy is limited in terms of raising domestic resources to organize production, investment and consumption. These features lead to vulnerability and

chronic instability of macroeconomic indicators (such as prices) and limits the role of the financial system, thus of monetary policy, in effectively influencing productive dynamics.

Graph 7: Total Private Investment in Mozambique (1997 - 2011)



Source: Elaborate by the author based on Data from Mozambique Centre of Public Integrity (CPI) (1997 – 2012)

Other Macroeconomic conditions

Other fundamental factors in monetary transmission are the financial integration and exchange rate regime. Chinn and Ito (2012) calculate an index of financial openness for Mozambique of -1.15. This means weak financial openness/integration, thus low capital mobility. To have a point of comparison index levels for Nigeria and Brazil, are about -0.53 and 0.16 respectively, and for the USA it is 2.46. Further, the *Annual Report on Exchange Arrangements and Exchange Restrictions 2009* points to capital account transactions controls in Mozambique concerning purchases and sales of securities abroad.

On the other side, the *IMF 2008 De Facto Classification of Exchange Rate* categorizes Mozambique has having a managed floating regime with no pre-determined path for the exchange rate. So, in the scope of the Mundell-Fleming model, monetary policy should be effective (Obsteld & Rogoff 1996).

In sum, the picture indicates that, in macroeconomic terms, the basic requirement of flexible exchange rate for monetary effectiveness is satisfied, though capital liberalization is still limited. But, concerning the financial structure, the picture is not so optimistic. There is an indication of weak linkage among commercial bank behaviour and monetary policy actions: banks are reluctant to respond to the policy rates, have excessive reserves besides driving significant part of their assets to other financial activities. Moreover, the weak dependency of the economic activity on the bank sector further suggests limited impact of monetary actions. A small part of the population uses credit, considerable part of economic activity is informal or more dependent on external resources than on the domestic financial system resources.

5. ECONOMETRIC ANALYSIS: METHODOLOGY AND ESTIMATION

The present section econometrically analyzes the monetary policy transmission in Mozambique. Although being a simplification of the complexity that surrounds any economy, this quantitative analysis provides a formal point of inference to answer the questions posed in this study.

5.1. Data

To assess the effectiveness of monetary policy in Mozambique, considering the BM policy framework, monthly time series data of the variables in the table7 were employed. The period covered is between September 1997 and March 2012 that comprises the actual use of indirect instruments of monetary policy and the most recent available data. This period followed a set of reforms initiated in 1992, which included the liberalization of the exchange and interest rates and the creation of an interbank foreign exchange market (BM 2010).

Table 7: Variables used for the econometric analysis

Categories	Variables	Source
Operational variables	Monetary base (**MBa**) and the three-month treasury bill rate (**T-Bill**)	BM:www.bancomoc.co.mz
Intermediate variable	Broad Monetary Aggregate:M3, Commercial Banks lending rate (**Irate**)	BM:www.bancomoc.co.mz Obs: the lending rate used is the average rate applied for year average interest rate
Indicator variables	M3 and the Metical-USD nominal exchange rate(**Exc**)[a]	BM:www.bancomoc.co.mz
Final targets/aggregate demand variables	Real GDP (**RGDP**) and the Consumer Price index (**P**) (base year=2010)	National Institute of Statistics. Obs: the Consumer price is a proxy for prices

[a] Depreciation is equivalent to an increase of the nominal exchange rate

To overcome heteroscedasticity in the residuals, all variables are employed in logarithms, except the lending rates and T-Bill interest rate. Also, because of heteroscedasticity problems, exogenous variables such as fuel and energy price indexes and seasonal dummies were discarded. It is assumed that the endogenous variables behavior indirectly consider such exogenous influences. Appendix4 shows the variables descriptive statistics and it can be see that the series are stable and approaches symmetry during the period in analysis.

The metical-US dollar (USD) exchange rate was chosen because the USD plays an important role in Mozambique's economy[8], considering that external reserves, debt and aid are mainly in US dollars (www.bancomoc.co.mz).

5.1.1. Unit Root and Cointegration Tests

Having the data, the transition to model specification was anticipated by two tests. First, tests of the variables order of integration were carried out using the Augmented Dickey Fuller (ADF) and Phillips-Perron tests. The results pointed that all variables are non-stationary and integrated of order 1 (appendix5**)**.

The non-stationarity of the variables implies that cointegration tests are needed to avoid spurious regressions (Gujarati and Porter 2009). So, the second step is the Johansen cointegration test that analyzes if multiple time series are cointegrated in a long-run equilibrium. The test results (table8) suggest two long-run economically meaningful cointegrating relationships among the variables (test details in appendix6).

Table 8: Johansen Cointegration test results

Johansen test : Both the Max-Eigen and the trace statistics point to 2 cointegrating vectors

No. of CE(s)	Max-Eigen Statistic and P-value in [ ]	0.05 Critical values	Trace Statistic P-values in [ ]	0.05 Critical Value
None *	**102.91 [.00]**	**44.50**	**205.08 [.00]**	**117.71**
At most 1 *	**41.09 [.02]**	**38.33**	**102.17 [.00]**	**88.80**
At most 2	26.41 [.21]	32.12	61.08 [.08]	63.88
At most 3	22.44 [.13]	25.82	34.67 [.26]	42.92
At most 4	11.80 [.43]	19.39	12.23 [.80]	25.87
At most 5	0.43 [1.00]	12.52	0.43 [1.00]	12.52

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

[8] Ubide (1997) and Omar (2003) found that the Metical –South Africa Rand exchange rate is also important for Mozambique economy. But using two exchange rates in the VECM leaded to multicollinearity problems. So, based on the aforementioned reasons this study decided to use the Metical-USD exchange rate. An initial idea was intercalate the two exchange rates between models and make comparisons, but for the objectives of this study comparison is made between operational variables.

The variables cointegration implies they must be modeled in a VECM that considers the long-run and short-run relationships.

5.2. Model Specification

In simple terms, a VECM can be expressed as follows Johansen and Juselius (1990) (details in appendix 6):

$$\Delta Y_t = \alpha\beta' Y_{t-p} + C_1 Y_{t-1} + \cdots + C_{p-1}\Delta Y_{t-p+1} + \delta_i X_t + (\alpha\mu_o + \mu_1) + (\alpha\delta_o)t + \varepsilon_t \qquad (5.2.1)$$

Where: Y_t is an *nx1* vector of endogenous variables that in this case will consist of:

$$VECM\ 1: Y_{t-p} = [LExc, LM3, lrate, LMoB\ LGDP, LP\ ]$$

$$VECM\ 2: Y_{t-p} = [\ LExc, LM3, lrate, T\_Bill, LGDP, LP\ ]$$

α is the vector of adjustment parameters; β denotes the cointegrating vector that contains the long-run coefficients; $\alpha\beta' = \Pi$ that is the coefficient on the error-correction term, $C_i, i = 1, \ldots (p-1)$, is the coefficient of lagged differences of the endogenous variables, X_t is a vector of exogenous that can be employed in the model, but in this case were discarded because of heteroscedasticity problems, *t* and *p* respectively denotes time and the lag terms; $(\mu_{1_o})\ and\ (\alpha\mu_o + \alpha\delta)$ Are the deterministic parts of the model, respectively, the constant term for the short-run regression and the second combines constant and trend coefficient for the cointegrating regression.[9]

The first component of this VECM provides long-run elasticities. For example they will tell how a shock in the MBa at time t, affect GDP at time t. While the short-run component of the model that is a VAR – because each endogenous variables are regressed on their own lags and other variables lags variable – shows the dynamic transmission of shocks over time, for example, how the shock at time t will affect output at t+q, q=1,2,3…p. So, it allows analyzing the dynamic of monetary policy transmission. Furthermore, impulse response functions and variances

[9] The deterministic component was selected based on the variables characteristics, but the *Pantula principle* suggested by Johansen and Juselius (1992) to select the appropriate combination of the deterministic components also leaded to the model employed.

decomposition are employed as complementary tools. The former allows seeing time and dimensional impact of a shock/innovation in monetary variables at a time t on the objective variables. While from the latter it can be see the source of variation of the endogenous variables.

The order of the variables in the VECM is fundamental. So, exchange rate is ordered first because it is assumed that its response to all other variables is not instantaneous. This is plausible considering the small nature of Mozambique's economy with few effects on 'world' variables. This is followed by M3, MBa, lending interest rate, output and prices. This means that output responds contemporaneously to all other endogenous variables but prices, while prices respond to all 5 variables.

From this set, the transmission of monetary policy in Mozambique can be analyzed. So, if considered $\boldsymbol{f_x(y)}$ a denotation of a function that characterizes $\boldsymbol{x}$ relationship with $\boldsymbol{y}$, testing for different monetary policy channels imply testing the following hypotheses:

(i) *The Lending Rate channel*

$\boldsymbol{f_{lrate}}(\boldsymbol{MBa}) < 0$ *lending interest rate falls under MBa expansion*

$\boldsymbol{f_{lrate}}(\boldsymbol{T\_Bill}) > 0$ *lending interest rate positively responds to the* T_{Bill} *rate*

And:

- $\boldsymbol{f_{LGDP}}(\boldsymbol{lending\ rate}) < 0$ *interest rate increase implies a fall in output*
- $\boldsymbol{f_{LP}}(\boldsymbol{lending\ rate}) < 0$ *interest rate increase implies a fall in prices*

so:

$\boldsymbol{f_{LGDP}}(\boldsymbol{MBa}) > 0$ *and* $\boldsymbol{f_{LP}}(\boldsymbol{MBa}) > 0$ *and* $\boldsymbol{f_{LGDP}}(\boldsymbol{T\_Bill}) < 0$ *and* $\boldsymbol{f_{LP}}(\boldsymbol{T\_Bill}) < 0$**:**

Through the lending rate, output and prices increase with monetary expansion (that equals to $\Delta MBa > 0$ *or* $\Delta T_{Bill} < 0$*) and fall under monetary contraction (that equals to* $\Delta MBa < 0$ *or* $\Delta T_{Bill} >$*)*

(ii) *The exchange rate channel*

$f_{LExc}(\boldsymbol{MBa}) > 0$ *a monetary expansion leads to exchange rate depreciation*

$f_{LExc}(\boldsymbol{T\_Bill}) < 0$ *a monetary expansion leads to exchange rate depreciation*

And:

- $f_{LGDP}(\boldsymbol{exchange\ rate}) > or < 0$
- $f_{LP}(\boldsymbol{exchange\ rate}) > or < 0$

So: ⇨ *The exchange rate will conduct to output and prices the effects of changes in the monetary policy operational variables (MBa and* T_{Bill}*). The net effect as above explained will depend on the economy specific conditions*

Furthermore, the impact of changes in the operational variables can be channeled to prices and output through the broad money M3. The results expected are in the same direction of the monetary base (and contrary to the T_Bill).

5.3. Estimation Results

5.3.1. VECM 1

Table 9 reports the results of the long-run relationship equations and error-corrections. The equations are normalized to prices and output and the overall specification was good (diagnostics tests and further specification details in appendix 7).

Table9: Monetary Policy Transmission: MBa as operational variable

Dependent variable	LExc (-1)	LM3(-1)	LMBa(-1)	lrate(-1)	@TREND(97M09)	c
LGDP(-1)	**-0.36**	**0.58**	-0.02	**-0.18**	**-0.01**	-12.74
	[-3.63]	**[-4.77]**	[-0.16]	**[-1.96]**	**[-4.63]**	
LP(-1)	**-1.39**	0.43	**0.59**	**1.75**	**-0.02**	-8.44
	[-4.71]	[-1.19]	**[-1.8]**	**[-3.55]**	**[-1.97]**	

Error Correction:	D(LGDP)	D(LP)	D(LExc)	D(LM3)	D(LMBa)	D(lrate)
CointEq1	**-0.78**	0.00	-0.10	**-0.25**	0.12	0.04
	[-4.66]	[-0.04]	[-0.87]	**[-2.66]**	[0.69]	[1.43]
	-0.05	**-0.03**	0.11	0.02	**-0.23**	-0.03
CointEq2	[-0.94]	**[-1.90]**	[2.96]	[0.67]	**[-3.97]**	[-3.35]

Coefficient in bold are significant at 5% and/or 10% levels

According to the cointegrating equations, 1% increase in the lending rate implies a 0.2% fall in GDP and 1.8% increase in prices in the long-run. The negative reaction of output indicates that, in the long-run, the components of the aggregate demand negatively respond to a higher cost of finance. The price response- that is somehow puzzling- may translate the cost that higher interest rates represent to business. This is in accordance with the fact that access to credit was ranked as the main difficulty in doing business in Mozambique (*World Economic Forum 2011*).

A monetary expansion, on the other side, has a positive impact on both objective variables. The output shows a significant elasticity to M3 (0.6%) and prices to MBa (0.6%). Furthermore, the significant responses of price and output to the exchange rate suggest an effective exchange rate pass-through, with effects on prices being more significant. 1% exchange rate depreciation makes prices and output fall, respectively, in 0.4% and 1.4%.

The significant and negative error-correction coefficients indicate that GDP, M3, prices and the MBa are the system equilibrating variables.

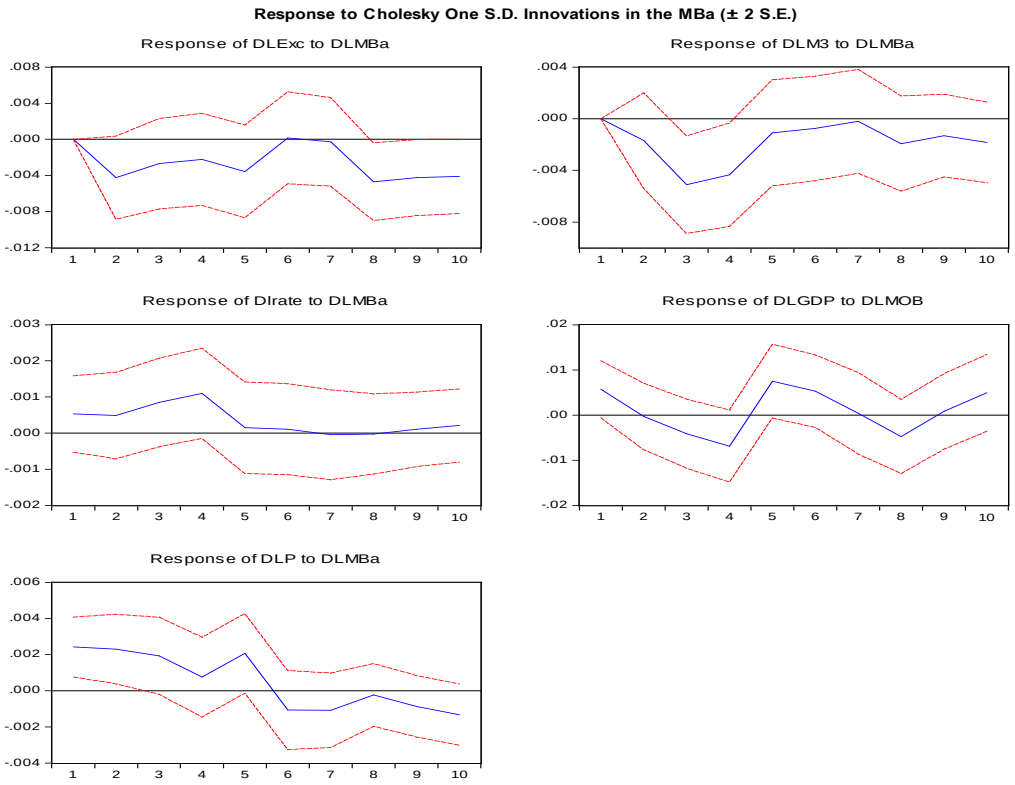
Appendix 8 presents the short-run causal relationships, i.e., the VAR. As variables are in log-differences the elasticities represent growth rates (and responses are interpreted as proportions, i.e., 0.002=0.2%). The VAR shows that, through its operational variable MBa, monetary policy actions pass-through to the intermediate variables does not occur. M3 that effectively affects prices has an ambiguous negative relationship with MBa. Furthermore, negative significant

relationships are found between lending rate and prices and exchange rate and output, but both intermediate variables do not respond to MBa.

Impulse responses from VAR

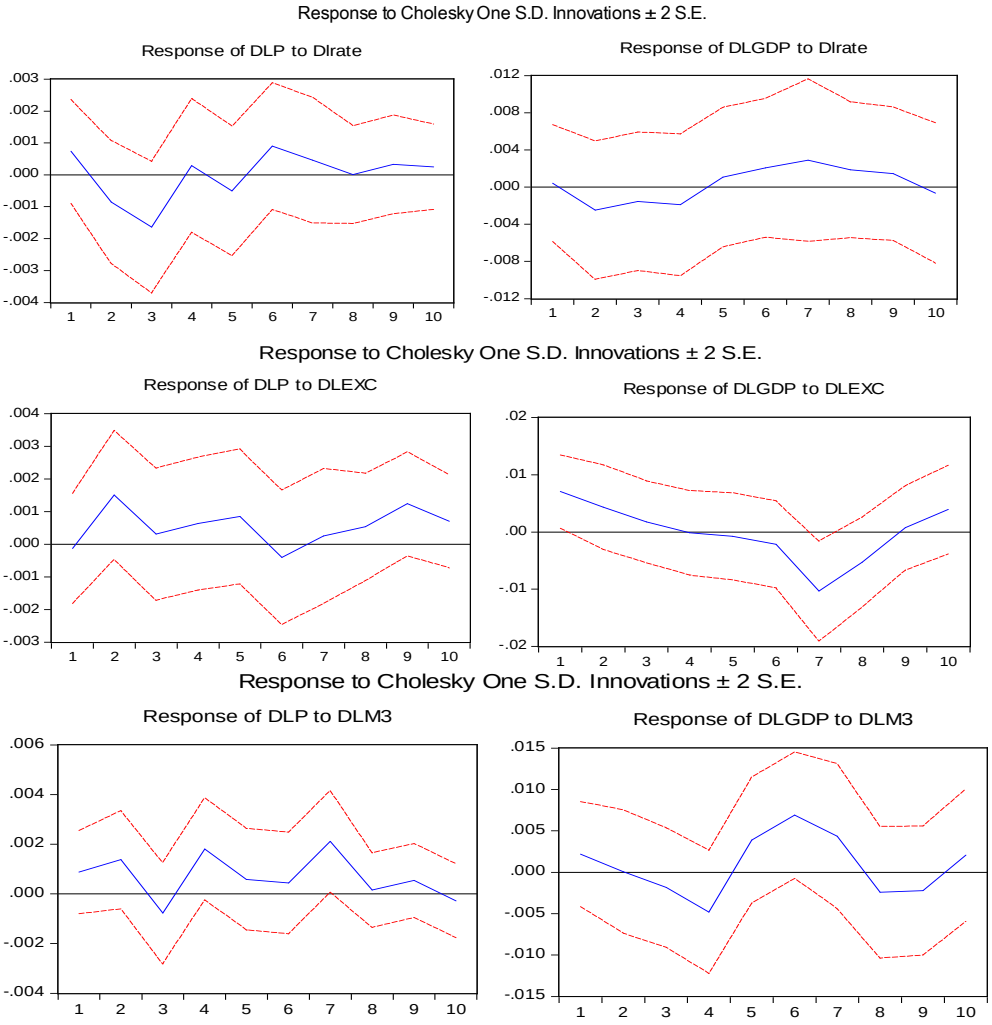
Figure 2 describes the repercussion one standard deviation positive shocks in the MBa (that can be interpreted as an unexpected shock in the MBa). All variables present non-monotonic reactions, most coefficients are insignificant and ambiguity in the responses is predominant. The lending rate besides having an insignificant response surprisingly increases until the 4th month peaking at 0.12% before falling. The exchange rate answer is only significant in the 8th month, but also ambiguously the reaction is negative (about -0.4%), that means an exchange rate appreciation under a monetary expansion. Similarly, puzzling is the negative reaction of M3 that becomes significant between the 2nd and 3rd months. Output and prices have a positive instantaneous reaction to the shocks, but only the prices response is statistically significant.

Figure 2: Effects of positive shocks in the MBa (on the Exc, M3, Irate, GDP and P)



This mixture of ambiguous results raises doubts about the model specification. But, re-specification of the model considering other identification schemes, dummy variables, different time period, exogenous variables and even other endogenous variables such as credit, in nothing improved the results. Further, similar analyses for the case of Mozambique (such as Peiris and Lledó (2008) and Rungo and Manjate (2011)) also found puzzling reactions from the variables in their models. Thus, the puzzling responses may be a manifestation of the variables weak sensitivity to monetary policy actions.

Figure 3: Response of Output and Prices to positive shocks, respectively, in the lrate (lending rate), Exchange rate and M3



Figures 3 present the reaction of the objective variables to innovations in the intermediary variables that may help diagnose possible monetary channels. Output and prices show an initial negative response to positive shocks in the lending rate. Although theoretically consistent, none of the effects is significant. The positive innovation in the exchange rate (that in this case means depreciation) has a significant effect in output only in the 7th month after the shock, and such impact is negative. And prices have a significant positive response to the broad money M3, in the 7th months after the shock.

From these results it cannot be confirmed the effectiveness of any of the channels in analysis. The insignificant relationship between MBa and the lending rate, and between the latter and the objective variables rejects the lending channel. Although M3 and the exchange rate effectively impacts the objective variables, the ambiguous and weak relationship with the MBa also do not allow confirming these channels.

5.3.2. VECM 2

Table 10 shows the cointegrating equations and error-correction of the VECM using the T_ Bill rate.

Table 10: Monetary policy transmission: the 3-months T-Bill rate as operational variable

Dependent	LExc(-1)	LM3(-1)	T_BILL(-1)	lrate(-1)	@TREND(97M09)	C
LGDP(-1)	**-0.31**	**0.47**	**-0.61**	**0.86**	**-0.01**	-12.2
	[-5.54]	**[5.12]**	**[-3.65]**	**[3.47]**	**[-8.48]**	
LP(-1)	**-0.46**	**0.51**	**-1.99**	**2.65**	**-0.01**	-7.09
	[-3.11]	**[2.11]**	**[-4.45]**	**[4.00]**	**[-3.65]**	

Error Correction:	D(LGDP)	D(LP)	D(LExc)	D(LM3)	D(T_BILL)	D(lrate)
CointEq1	**-1.10**	0.10	**-0.34**	**-0.20**	**-0.13**	0.01
	[-5.67]	[1.67]	**[-2.48]**	**[-1.75]**	**[-2.33]**	[0.46]
CointEq2	0.21	-0.03	0.14	0.00	0.04	**-0.06**
	[2.31]	[-1.24]	[2.27]	[-0.02]	[1.52]	**[-4.27]**

Coefficient in bold are significant at 5% and/or 10% levels

Both equations show significant coefficients. The T_Bill rate increase by 1% leads to 2% and 0.6%, respectively, decrease in prices and output. This suggests that the T_Bill rate has a long-run effect in the commercial banks supply of credit that affects the aggregate spending. But, in contrast, there is a positive puzzling long-run lending rate elasticity of prices (2.6%) and output (0.9%). On the price side, as argued above it may be due to higher costs in terms of interest rate for businesses, and the positive output response can be interpreted as a positive movement in the output supply curve following higher prices. An alternative explanation for this puzzle that is very common in the literature (Sims 1992, Ngalawa and Viegi 2011) is that the operation variable is not appropriated, as no puzzle is found with the MBa.

Again, the positive long-run elasticity of output and prices relative to M3 implies positive long-run effects of expansionary policies. And, relative to the lending rate the effect of M3 on prices is minor.

Both objective variables exhibit a negative long-run elasticity to the exchange rate. This is possibly due to imports rigid elasticity to exchange rate and Mozambique's limited capacity to overcome dependency on imported goods through time. That is consistent with the fact that the economy imports coverage ratio only improved by 10% in 20 years (Castel-Branco (2012)).

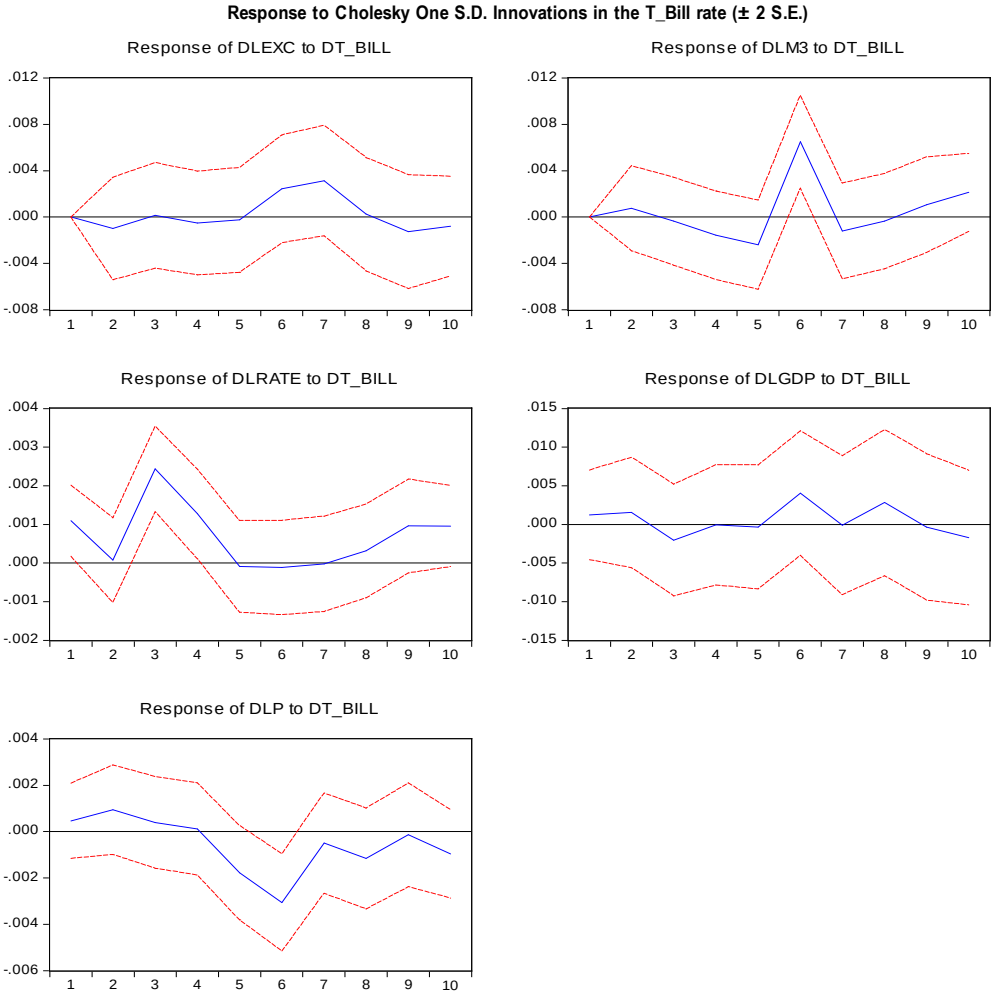
The VAR is reported in the appendix11, again it is hard to identify effective transmission channels**.** The T_Bill has a consistent, negative and significant impact on M3 and a positive impact in the lending rates. But only M3 effectively affects at least one of the objectives (prices). No causality from T_Bill to exchange rate can be identified, neither from the latter to the main targets.

Impulse responses

Figure 4 shows the impulse response of unexpected positive shocks in the T_Bill rate. Output and the exchange rate responses are statistically insignificant. The consistency of the result seems to be better in this model. The lending rate shows a positive and significant reaction between the 2nd and 4th months that is in accordance with the theoretically expected. Prices have

a negative and significant impact between the 5th and 6th month. However, M3 has a lagged and non-monotonic positive response (significant in the 6th month) that is puzzling.

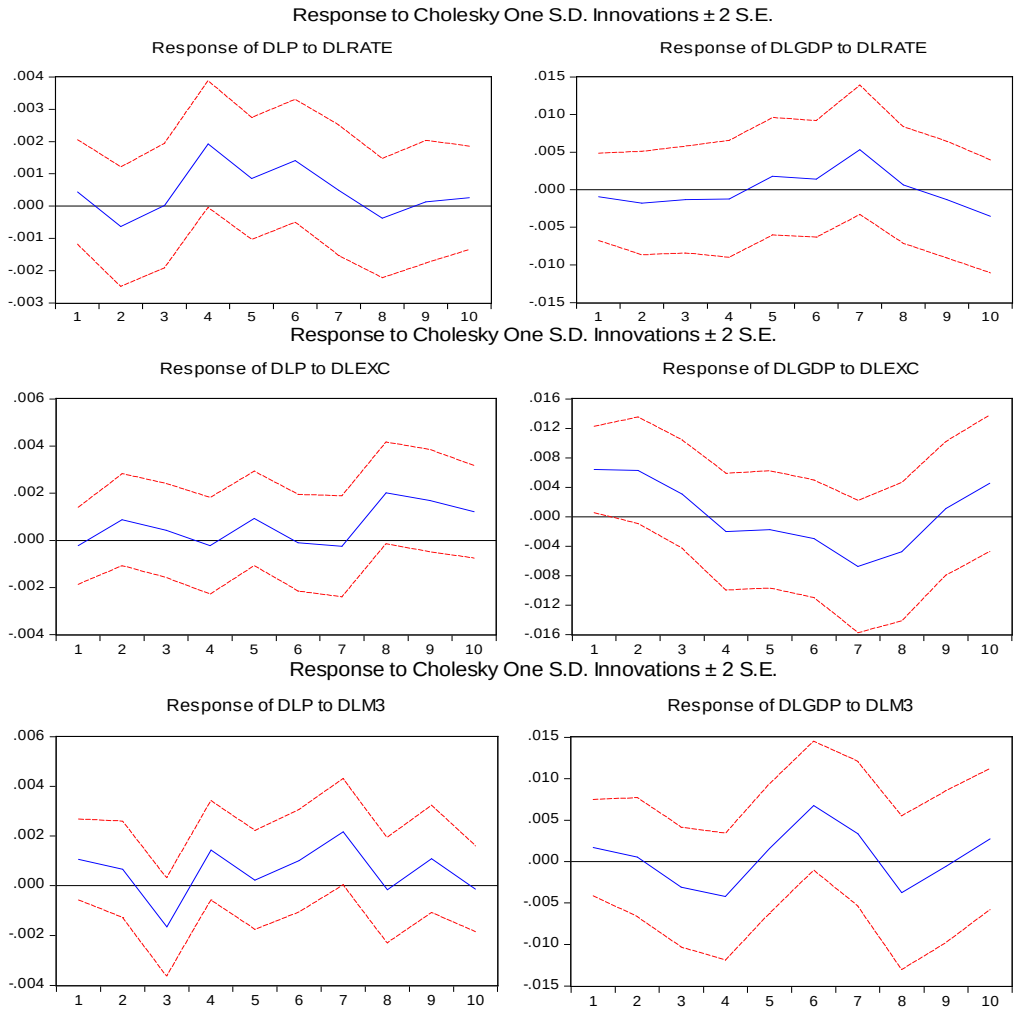
Figure 4: Effects of positive shocks in the T_Bill rate (on the Exc, M3, lrate, GDP and Prices)



The channels of monetary policy transmission cannot be identified (figure 5). The lending rate fails to transfer the shocks in the T-bill rate to the objective variables. As no significant impulse responses to shocks in the lending rate are presented by prices and output. Exchange rate innovations have no significant impact on prices but trigger an instantaneous significant positive impact on output growth of 0.6% in the 1st month. As there is no effective impact of the T_Bill

rate on the exchange rate, an exchange rate channel cannot be confirmed. Also, M3 innovations fail to significantly impact prices and output.

Figure 5: Response of Output and Prices to positive shocks, respectively, in the lrate (lending rate), Exchange rate and M3



5.3.3. Variance Decompositions

Through the variance decomposition variables relationship can also be identified. So, if a certain variable substantially contributes to the variance of another variable, it can be induced that the former is important in the determination of the latter.

Table 11: VECM 1 Variance Decomposition

Variance Decomposition (in %)							
Variable	**Period**	**LExc**	**LM3**	**LMBa**	**Irate**	**LGDP**	**LP**
Irate (Lending rate)	1	0.99	1.08	0.05	97.89	0.00	0.00
	6	2.20	5.05	0.32	90.41	1.98	0.04
	12	**14.61**	2.18	2.70	75.22	3.61	1.67
LGDP	1	5.13	0.32	1.72	0.05	92.78	0.00
	6	**16.94**	**14.76**	2.28	0.56	63.14	2.33
	12	**14.60**	**10.56**	5.05	1.57	64.72	3.51
LP (Prices)	1	0.13	0.54	3.39	0.26	0.04	95.64
	6	5.27	2.16	**10.06**	2.54	0.73	79.25
	12	**12.48**	6.98	8.42	3.42	2.81	65.88
Exc (Exchange Rate)	1	100	0	0	0	0	0
	6	93.47	2.34	0.13	3.52	0.05	0.49
	12	73.35	**10.38**	0.19	**11.91**	2.14	2.04

In bold are the contribution >=10%

Table 12: VECM 2 Variance Decomposition

Variance Decomposition (in %)							
Variable	**Period**	**LExc**	**LM3**	**T_Bill**	**Irate**	**LY**	**LP**
Irate (Lending rate	1	2.34	0.73	4.21	92.73	0.00	0.00
	6	3.52	2.96	**27.80**	50.55	**11.47**	3.68
	12	9.13	5.97	**34.51**	35.54	**11.82**	3.03
LGDP	1	1.48	0.06	0.02	0.00	98.44	0.00
	6	**11.31**	5.07	0.69	0.44	76.04	6.45
	12	**10.09**	5.34	3.25	2.16	73.26	5.90
LP (Prices)	1	0.04	3.19	0.88	0.09	0.99	94.81
	6	5.20	8.50	3.58	0.44	2.64	79.63
	12	**32.67**	9.86	**11.55**	0.50	2.68	42.74
Exc (Exchange Rate)	1	100	0.00	0.00	0.00	0.00	0.00
	6	86.51	7.02	1.58	0.63	3.09	1.18
	12	64.93	**13.98**	6.78	0.59	**12.07**	1.64

In bold are the contribution >=10%

The results show weak monetary transmission. The MBa contribution to lending and exchange rate variations is low, respectively, 3% and 0.2% after 12 months. Also small is the lending rate contribution to variation in GDP and prices in the first model.

In the second model, the T_Bill rate is important to the lending rate variation, explaining 35% of variations in the latter after 6 months. But the lending rate contribution to output and prices variation is not considerable.

Both models present the exchange rate as an important determinant of both prices and output variance (with percentages above 10%). But, the exchange rate is not significantly influenced by the monetary variables (MBa and T_Bill). It is possible that the monetary variables influence the exchange rate through M3, as it seems to be important for the exchange rate variation.

Additionally, the low contribution of prices to output variation indicates that the focus on inflation is not as fundamental for the economic activity performance.

6. CONCLUSIONS

This paper has discussed the transmission of monetary policy in Mozambique. The evidence found shows that there is a long-run relationship between the objective variables (in this case output and prices) and monetary policy variables. But, the short-run relationships among variables suggest ineffectiveness of monetary policy as a stabilization tool. The results found points to no effective concretization of the expected transmission from monetary policy operational to intermediate variables, and from these to the objective variables. The lending rate, for example, is found to be significantly affected by the T_Bill rate, but have no significant effects on output and prices. Similarly, the broad monetary aggregate M3 responds to monetary operational variables but fails to transmit that to prices and output. The exchange rate channel is the only that seems effective, as exchange rate that contributes significantly to prices and output variation is considerably affected by M3. But it does not respond to the operational variables (MBa and T_Bill).

The long-run relationships suggest that tightening monetary stance is not without costs to output as suggested by the country monetary framework. Output shows a long-run negative significant reaction to higher lending and T_Bill rates, furthermore, prices rise under higher lending rates presumably as a reflection of higher finance costs. The weak influence of prices in output suggests that the focus on lowering inflation is not that fundamental to economic performance as advocated. This suggests that more gains can be taken from prudent expansionary policies, which besides having a positive impact in output, have fewer costs in terms of price increase in the long-run.

The reasons behind the monetary policy ineffectiveness are related to Mozambique economic and financial structure as shown in section 4. This has to do with a concentrated and developing financial structure with weak linkages to the real economy. Therefore, the path to effective use of monetary policy requires more than anything a focus on financial development, but even more important the transformation of the economic structure in order to effectively link with the financial sector. This includes focusing on the informal economy and address the constraints behind the low financial access levels.

Future research and Limitations

This study is far from providing a definite answer about the effectiveness of monetary policy in Mozambique. Employment of further methods and variables for the Mozambique case and for other SSA countries would be valuable to extend the process of clarification of the black box behind the transmission of monetary policy in SSA countries. An effort in such direction would be study the ambiguous relationships among the endogenous variables found in this study as in other SSA countries studies. Further, efforts beyond testing econometric relationships would also be important. It would be interesting to do a more in-depth analysis of the economic activity and financial sector dynamics to assess the real-time impacts besides the direction of the impacts. For example, investigate the commercial banks portfolios, the obstacles that keep the informal sector and private domestic investment from having a strong linkage with the financial sector in order to create effective monetary policy channels.

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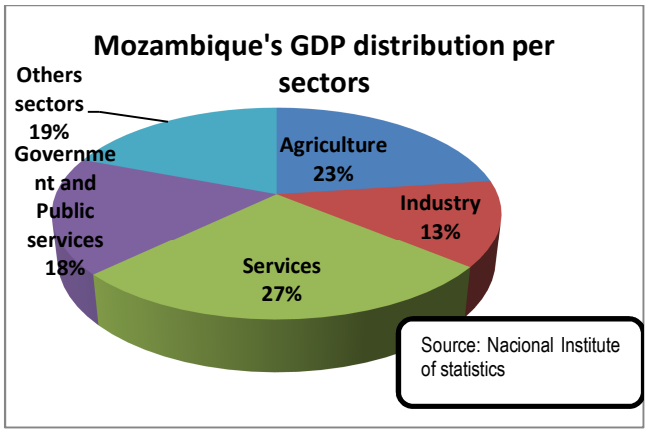
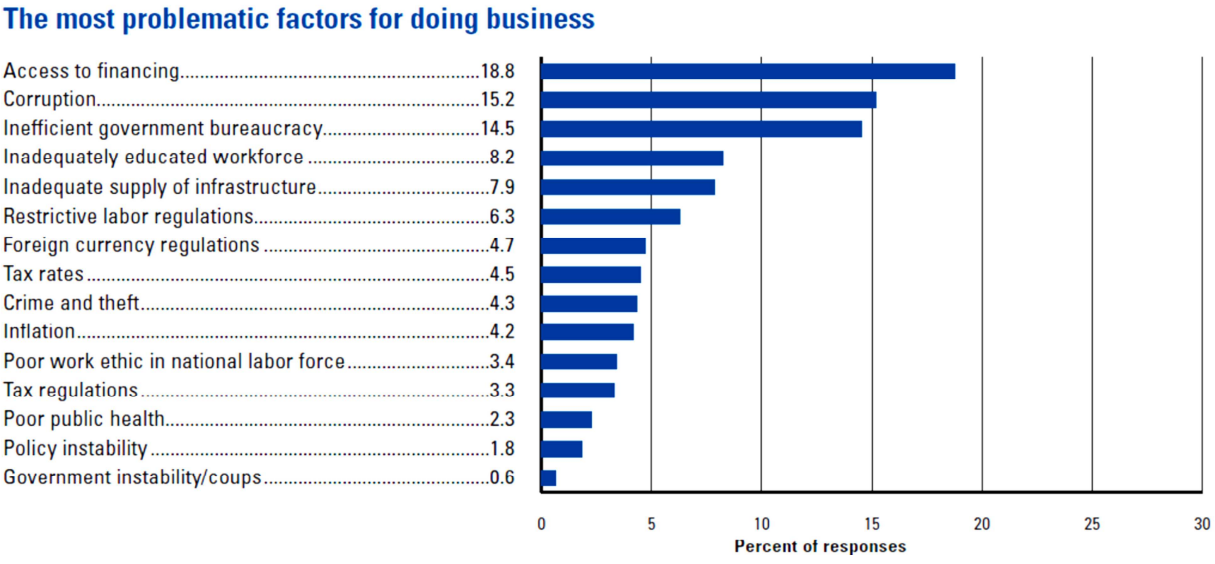
APPENDICES

Appendix 1: Mozambique: Selected Economic Indicators

Economy	2008	2009	2010	2011
GDP (current US$) (billions)	9.89	9.67	9.21	12.80
GDP growth (annual %)	6.8	6.3	6.8	7.1
GDP per capita (current US$)	443	423	394	535
GDP per capita, PPP (constant 2005 international $)	759	788	823	861
Inflation, GDP deflator (annual %)	8.4	4.2	10.0	11.1
Poverty headcount ratio at $1.25 a day (PPP) (% of population)	59.6	n/d	n/d	n/d
Poverty headcount ratio at $2 a day (PPP) (% of population)	81.8	n/d	n/d	n/d
Time required to start a business (days)	26	26	13	13

n/d -No Data World Bank (2012)





Note: From a list of 15 factors, respondents were asked to select the five most problematic for doing business in their country and to rank them between 1 (most problematic) and 5. The bars in the figure show the responses weighted according to their rankings.

Source: *World Economic Forum 2011*

Appendix 2: Further Details on the Bank Sector in Mozambique

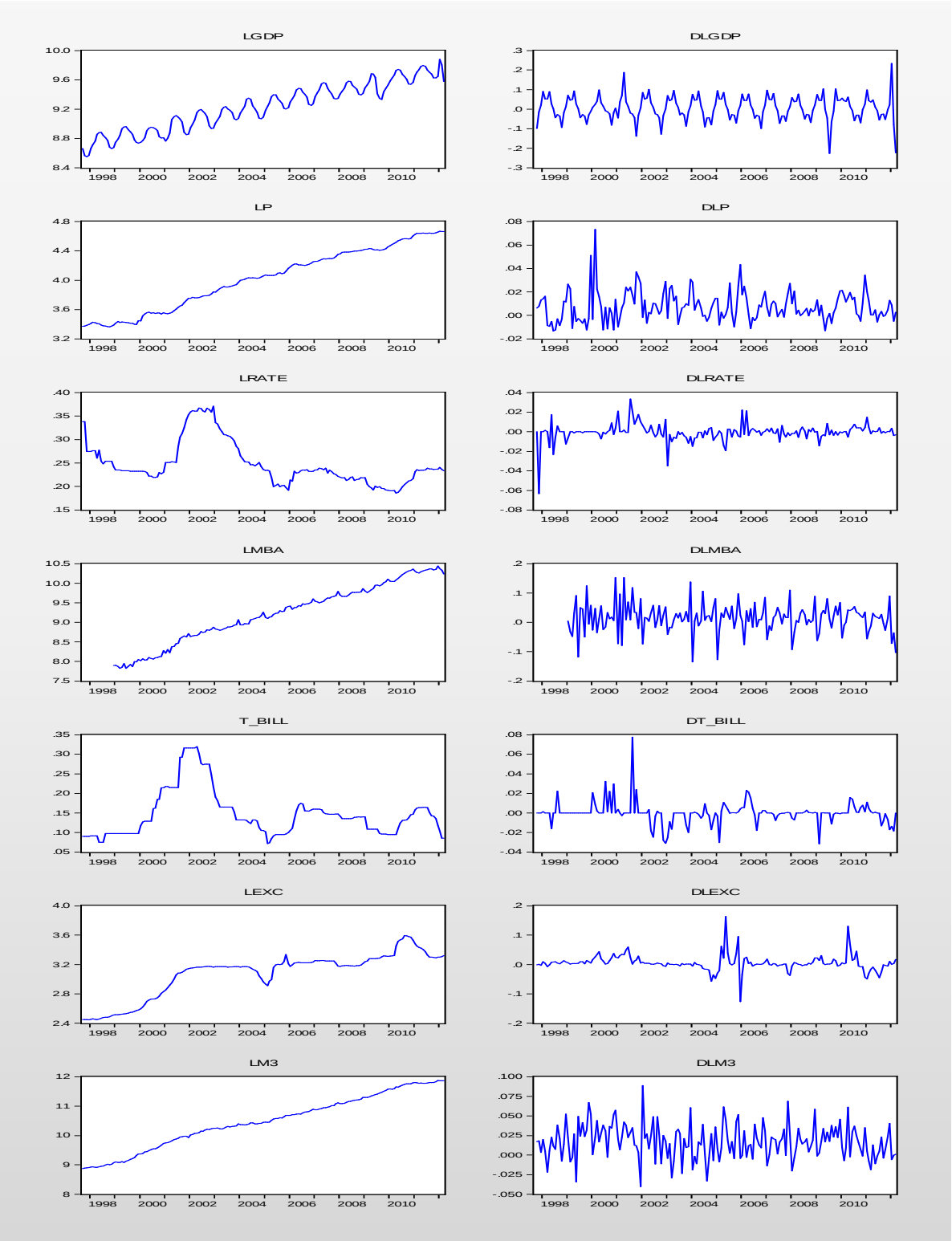
Commercial Banks	Number of Branches (2009)	% of the total
Millennium Bim	117	33%
Banco Comercial e de Investimentos	71	20%
Standard Bank	21	6%
Barclays	59	17%
Mauritius Commercial Bank	2	1%
First National Bank	12	3%
African Banking Corporation	2	1%
Moza Bank	2	1%
Banco Mercantil e de Investimentos	9	3%
Banco Internacional de comercio	10	3%
Banco Terra	8	2%
Socremo	12	3%
Banco oportunidade	6	2%
Banco Procredit	21	6%
Total	352	100%

Commercial Banks Branch distribution per province

Province	Branches (2009)	% of the total
Maputo	167	47%
Gaza	24	7%
Inhambane	27	8%
Manica	17	5%
Sofala	33	9%
Zambezia	16	5%
Tete	19	5%
Nampula	31	9%
Niassa	9	3%
Cabo Delgado	9	3%
Total	352	100%

Source: Amarcy and Massingue (2011)

Appendix 3: Data graphical representation



Appendix 4: Variables descriptive Statistics

	LExc	LM3	LMBa*	LP	LGDP	LRATE	T_Bill
Mean	3.07	10.47	9.21	4.02	9.23	0.25	0.15
Median	3.17	10.45	9.26	4.06	9.24	0.23	0.15
Maximum	3.60	11.88	10.44	4.67	9.88	0.37	0.32
Minimum	2.45	8.87	7.82	3.36	8.55	0.19	0.07
Std. Dev.	0.31	0.90	0.76	0.42	0.32	0.05	0.06
Skewness	-0.83	-0.17	-0.20	-0.12	-0.10	1.26	1.45
Kurtosis	2.63	1.98	1.98	1.70	1.99	3.77	1.67
Jarque-Bera	21.28	8.40	8.00	12.80	7.78	50.67	82.09
Probability	0.00	0.01	0.02	0.00	0.02	0.00	0.00
Sum	537.1	1832.6	1474.0	702.9	1614.7	43.3	25.6
Sum Sq. Dev.	16.3	140.8	91.4	30.4	18.3	0.4	0.6
Observations	175	175	160	175	175	175	175

**As explained in the main text, the MBa data available on the BM website, only starts on December 1998 while all other variables database start in January 1997. This justifies the lower number of observations. The model using the monetary base as instruments was adjusted to its number of observations.*

Appendix 5: Unit Root tests results (Augmented Dickey-Fuller (ADF) test and Phillips- Perron

Variable	test				Variable	test			
	ADF	5% Critical value	Phillips and Perron	5% Critical value		ADF	5% Critical value	Phillips and Perron	5% Critical value
le	-1.91	-2.88	-1.86	-2.88	D(le)	-8.69	-2.88	-8.83	-2.88
Lm3	-1.38	-2.88	-1.40	-2.88	D(Lm3)	-12.71	-2.88	-12.71	-2.88
Lmba	-3.08	-3.44	-2.39	-3.44	D(Lmba)	-5.61	-3.44	-16.84	-2.88
T_bill	-2.01	-2.88	-1.80	-2.88	D(T_bill)	-6.24	-2.88	-10.17	-2.88
Lrate	-1.35	-2.88	-2.28	-2.88	D(Lrate)	-6.24	-3.44	-12.65	-3.44
Ly	-1.01	-2.88	-1.85	-2.88	D(Ly)	-6.02	-2.88	-5.57	-2.88
Lp	-3.34	-3.44	-2.57	-3.44	D(Lp)	-6.89	-2.88	-9.28	-2.88

Note: The Phillips-Perron test was considered to overcome the problems the problems of heteroscedasticity found in some of the Augmented Dickey Fuller (ADF) test equations. No problems of autocorrelation were presented by the ADF test equations.

All tests started with equations considering trend and intercept, as the series charts suggested such option. The trend was dropped where it was found to non-significant under the Phillips-Perron test. Tests with no constant in the cases it was found to be insignificant was also performed with similar results.

The test Kwiatkowski-Phillips-Schmidt-Shin (KPPS) stationarity test was also performed to confirm the results; the results are not presented here but can be provided upon request. Details of the tests can be found on Dickey and Fuller (1979), Phillips and Perron (1988) and Kwiatkowski *et al.* (1992).

Appendix 6: The VECM and the Johansen Cointegration test

Johansen and Juselius (1990, 1992), Asteriou and Hall (2006) provide good explanation explanations of the VECM test. A summary is below.

A VECM is essentially a VAR with error correction. It can be deducted from a VAR in levels by introducing an error correction model and first differences of the endogenous variables.

Considering a VAR with *k* lags:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_k Y_{t-k} + \varepsilon_t$$

Where Y_t is the vector of exogenous variables that in this case is constituted by the exchange rate, M3, the monetary base (or the T-bill rate), the lending rate, output and prices. A_1 is a *nxn* matrix of coefficients and ε_t is a white noise error, with all classical assumption satisfied. This is a vector autoregressive because each endogenous variable is regressed on its own lags besides on other variables lags.

From this VAR a VECM structure can be written as follows:

$$\Delta Y_t = \Pi Y_{t-p} + C_1 \Delta Y_{t-1} + \cdots + C_{p-1} \Delta Y_{t-p+1} + \delta_i X_t + (\alpha\mu_o + \mu_1) + (\alpha\delta_o + \delta_1)t + E_t$$

Where Π is a nxn matrix containing information about the long-run relationships. It is constituted by: $\Pi = \alpha\beta'$, where α is the vector of adjustment parameters and β denotes the cointegrating vector that is the long-run coefficients.

X_t Is the vector of exogenous and dummy variables that can be allowed in the model, this case this was discarded because of the issues above explained.

$(\alpha\mu_o + \mu_1)\ and\ (\alpha\delta_o + \delta_1)$ Are the deterministic part of the model, respectively the constant and the trend coefficients. Specifically, $\alpha\mu_o\ and\ \alpha\delta_o$ are the constant and the trend coefficient for the long-run model that is the cointegrating equation. $\mu_1\ and\ \delta_1$ Are the same for the short-run regression (the VAR model or adjustment model). In the formulation of the VECM about 5 model can be chosen if considered the inclusion or not of the constant and/or trend coefficient for the long-run and short-run regressions. In this case in analysis a model with intercept and trend for the CE equation and only intercept for the short-run regression. This choice is related with

the linear trend observed in the level data, that is absent in the first differences as series are I(1). The VAR regression is allowed to drift around an intercept, and as the intercept in the CE is allows consideration of exogenous factors. Nevertheless, other models were used for comparisons reasons.

The VECM model estimation depends on the result of the cointegrating test. That is, as a VECM reports besides short-run relationships, long-run equilibrium through an Error correction it requires the series to be cointegrated.

So the, the Johansen cointegration test is used for this purpose (Johansen and Juselius 1992). It consists in estimating the rank *r* of the *n x n* matrix Π, and from this find if the series are cointegrated and the number of cointegrating regressions. Three main results are possible:

- *r=n* that means the matrix has a full rank. In this case the variables Yt are stationary, and a VAR can be estimated.
- *r=0* there are no long-run relationships among endogenous variables in Yt. So a VAR in first differences should be estimated with no long-run factors.
- $r \leq (n-1)$ there are at most (n-1) cointegrating vectors in β such that $\beta' Y_{t-1}$ is I(0). So the model should be written as a VECM that allows for the long-run and short-run relationship existents.

To determine the rank Johansen and Juselius (1990) suggested two test statistics:

(i) The *maximal eigenvalue statistic* tests the null hypothesis of r cointegrating relationship against the alternative of r+1 cointegrating vector. And is calculated by:

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1})$$

Where λ_{r+1} are the characteristic roots also called eigenvalues (r+1=1, 2, ..., n). S the test consists in ordering the eigenvalue in descending order and test if they are significantly different from zero. Under no cointegrating vectors having $\hat{\lambda}_{r+1} = 0$ that is $(1 - \hat{\lambda}_{r+1})$ equals 1, as ln (1) =0.

(i) The *trace statistics*, that test the null of k ≤ r cointegrating relations against the alternative that k>r. It is calculated as follows:

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} ln\,(1 - \hat{\lambda}_{r+1})$$

If $\hat{\lambda}_{r+1}$=0 the trace statistic will be zero meaning no cointegration. The critical values are normally provided by the econometric software, being from the Johansen and Juselius (1990).

Appendix 7: VECM 1 Model specification steps and previous diagnostic tests

a) VECM 1: The lag selection

The results of the cointegration test are very sensitive to number of lags employed in the model. So, it was first run the test for lag selection that present the number of lags considered appropriate by five main criteria: the sequential modified LR test statistic, the Final prediction error, Akaike, Schwarz and Hannan-Quinn information criterion.

The criteria presented conflicting results; respectively 12, 6, 12, 2 and 3 lags (see the table bellow). So, considering the parsimonious principle - that says the better if consistent and efficient results can be achieved with a small number of variables- it was first employed 2 lags. But as the test for no autocorrelation and no heteroscedasticity failed to be accepted, the lags were extended until six, were white noise errors were found.

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1386.543	NA	3.74e-16	-18.49382	-18.12930	-18.34572
1	2196.555	1521.509	1.07e-20	-28.95344	-27.85986*	-28.50912
2	2271.432	134.5760	6.38e-21	-29.47880	-27.65618	-28.73827*
3	2313.909	72.89979	5.88e-21	-29.56633	-27.01465	-28.52959
4	2354.767	66.80927	5.58e-21	-29.63199	-26.35126	-28.29903
5	2387.861	51.42996	5.93e-21	-29.59272	-25.58293	-27.96355
6	2433.036	66.54176	**5.40e-21***	-29.71671	-24.97787	-27.79133
7	2468.365	49.17365	5.69e-21	-29.70763	-24.23975	-27.48604
8	2510.416	55.12077	5.55e-21	-29.78940	-23.59246	-27.27160
9	2541.431	38.14028	6.40e-21	-29.72204	-22.79605	-26.90803
10	2584.711	49.71365	6.38e-21	-29.82042	-22.16538	-26.71019
11	2627.385	45.55736	6.58e-21	-29.91061	-21.52652	-26.50417
12	2681.366	53.25103*	6.01e-21	-30.15359*	-21.04044	-26.45094

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Residual Autocorrelation and heteroscedasticity tests for 6 lags in the cointegration test

VAR Residual Serial Correlation LM Tests
Null Hypothesis: No serial correlation
Included observations: 154

Lags	LM-Stat	Prob
1	50.59268	0.0541
2	40.70911	0.2708
3	59.49832	0.0082
4	72.14644	0.0003
5	57.63164	0.0125
6	38.81034	0.3442

Probs from chi-square with 36 df.

Heteroskedasticity White test
Null hypothesis: No heteroskedastcity
Joint test:

Chi-sq	df	Prob.
1635.883	1554	0.0727

The Lag exclusion test points that all lags are significant and none should be excluded

Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	df
613.6787	49.35870	61.40698	38.52375	34.74574	70.14055	36
[0.000000]	[0.068146]	[0.005213]	[0.356075]	[0.528170]	[0.000564]	

b) VECM 1: the cointegration test

Considering that the pre-conditions were satisfied the Johansen cointegration test was run, considering a deterministic component in the cointegrating equation, but only a constant in the VAR. The results are the presented in the main test, two cointegrating vector were chosen.

Appendix 8: VECM 1 : Error correction and short-run relationships

	DLGDP	D(LP)	D(LExc)	D(LM3)	D(LRATE)	D(LMBa)
CointEq1	(-0.78)*	0.00	-0.10	(-0.25)*	0.04	0.12
CointEq2	-0.05	0.03*	0.11*	0.02	(-0.03)*	(-0.23)*
Output						
D(LY(-1))	0.68*	-0.02	0.08	0.11	-0.03	-0.08
D(LY(-2))	0.32*	-0.03	0.12	0.07	-0.03	-0.40
D(LY(-3))	0.14	0.06	0.08	0.18*	-0.02	0.14
D(LY(-4))	0.40*	-0.03	0.11	0.10	0.00	0.08
D(LY(-5))	0.35*	(-0.08)*	0.05	0.05	0.01	-0.21
D(LY(-6))	(-0.27)*	0.04	0.09	0.13*	-0.04	0.17
Prices						
D(LP(-1))	0.48	0.24*	(-0.37)**	-0.30	0.05	-0.05
D(LP(-2))	0.07	0.31*	0.02	-0.25	0.02	-0.16
D(LP(-3))	-0.13	-0.15	0.21	0.08	0.06	-0.10
D(LP(-4))	0.33	-0.14	0.11	-0.10	0.02	-0.03
D(LP(-5))	0.07	0.15	(-0.66)*	(-0.43)*	-0.01	-0.17
D(LP(-6))	-0.30	-0.04	-0.16	-0.21	-0.05	-0.44
Exchange rate						
D(LE(-1))	-0.13	0.02	0.34*	0.05	-0.05	-0.17
D(LE(-2))	-0.15	-0.04	0.16	0.11	0.03	0.17
D(LE(-3))	-0.01	-0.07	0.11	0.18*	-0.07	0.05
D(LE(-4))	-0.05	-0.01	0.14	-0.01	0.01	-0.13
D(LE(-5))	-0.09	-0.05	0.00	0.07	0.00	-0.13
D(LE(-6))	(-0.28)**	-0.06	0.18**	0.05	-0.04	-0.16
M3						
D(LM3(-1))	0.27	0.06	0.12	-0.09	0.03	0.27
D(LM3(-2))	0.15	-0.06	0.02	-0.09	-0.01	0.07
D(LM3(-3))	0.00	0.09**	0.13	-0.02	0.05	-0.03
D(LM3(-4))	0.04	0.02	0.17	0.05	0.02	-0.05
D(LM3(-5))	0.08	0.02	0.22**	0.10	-0.05	0.06
D(LM3(-6))	0.08	0.11*	0.01	0.07	0.01	0.12
Lending rate						
D(LRATE(-1))	-0.49	-0.15	-0.07	0.06	0.02	0.53
D(LRATE(-2))	-0.09	(-0.27)**	0.09	0.37	0.19*	0.69
D(LRATE(-3))	-0.04	0.11	0.02	0.16	0.08	-0.32
D(LRATE(-4))	0.22	0.05	0.52	-0.18	0.09	0.14
D(LRATE(-5))	0.23	0.03	0.05	-0.19	0.07	0.01
D(LRATE(-6))	0.31	0.01	(-0.71)*	0.38	0.16*	0.33
Monetary base						

D(LMBA(-1))	-0.01	0.05*	-0.08	-0.01	0.01	-0.50
D(LMBA(-2))	-0.10	0.06*	-0.06	-0.09	0.02	-0.32
D(LMBA(-3))	-0.18	0.03	-0.05	(-0.17)*	0.03	(-0.27)*
D(LMBA(-4))	0.04	0.09*	-0.11	(-0.15)*	0.01	-0.15
D(LMBA(-5))	-0.04	0.03	0.06	-0.08	0.00	-0.13
D(LMBA(-6))	0.00	0.00	0.08	0.02	0.01	0.22*
C	-0.01	0.00	-0.01	0.03*	0.00	0.04*

Respectivelly * and **, indicate 5% and 10% Significance levels

The shadow areas aim to show the areas the different transmission channels

Appendix 9: VECM 1 Post estimation diagnostic test

a) VECM 1: diagnostic tests

Tests on the residuals of the VECM 1 were performed to see how much the results can be trusted, and as it can be see no problems of serial correlation or heteroscedasticity were found.

VAR Residual Serial Correlation LM Tests
Null Hypothesis: No serial correlation
Included observations: 154

Lags	LM-Stat	Prob
1	45.27005	0.1383
2	33.38817	0.5935
3	37.40570	0.4044
4	44.34336	0.1602
5	44.08819	0.1667
6	**33.55289**	**0.5855**
	33.05976	0.6092
	35.55373	0.4897
	42.53385	0.2103

Probs from chi-square with 36 df.

Heteroskedasticity White test
Null hypothesis: No heteroskedastcity
Joint test:

Chi-sq	df	Prob.
1683.288	1596	**0.0631**

Test for Roots of Characteristic Polynomial	Results
Endogenous variables: DLEXC DLM3 DLMBA DLRATE DLGDP DLP	No root lies outside the unit circle. VAR satisfies the stability condition

Appendix 10: VECM 2 *Model specification steps and previous diagnostic tests*

a) VECM 2: Lag selection

Exactly the same situation with the lag selection criteria was face, so the same procedure was adopter, culminating the final model with 9 lags.

VAR Lag Order Selection Criteria
Endogenous variables: LE LM3 T_BILL LRATE LY LP
Exogenous variables: C @TREND
Date: 08/24/12 Time: 12:09
Sample: 1997M09 2012M03
Included observations: 163

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1513.370	NA	4.02e-16	-18.42172	-18.19396	-18.32925
1	2659.201	2179.187	4.91e-22	-32.03927	-31.12823*	-31.66940
2	2736.650	141.5949	2.96e-22	-32.54786	-30.95353	-31.90058*
3	2773.314	64.33019	2.95e-22	-32.55600	-30.27839	-31.63132
4	2813.238	67.11162	2.83e-22	-32.60415	-29.64326	-31.40206
5	2851.148	60.93550	2.81e-22	-32.62759	-28.98341	-31.14809
6	2891.886	62.48118	2.71e-22*	-32.68572	-28.35826	-30.92882
7	2924.209	47.19559	2.92e-22	-32.64060	-27.62987	-30.60630
8	2967.992	60.70451	2.76e-22	-32.73609	-27.04207	-30.42438
9	2991.366	30.68813	3.40e-22	-32.58118	-26.20388	-29.99206
10	3039.575	59.74381	3.13e-22	-32.73098	-25.67040	-29.86446
11	3087.392	55.73717*	2.94e-22	-32.87597	-25.13211	-29.73205
12	3133.692	50.56101	2.87e-22	-33.00236*	-24.57521	-29.58103

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Residual diagnostics

VAR Residual Serial Correlation LM Tests
Null Hypothesis: No serial correlation
Included observations: 154

Lags	LM-Stat	Prob
1	52.72994	0.0355
2	56.20341	0.0171
3	46.74719	0.1083

4	29.80963	0.7569
5	34.09840	0.5593
6	28.13908	0.8222
7	50.92634	0.0507
8	35.55622	0.4895
9	45.70180	0.1290
10	40.13684	0.2919

Probs from chi-square with 36 df.

Heteroskedasticity White test
Null hypothesis: No heteroskedastcity
Joint test:

Chi-sq	df	Prob.
2630.115	2562	0.1704

Lag exclusion test : all

Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9
650.13	53.70	48.97	41.00	36.17	76.15	58.90	41.32	32.25
[0.00]	[0.03]	[0.07	[0.26]	[0.46]	[0.00]	[0.01]	[0.25]	[0.65]

b) VECM 2: Cointegration test

The results of the trace and Eigen in the Johansen test produced different results concerning the number of cointegrating equations. The results of the maximum Eigen value were followed, that is two cointegrating equation were considered.

Sample (adjusted): 1998M07 2012M03
Exogenous series: @TREND

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.281339	164.2454	117.7082	0.0000
At most 1 *	0.225584	109.7350	88.80380	0.0007
At most 2 *	0.141313	67.55346	63.87610	0.0238
At most 3	0.121821	42.41564	42.91525	0.0561
At most 4	0.109515	20.98139	25.87211	0.1803
At most 5	0.011109	1.843248	12.51798	0.9774

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.281339	54.51036	44.49720	0.0030
At most 1 *	0.225584	42.18157	38.33101	0.0172
At most 2	0.141313	25.13782	32.11832	0.2784
At most 3	0.121821	21.43425	25.82321	0.1710
At most 4	0.109515	19.13814	19.38704	0.0543
At most 5	0.011109	1.843248	12.51798	0.9774

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Appendix 11: VECM 2 Error Correction and short-run relationships

c) VECM 2 : Error correction and short-run relationship

	D(LGDP)	D(LP)	D(LExc)	D(LM3)	D(LRATE)	D(T_BILL)
CointEq1	-1.10*	0.10	-0.34*	-0.20	0.01	-0.13*
CointEq2	0.21*	-0.03	0.14*	0.00	-0.06*	0.04
Output						
D(LY(-1))	1.13*	-0.10*	0.31*	0.12	-0.01	0.10*
D(LY(-2))	0.50*	-0.14*	0.32*	0.06	0.01	0.14*
D(LY(-3))	0.33*	-0.02	0.19*	0.14	-0.01	0.06
D(LY(-4))	0.67*	-0.07	0.26*	0.10	0.01	0.16*
D(LY(-5))	0.45*	-0.12*	0.14	0.01	0.03	0.05
D(LY(-6))	-0.28*	-0.04	0.20*	0.07	-0.03	0.03
D(LY(-7))	0.50*	-0.03	0.15	0.08	0.01	0.08*
D(LY(-8))	0.00	-0.04	0.10	0.02	0.02	0.07
Prices						
D(LP(-1))	0.18	0.20*	-0.35	-0.40*	0.06	-0.01
D(LP(-2))	0.42	0.29*	0.08	-0.17	0.07	0.16*
D(LP(-3))	-0.11	-0.16	0.28	0.02	0.09*	0.04
D(LP(-4))	0.30	-0.15	-0.04	-0.17	0.02	-0.05
D(LP(-5))	0.10	0.05	-0.52*	-0.25	-0.01	0.10
D(LP(-6))	-0.18	-0.10	0.10	0.06	-0.06	-0.14
D(LP(-7))	0.17	0.11	-0.02	0.20	-0.03	0.02
D(LP(-8))	0.00	0.04	-0.29	-0.03	0.02	-0.01
Exchange rate						
D(LExc(-1))	-0.12	0.06	0.23*	0.14	-0.04	0.03
D(LExc(-2))	-0.03	0.04	-0.01	0.07	0.01	-0.01
D(LExc(-3))	-0.01	-0.01	0.03	0.07	-0.05*	-0.05
D(LExc(-4))	0.02	0.04	-0.03	-0.07	0.02	-0.01
D(LExc(-5))	-0.11	-0.01	-0.06	-0.01	0.01	-0.02
D(LExc(-6))	-0.13	-0.01	0.16	-0.04	0.00	0.00
D(LExc(-7))	0.00	0.05	-0.35*	-0.14	0.01	0.03
D(LExc(-8))	-0.04	-0.01	0.09	0.15*	0.04	0.08*
M3						
D(LM3(-1))	0.21	0.00	0.21	-0.11	0.01	0.06
D(LM3(-2))	0.00	-0.12*	0.13	-0.16	-0.02	0.07
D(LM3(-3))	-0.09	0.04	0.20	-0.10	0.01	0.09*
D(LM3(-4))	-0.01	0.01	0.27*	0.04	-0.03	0.00
D(LM3(-5))	-0.04	0.04	0.31*	0.07	-0.10*	-0.01
D(LM3(-6))	0.00	0.13*	0.05	0.15	-0.03	0.01
D(LM3(-7))	-0.25	0.02	0.06	0.15	-0.02	0.04

D(LM3(-8))	-0.15	0.05	-0.11	0.00	-0.02	-0.05
Lending rate						
D(LRATE(-1))	0.09	-0.16	-0.06	0.31	-0.11	0.44*
D(LRATE(-2))	0.29	-0.13	0.43	0.28	0.03	0.12
D(LRATE(-3))	0.31	0.32	0.25	-0.08	-0.01	0.00
D(LRATE(-4))	0.61	0.09	0.50	-0.24	-0.01	-0.24
D(LRATE(-5))	0.46	0.11	0.28	-0.24	0.05	-0.22
D(LRATE(-6))	0.60	0.13	-0.67	-0.05	0.16	-0.07
D(LRATE(-7))	-0.11	-0.16	0.03	0.35	0.08	0.05
D(LRATE(-8))	0.05	0.00	0.43	0.24	-0.10	-0.06
Treasury Bill rate						
D(T_BILL(-1))	-0.39	0.13	-0.12	-0.08	-0.07	0.02
D(T_BILL(-2))	-0.64*	0.03	0.02	-0.11	0.14*	0.12
D(T_BILL(-3))	-0.24	-0.01	-0.07	-0.29	0.05	-0.20*
D(T_BILL(-4))	-0.62**	-0.12	-0.25	-0.42**	-0.11	-0.02
D(T_BILL(-5))	-0.26	-0.29	0.08	0.52**	-0.09	0.05
D(T_BILL(-6))	-0.32	0.01	0.11	-0.23	-0.05	0.23**
D(T_BILL(-7))	0.22	0.04	-0.05	-0.22	-0.02	0.03
D(T_BILL(-8))	-0.32	-0.14	0.06	0.00	-0.05	0.00
C	-0.01	0.01	-0.02**	0.02**	0.00	-0.01**

Appendix 12: VECM post-estimation diagnostic tests

d) VECM 2: diagnostic tests

VAR Residual Serial Correlation LM Tests
Null Hypothesis: No serial correlation
Included observations: 154

Lags	LM-Stat	Prob
1	49.34462	0.0683
2	39.23299	0.3270
3	50.60678	0.0539
4	33.38924	0.5934
5	49.80233	0.0628
6	34.49046	0.5404
7	50.85870	0.0514
8	35.57715	0.4885
9	48.05778	0.0862
10	39.52068	0.3156

Probs from chi-square with 36 df.

Heteroskedasticity White test
Null hypothesis: No heteroskedastcity
Joint test:

Chi-sq	df	Prob.
2201.325	2100	0.0607

Test for Roots of Characteristic Polynomial	Results
Endogenous variables: DLEXC DLM3 DT_BILL DLRATE DLGDP DLP	No root lies outside the unit circle. VAR satisfies the stability condition