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Monetary Policy Transmission Mechanism in a Small Open Economy under Fixed Exchange Rate: An SVAR Approach for Morocco

Rachid Ouchchikh[1]

[1]INREED, Faculty of Economics, Cadi Ayyad University, Morocco

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ABSTRACT

Purpose
The main purpose of this study is to investigate the transmission mechanism of monetary policy in Morocco, taking external constraints on monetary policy into consideration.
Design/methodology/approach:
This study uses a structural vector autoregression model (SVAR) to examine the transmission of the effects of a positive monetary policy shock to the real economy.
Findings:
The analysis provides evidence that monetary policy shocks are transmitted to the Moroccan economy principally via credit and interest rate channels. However, the exchange rate and asset prices channels are inoperative. Furthermore, the findings show that the monetary aggregate contains important additional information in the transmission of monetary policy shocks.
Research limitations/implications:
Generally, the analysis leads to three policy implications. First, when analyzing the transmission mechanisms in Morocco, it is important to take into account the effect of externals shocks on monetary policy, since it allows a better appreciation of the effect and the functioning of the transmission channels. Second, since Moroccan authorities prepare its transition to an inflation targeting strategy, the functioning of the interest rate channel is important. However additional efforts are needed to develop a more resilient, competitive and dynamic financial system, to diversify the financing alternatives for the private sector, and to establish a more flexible exchange rate. Third, given the fact that the bank credit is a strong transmission channel and constitutes a major source of external financing for the Moroccan economy, it is crucial in the health and stability of the banking system as a pre-condition towards economic stability.
Originality/value:
To our knowledge, this study is the first investigation of transmission channels in Morocco using recent econometric techniques and taking into account the external constraints on monetary policy.

1. Introduction

It is widely accepted in the economic literature that monetary policy has a short-run real effect and a long-run impact only on prices. These effects pass through to the economy via many mechanisms that may be generally defined as the process through which monetary policy decisions are transmitted into changes in income and inflation (Taylor, 1995). Understanding the transmission mechanism (in terms of timing and magnitude) is essential in achieving a successful monetary policy. The transmission mechanism includes the interest rate channel, the credit channel, the asset prices channel and the exchange rate channel.

Because of its close dependence upon the economic and financial structure, these mechanisms differ from country to country. A large number of empirical studies has been undertaken in developed countries, and to a lesser extent in emerging and underdeveloped countries. However, these studies do not reach the common trend that clarifies the transmission process.

Contrary to developed economies, the under-developed and emerging economies are subject to monetary policy dictated by the world's main central banks such as the European Central Bank and the Federal Reserve Bank. Consequently, the modeling of monetary

†Corresponding Author: Rachid Ouchchikh
E : ouchchikhra@yahoo.fr
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transmission mechanisms for those countries should be different from that of the developed countries. The negligence of such a characteristic may bias the result and generate empirical puzzles. Moreover, if the exchange rate is fixed, as in Morocco, monetary policy becomes more constrained because of its dependence[1] on the level of official foreign reserves[2] and on the interest rate of the country to which the exchange rate has been fixed.

The study of transmission mechanisms of monetary policy (TMMP) in the Moroccan case is interesting because of the deep liberalization of the domestic financial system and the adoption of market-oriented monetary policy instruments and operating procedures. In this new framework, the issue of transmission channels has recently gained the attention of the Moroccan policymaker. However, from an academic point of view, a few studies have investigated Moroccan monetary policy transmission channels (Boughrara, 2008; Ouchchikh, 2014). To the best of our knowledge, this study is the first to consider the external constraints on the Moroccan case. This study investigates the transmission channel by taking account of the external constraints on monetary policy. Particularly, it examines four channels of monetary transmission in Morocco, namely the interest rate channel, the credit channel, the asset prices channel and the exchange rate channel, in the presence of exogenous external shocks.

The organization of the paper is as follows. The following section gives a short review of the literature on monetary transmission mechanisms. The data research methodology is presented in Section 3. Section 4 reports and discusses the results. Section 5 concludes the study.

2. Literature Review

Due to its potential to impact the real sector, monetary policy has recently been subject to intense academic debate. While it is widely accepted that monetary policy is ineffective in the long-run and has a powerful effect on economic activity in the short-run, New Open Macroeconomics asserts that monetary policy can also have a strong impact in the long-run. Bernanke and Gertler (1995) and Morsink and Bayoumi (2001) describe the TMMP as a black box. Efforts to understand these mechanisms have given a raise to a large body of theoretical[3] and empirical work[4]. Economists have investigated a wide range of channels through which monetary policy may influence the economy. Commonly, these include the following: the interest rate channel which stresses that, in the presence of price rigidity in the short-run, monetary policy may impact the real interest rate, which in turn influences the aggregate demand through the cost of capital and substitution and income effects.

In the monetarist asset price channel, monetary policy affects the economy by means of its impact on asset prices and real wealth. Thus, an easing of monetary policy appreciates asset prices and, therefore, promotes investment as described by Tobin's q theory, and consumption through wealth and liquidity effects.

The exchange rate channel postulates that when the economy is open, a monetary contraction will increase the domestic interest rate up to the foreign one and, thereby, appreciates domestic currency in nominal and/or real terms. Accordingly, this appreciation impacts the economy through international competitiveness and the costs of imported goods.

Finally, the bank lending channel seeks to assess the role of banks in transmitting and amplifying the effect of monetary policy. In this vein Bernanke and Blinder (1988) expanded the standard IS-LM model by including the bank loans market. Based on the presence of asymmetric information on the credit markets, the credit channel supports the interest rate channel. Indeed, monetary contraction reduces bank reserves and in turn the supply of loans, which may drop investment and consumption expenditures for bank-dependent borrowers.

Transmission channels are not similar in all economies, because they depend on specific features of the economy, such as the structure of the financial system (Cecchetti, 1999). Indeed, the effectiveness of these channels is an empirical issue that varies from one country to another.

The VAR models are the most widely used empirical methodology to analyses the TMMP (Mojon and Peersman, 2003), since the seminal work of Sims (1980). Bernanke and Blinder (1992) found that in the United States, monetary policy affects composition of bank assets. However, Ramey (1993) concludes to the predominance of the money channel in transmitting the monetary policy shocks in the same country. Taylor (1995) emphasizes strong evidence of the importance of the interest rate and exchange rate in the transmission process, as opposed to financial quantities. This result, nonetheless, is criticized by Bernanke and Gertler (1995) that stress the importance of financial market quantities i.e. credits. Morsink and Bayoumi (2001) and Suzuki (2004) conclude that the lending channel is effective in Japan. Angeloni et al. (2003), find that the interest rate channel is dominant in Germany, Belgium, Finland, Spain and Luxembourg. In an extensive literature survey, Boivin et al. (2010) emphasize the importance of neoclassical channels (such as direct interest rate effects on investment spending, wealth and intertemporal substitution effects on consumption and the trade effects through the exchange rate) in macroeconomic modeling.

In the case of developing countries, the transmission process is even more uncertain (Kamin and Van't dack, 1998). Ganev et al. (2002) highlight, on the basis of a survey of 40 empirical studies in Central and Eastern European countries, the weakness of the first stage of TMMP (propagation of monetary policy actions to

[1] However, this dependence is alleviated as long as the central bank have limited capital mobility, due, for instance, to the keeping of some capital controls or to the presence of an underdeveloped financial markets.

[2] Since the central bank intervene in the foreign exchange market through sterilized interventions in order to preserve the fixed exchange rate parity.

[3] See among others Mishkin (1995), Meltzer (1995), De Bondt (1997), Walsh (2003) and Mishkin (2007) for an extensive survey of the TMMP.

[4] See in particular Angeloni et al. (2003), Boivin et al. (2010), Ganev et al. (2002), Mohanty and Turner (2008) and Mishra and Montiel (2012) for an empirical literature review.

lending and deposit rates) and the absence of the second stage (diffusion of variations of intermediate variables to ultimate goals such as investment, consumption, growth and inflation). Most authors have justified these results by the institutional factors like the underdeveloped banking sectors, weak competition among banks and the constant changes in monetary policy. Disyatat and Vongsinsirikul (2003) found the functioning of the bank lending channel in Thailand. While Al-Mashat (2003) uncovers a small role for banks in transmitting monetary policy shocks to the real sector, the results of Aleem (2010) supports a more active role for banks in the transmission process in India. In a survey on the effectiveness of monetary policy transmission mechanisms in low-income countries, Mishra and Montiel (2012) stress that bank lending is the only operating channel in those countries.

3. The econometric methodology

We propose that the Moroccan economy may be described by the following structural VAR system:

$$Y_t = A(L)Y_{t-1} + B(L)X_t + C^* D_t + \varepsilon_t \qquad (1),$$

where Y_t is a vector of endogenous variables and X_t is a vector of exogenous foreign variables. ε_t is the vector of structural innovations, D_t contains a deterministic terms i.e. a constant and one dummy to capture the revision of the basket of Dirham in April 2001. The exogenous foreign variables is included to capture external constraints and to control for foreign economics events. By assuming these variables as exogenous, we suppose that they do not have a contemporaneous impact on the endogenous variables, and changes in the domestic economy have no effect on the exogenous variables.

The vector of endogenous variables consists of the industrial production index (IPI), consumer prices index (IPC), the monetary aggregate (M2), the credit to private sector (CBP), the nominal effective exchange rate (NEER), the six-month Treasury Bill rate (TB6) and, finally, the Casablanca stock market index MASI (*Moroccan All Shared Index)* as a proxy to the asset prices:

$$Y_t^{'} = \left[IPI_t, IPC_t, M2_t, CBP_t, NEER_t, TB6_t, MASI_t\right]$$

The vector of exogenous variables contains a Germany money market interest rate (i^*) and the euro area industrial production index (*IPI*): $X_t^{'} = \left[IPI_t^*, i_t^*\right]'$.

Due to the fixed exchange rate regime, the implementation of Bank Al-Maghrib's (BAM) monetary policy focuses on the variations of the targeted exchange rate and on changes in the anchor country interest rate. Given that the external value of Dirham has been set on the basis of basket of currencies for which the composition was limited since 2001 to the euro and dollar, with the respective weights are 60 and 40 %, it seems reasonable to retain the short-run euro area interest rate to capture the effect of the anchor country's monetary policy. However, for the reason of the unavailability of such interest rate during the studied period, we retain the Germany money market interest rate because this country is the anchor[5] of the European Monetary System.

Furthermore, Morocco is a small open economy and heavily dependent on the European Union (EU) since it is considered its first client, supplier and purveyor of influx of tourists and the major source of transfer of funds by Moroccans living abroad. In 2011, this group of countries represented 50.8% of foreign trade, 47.6% of imports and 57.7% of exports. At the same time, the amount of foreign direct investment coming from this group to total foreign direct investment is 57.8% and the tourist influx approximate 3.9 million, while the remittances flows make up 74.6% of the total transfer of funds by Moroccan living abroad. Indeed, the Moroccan economy is particularly exposed to shocks that are related to EU economies. In fact, the EU gross domestic product seems to be a good variable for world demand. Nonetheless, the unavailability of data on such a variable during the studied period leads us to retain the euro zone industrial production index at 17 countries[6].

The model is estimated on the basis of the monthly data spanning the period 1992M1 to 2011M12. The data is sourced from the IMF *International Financial Statistic* and Bank Al-Maghrib databases, the annual reports of Bank Al-Maghrib and from the Casablanca stock market and the Bundesbank websites. Except for the interest rates, all series are transformed into logarithm values. Moreover, the series IPI, IPC, M2, CBP, MASI, and IPI*[7] are seasonally adjusted.

To establish the order of integration of the time series, Augmented Dickey–Fuller (ADF), Phillips Perron (PP), and the Kwiatkowski, Phillips, Schmidt, Shin (KPSS) tests are performed for all the variables. All in all, the tests give strong evidence that the variables are stationary in the first difference[8]. The reason we examine the cointegrating proprieties of the data is that they may share common stochastic trends (cointegrating relationships). Because the model includes a shift dummy, we use the cointegration test introduced by Saikkonen and Lütkepohl (2000) instead of Johansen's trace test (Johansen and Juselius, 1990). When the shift dummy variable is included in the model, the latter test is no longer appropriate since their critical values are calculated for the case where the shift dummy is not included in the deterministic terms. The presence of this dummy impacts the asymptotic distribution under the null hypothesis, thereby becoming inappropriate. To remedy this limit, Saikkonen and Lütkepohl (2000) introduced a test that is asymptotically unaffected by the presence of the shift. When this test is used to test for common stochastic trends in data, the null hypothesis of no cointegration cannot be rejected (see appendix 2).

[5] Indeed, the Germany's monetary policy is the anchor for others monetary policies in Euro Area. In that sense, many studies support that the Germany's monetary policy influence the domestic monetary policies (Henry and Weidmann, 1994; Smets, 1997; Mojon, 1998; Bruneau and De Bandt, 1998; Kim, 1998; Clements et al., 2001; Mojon and Peersman, 2003; among others).

[6] The countries included are Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Austria, Portugal, Slovakia, Slovenia and Spain.

[7] This is done by the TRAMO and SEATS program.

[8] Detailed results from the unit root and stationarity tests are reported in appendix 1.

Thus, we choose to estimate our SVAR model in level[9]. This approach is common in the literature (see Sims, Stock, and Watson, 1990; Cushman and Zha, 1997; Amisano et al., 1997; Ramaswamy and Sloek, 1998; Bernanke and Mihov, 1998; Kim and Roubini, 2000; Elbourne, 2008; Ouchchikh, 2014 amongst others). Moreover, in view of the fact that Phillips (1998) stressed that impulse responses from VAR in levels are inconsistent at long-run horizons and Faust and Leeper (1997) demonstrated that imposing inappropriate cointegration relationships can lead to biased estimates of the short-run parameters, the reasonable approach seems to be estimating the model in levels concentrating on the short-run dynamic.

The residuals from the reduced form estimation of equation (1) can be related to the structural shocks, as in Breitung et al. (2004), by the following general structure model:

$$A\mu_t = B\varepsilon_t \qquad (2)$$

In order to identify the structural form of the model, we adopt the identification scheme as illustrated below. Given that the primary concern of this paper is in short- and medium-term dynamics, we use contemporaneous restrictions on the A matrix to identify the shocks as in (3). This avoids the misspecification problem associated with long-run restrictions (Faust and Leeper, 1997), because of the inadequacy of those restrictions to recover the true structural shocks. More recently, Erceg et al. (2005) and Chari et al. (2005) have questioned the ability of the long-run restrictions in the SVAR to recover accurately the shocks. Christiano et al. (2005) showed that the short-run restrictions perform remarkably well compared with the long-run restrictions.

The behaviors of endogenous variables are explained by seven structural disturbances, namely the aggregate supply shock (ε^{AS}), the aggregate demand shock (ε^{AD}), the money-demand shock (ε^{MD}), the credit shock (ε^{CBP}), the balance of payment shock (ε^{BP}), the monetary policy shock (ε^{MP}) and the asset prices shock (ε^{MASI}). The AB-model is written as:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & a_{36} & 0 \\ a_{41} & a_{42} & 0 & 1 & 0 & a_{46} & 0 \\ a_{51} & a_{52} & 0 & 0 & 1 & a_{56} & 0 \\ 0 & 0 & a_{63} & 0 & a_{65} & 1 & a_{67} \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & 1 \end{bmatrix} \begin{bmatrix} u_{IPI} \\ u_{IPC} \\ u_{M2} \\ u_{CBP} \\ u_{NEER} \\ u_{TB\ 6} \\ u_{MASI} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} \end{bmatrix} \begin{bmatrix} \varepsilon^{AS} \\ \varepsilon^{AD} \\ \varepsilon^{MD} \\ \varepsilon^{CBP} \\ \varepsilon^{BP} \\ \varepsilon^{PM} \\ \varepsilon^{MASI} \end{bmatrix} \qquad (3)$$

The first two equations summarize the equilibrium conditions in the goods market. They represent the sluggish reaction of the real sector (output and prices) to shocks in the monetary sector (interest rate, exchange rate, monetary and credit aggregates, and asset prices). There is no contemporaneous effect of money demand, credit, exchange rate, monetary policy, and asset prices shocks on output and prices. The third row may be interpreted as a short-run money demand relation assuming that money demand responds contemporaneously to output, prices and interest rate. The fourth row corresponds to the loan supply equation as in Ehrmann et al. (2003), where the credit is a function of interest rate, output and inflation. The fifth equation designates the balance of payment function according to De Arcangelis (1997) and Camarero et al. (2002), since Morocco is a small open economy. The sixth row refers to the central bank's reaction function where BAM react contempouraneously to the monetary aggregate, exchange rate, and asset price. Finally, the asset price react immediately to all other innovations.

In selection of the autoregressive order of the model, the information criterions (AIC, FPE, SC, and HQ) gives a number ranging from 1 to 9[10]. However, based on misspecification tests and the need to capture the dynamic of transmission of monetary policy satisfactorily, we choose to estimate our model with 8 lags. Furthermore, the shift dummy variable included in the model obtains a value of one from 2001M5 onward and zero before. For each point estimate, we construct a 95% bootstrapped confidence intervals using Hall's method as proposed by Benkwitz et al. (2001), with 300 bootstrapping replications in order to show the uncertainty associated with the points estimates. The restrictions imposed in (3) were estimated by maximum likelihood through the scoring algorithm of Amisano and Giannini (1997). Compared to the just-identified model, the over-identifying restrictions imposed on the structural covariance matrix are not rejected by the LR (*Likelihood Ratio*) test at 5% confidence levels, with a p-value of 0.6086. Thus, the restrictions imposed are supported by Moroccan data.

Before initiating the analysis, our model was submitted to misspecification and stability tests (see appendix 3 and 4). The Ljung-Box (LB) and Lagrange Multiplier (LM) tests for residuals autocorrelation and the multivariate autoregressive conditional heteroscedasticity test (MARCH-LM) for ARCH effects in model residuals do not indicate any major concerns about the model adequacy. Concerning the Jarque-Bera test, the null hypothesis of normality is rejected for all residuals except those of IPI and TB6. Nevertheless, in spite of the non-normality, the VAR model still yields the consistent and unbiased estimates (Gonzalo, 1994; Brooks, 2008, p.164). To test the stability (stationarity) of the model, the inverse roots of the characteristic AR polynomial are reported in appendix 4. The latter shows that all inverse roots of the characteristic AR polynomial have modulus that they lie inside the unit circle, showing that our model is stable or stationary. As the following section will show, this stability is also illustrated in the impulse response functions that indicate no sign of explosion. They die down with time. Consequently, our SVAR is a satisfactory representation for Moroccan data.

4. The empirical findings

Most of the coefficients of the matrix A have the signs consistent with theory predictions. The coefficient for

[9] Because the OLS (Ordinary Least Square) method still yields a consistent estimate of parameters of the model even if the series are I(1) (Hamilton 1994, p.652).

[10] The numbers of lags selected are 1 for Schwarz Criterion (SC), 2 for Hannan-Quinn Criterion (HQ), 3 for Final Prediction Error (FPE), and 9 for Akaike Info Criterion (AIC).

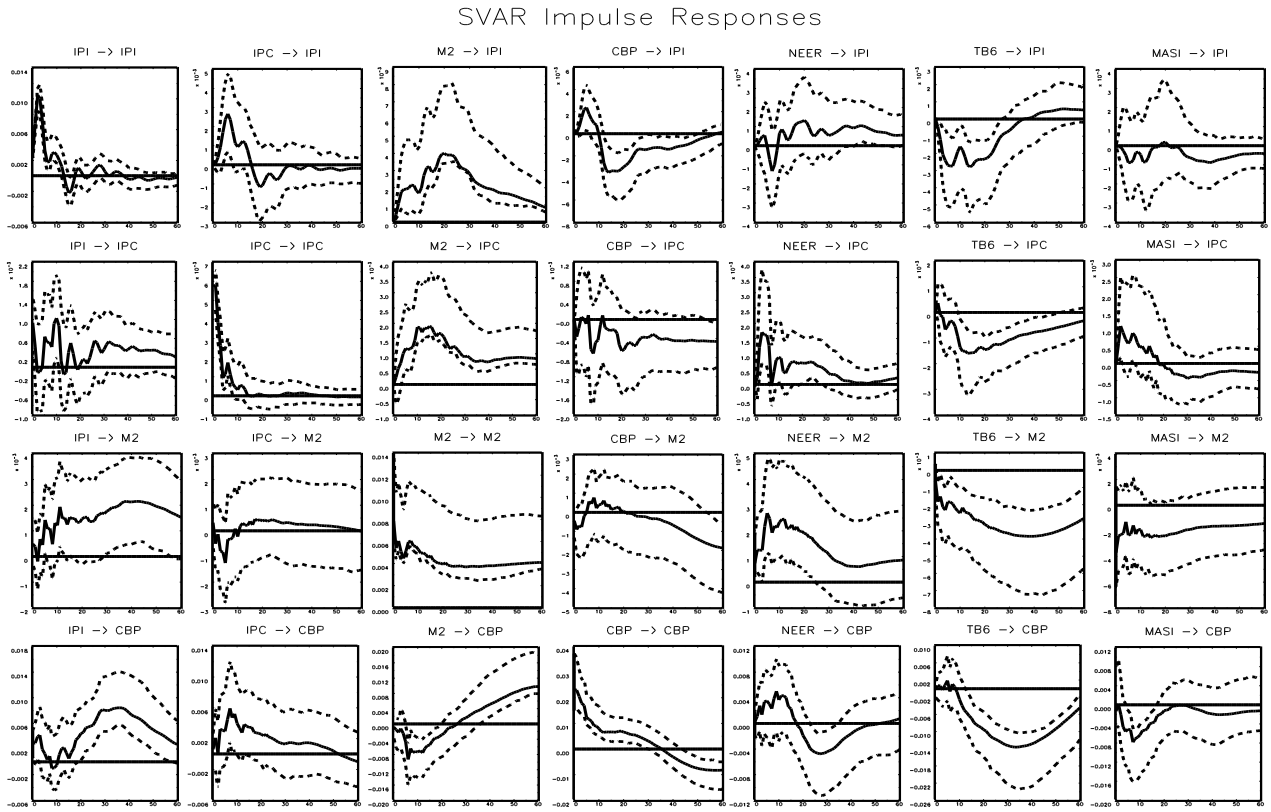
monetary aggregate (a_{63}) has the expected negative sign. Moreover, the coefficients associated with the exchange rate (a_{65}) and the asset prices (a_{67}) have the positive signs. However, a few coefficients are statistically significant and as a result more information may be derived from structural impulse response analysis and variance decomposition.

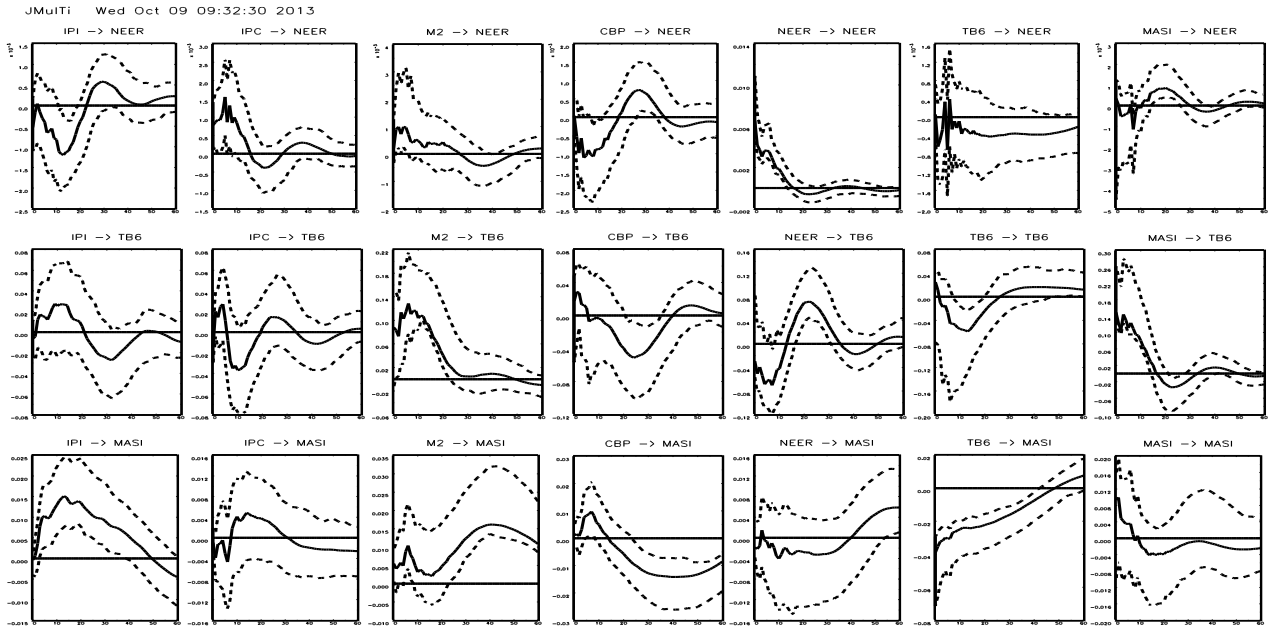
4.1. Impulse response

Figure 1 shows the results of the impulse response functions. The dotted lines represent 95% bootstrapped confidence intervals and the responses up to 5 years ahead are considered. The values on the vertical line correspond to the deviation from the baseline level of the variable in response to a considered shock. The values on the horizontal line represent the time passed after the occurrence of the shock. Each column corresponds to the effects of one shock on the variables, whereas each line reflects the effects of different shocks on the same variable.

To begin the analysis, we focus on the responses to positive monetary policy shock of a magnitude of 3 basis points (sixth column of Figure 1). Our results emphasize that the reactions of all variables are in accordance with the economic theory: output, prices, money, credit, exchange rate, and asset price fall. The monetary policy shock leads to a statistically significant decrease in real output with a peak effect of -0.28% occurring after fourteen months, as predicted by Keynesian models with price-wage inertia. In line with the assumption of a transitory impact of monetary policy, output converges slowly to its pre-shock level. Interestingly, the same shock also causes a significant decline in the price level, peaking at -0.16% below the baseline after sixteen months, suggesting that BAM control the prices level by its interest rate. However, we note that this reaction is significant from the tenth month. Compared with the output, the response of price is more persistent. The monetary policy shock leads to a significant and persistent decrease in M2 and reach their lowest point after three years at -0.38%. This result highlights a significant liquidity effect which indicates the sensitivity of BAM's intermediate target in the monetary policy instrument.

Figure 1- Impulse response functions





Credit to the private sector also contracts significantly but after one year delay. The peak effect is reached after thirty-three months at -1.36%, unveiling the ability of BAM to influence the quantity of credit. The rigidity of this reaction may be caused by the contractual nature of credit, the concentration of the banking sector and by the importance of cash savings in the Moroccan banking system. The response of exchange rate, although consistent with economic intuition i.e. a decline, is not significant due to the fixed exchange rate regime. Thus, there is no evidence that the exchange rate is driven by monetary policy shocks. Finally, the asset price decline immediately and significantly by -3.9% and converge slowly to its equilibrium level.

At present, we look to the effects of the monetary aggregate, private credit, exchange rate, and asset prices on output and prices. Both output and consumer prices respond significantly to unexpected changes in M2. A sudden increase of approximately +0.8% in M2 boosts significantly the output after a period of one month, peaking at +0.4% above the baseline after nineteen months and still significant up to 5 years. Likewise, prices level increase after a period of one month. This reaction is significant and persistent with a magnitude of about +0.19% at ten months. The output responds significantly and temporarily to a +2.32% unexpected increase in the bank lending with a rise, peaking at +0.24% after five months. However, the effect of credit shock on prices is non-distinguishable from zero and inconsistent with the theoretical expectations (i.e. negative feedback). Moreover, an unexpected increase of about +0.66% in the exchange rate has no statistically significant effect on output. On the other hand, prices rise but after one-month, with a peak impact of +0.17% occurring after three months. The response is significant up to six months. Finally, the effect of a sudden +0.93% increase in asset prices on output and prices is not statistically significant. This result is natural since Moroccan stock market is limited to a few firms and insufficiently developed.

4.1. Variance Decomposition[11]

When the impulse response functions pin down the impact of a shock of a given variable on the remaining variables in the VAR model, the variance decomposition gives information about the relative importance of each shock hitting the VAR in explaining the variability of each variable in the model at different horizons. Table 1 shows the variance decomposition of output and prices computed at forecast horizons up to 5 years. It is clear from this table that the variation in output and prices come mainly from their own shocks. After two months, 99% and 97% respectively of the variance of output and prices are explained by their own shocks. In addition, 34% of the variability of these variables is sourced from their own shocks after five years.

Now we examine the relative strengths of various channels through which monetary shocks are transmitted to output and prices. Excluding own shocks, fluctuations in output are mostly accounted for by monetary aggregate. M2 accounts for 7% of the variations in output after a year and 27% after five years. Notice that the contribution of interest rate to the variance of M2 represents 20% after four years, which corroborates the previous results of impulse response functions highlighting a significant influence of interest rate on M2. Thus, the quantitative channel is effective in the Moroccan case. This suggests that the money still plays an important role in the monetary policy strategy.

Regarding the other transmission channels, bank credit explains a dominant part of the variance of output relatively to other channels. After three and a half years, 18% of variations in output result from credit shocks. In the same vein, the growing contribution (changed from 1% at year one to 35% after three and a half years) of interest rate to fluctuations in bank credit corroborates the relative importance of the bank lending channel.

[11] Here we report only the variance decomposition of output and consumer prices and other results are available with authors upon request.

Subsequently, the interest rate explains 12% of variance of output after two years. This result supports the significant and transitory impact of monetary policy on output as highlighted by the impulse response functions. The asset prices and exchange rate channels are weak. The proportion of output variations attributable to the shock to these variables is 4% after twenty-six months for MASI and after forty-nine months, for the exchange rate. Consequently, the ineffectiveness of the exchange rate and asset prices channels in transmitting monetary policy shocks as showed by the impulse response analysis. These findings are not surprising in the context of the fixed exchange rate and the limited role of the stock market in financing the Moroccan economy. Indeed, the exchange rate and MASI are not major sources of national output fluctuations.

Regarding the variance decomposition of prices, the monetary aggregate shocks accounts for 23% of the fluctuations in consumer prices after five years, implying that shocks in monetary aggregate are an important source of inflation in Morocco. The interest rate also plays an active role in explaining the fluctuations in prices since it accounts for 19% after four years, involving the effectiveness of the interest rate channel as shown by impulse response analysis. Likewise, a non-negligible part of variance in prices is sourced from a shock on exchange rate which amount to 14% after one and a half years, indicating a significant exchange rate pass-through. The Moroccan monetary authorities should take into account this result at the time of the liberalization of exchange rate due to its significant effect on prices stability, defined as a primary goal of BAM. At last, the contribution of shocks to asset prices and bank credit are limited. While the asset prices shock explains 7% the variations in prices, the credit to private sector accounts for only 4% after twenty-six months.

Table 1: Variance decomposition of output and prices

Variance decomposition of IPI							
Horizon	IPI	IPC	M2	CBP	NEER	TB6	MASI
2	0.99	0.00	0.00	0.00	0.00	0.00	0.00
6	0.86	0.03	0.03	0.03	0.00	0.04	0.01
12	0.72	0.06	0.07	0.03	0.01	0.08	0.03
18	0.55	0.05	0.13	0.12	0.01	0.11	0.02
24	0.43	0.04	0.18	0.17	0.02	0.12	0.03
30	0.40	0.04	0.21	0.17	0.03	0.11	0.04
36	0.38	0.04	0.24	0.17	0.03	0.11	0.04
42	0.36	0.04	0.25	0.18	0.03	0.11	0.04
48	0.35	0.04	0.26	0.18	0.03	0.10	0.04
54	0.35	0.04	0.27	0.17	0.04	0.10	0.04
60	0.34	0.04	0.27	0.17	0.04	0.10	0.04
Variance decomposition of IPC							
Horizon	IPI	IPC	M2	CBP	NEER	TB6	MASI
2	0.02	0.97	0.00	0.00	0.00	0.00	0.00
6	0.01	0.83	0.01	0.00	0.13	0.01	0.01
12	0.03	0.66	0.04	0.03	0.15	0.05	0.04
18	0.03	0.53	0.09	0.03	0.14	0.12	0.07
24	0.03	0.45	0.14	0.03	0.14	0.15	0.06
30	0.03	0.41	0.16	0.04	0.13	0.17	0.06
36	0.03	0.39	0.18	0.04	0.13	0.18	0.06
42	0.04	0.37	0.19	0.04	0.12	0.18	0.05
48	0.04	0.36	0.20	0.04	0.12	0.19	0.05
54	0.04	0.35	0.22	0.05	0.11	0.19	0.05
60	0.04	0.34	0.23	0.05	0.11	0.18	0.05

5. Summary and Conclusions

While the monetary transmission mechanisms have been widely studied in developed countries, such studies in developing countries like Morocco are scarce. As for the majority of the empirical works on the transmission channels, we estimate an SVAR model to investigate four transmission channels of monetary policy, with an economic interpretation to each of the structural shocks. The presence of external constraints on monetary policy in developing countries necessitates a model specification, unlike that of developed economies. The model includes two vectors of variables. The first one contains the endogenous domestic variables while the second encompass the exogenous foreign variables. We imposed restrictions on contemporaneous effect of the endogenous variables. The results of SVAR analysis show that an unexpected monetary policy shock produces a transitory decrease in output and a persistent decline in prices. Moreover, when the decrease of output is immediately significant, the response of prices become significant after ten months. The study also illustrates that the monetary aggregate contains important additional information in the transmission process of monetary policy shocks in Morocco. Excluding own shocks, fluctuations in output and consumer prices are largely attributed to M2.

Furthermore, evidence from impulse responses and variance decomposition suggests that the credit channel and interest rate channel[12] play an important role in transmitting the monetary policy effect to the real sector. These results are natural, given that the banks are the major source of external funding for Moroccan economy and due to market-oriented monetary policy instruments and operating procedures during the past two decades. The two channels impact the real sector differently. While the credit channel is important for the economic growth, the interest rate channel is crucial for managing inflation.

Concerning the financial asset prices channel and the exchange rate channel, empirical estimates show that they are not important in transmitting monetary policy shock. These results are not surprising because, on the one hand, the Moroccan capital market is narrow and not sufficiently developed and on the other hand, of the fixed the exchange rate. These two channels could play a more active role in the transmission process owing to the growing flexibility in the exchange rate and the substantial efforts undertaken in order to render Casablanca the first financial city in the North Africa.

The analysis provides some policy implications. First, it is important to take into account the effect of externals

[12] This is in line with Bank Al-Maghrib's decision to set interest rate as operational target replacing monetary aggregate.

shocks on monetary policy when analyzing the transmission mechanisms in Morocco. Considering the external constraints on monetary policy and controlling for international shocks allows one to better appreciate the effect and the functioning of the transmission channels. Second, since Moroccan authorities prepare its transition to an inflation targeting strategy, the functioning of the interest rate channel is a good argument. However, additional efforts are needed in order to develop a more resilient, competitive and dynamic financial system, to further diversify the financing alternatives for the private sector, and to establish more flexible exchange rate. This can enhance the functioning of the four channels studied and reduce the dependence of the national economy on the bank's credit. Naturally, these transformations should be accompanied by a dynamic monetary policy formulation. Third, given the fact that the bank credit is a strong transmission channel and a major source of external financing for the Moroccan economy, it is crucial to ensure the health and stability of the banking system which is a pre-condition towards economic stability. Finally, the stickiness of bank credit in reaction to monetary policy shocks involves anticipating credit movements one year in advances in order to avoid the risk that is likely to alter BAM's primary goal.

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Appendices

Appendix 1

A1: Results of ADF, PP and KPSS tests

Tests / Variables	ADF	PP	KPSS	Integration order
IPI	-2.317869 (ct) (7)	-1.996310 (ct) (3)	0.311148 (ct) (11)	I(1)
ΔIPI	-4.979322 (c) (6)*	-6.397965 (c) (10)*	0.065415 (c) (3)*	
IPC	-2.956522 (ct) (2)	-2.717001 (ct) (12)	0.408268 (ct) (11)	I(1)
ΔIPC	-12.38944 (c) (1)*	-13.64425 (c) (12)*	0.158341 (ct) (9)*	
M2	11.30469 (1)	1.027522 (c) (4)	0.444285 (ct) (12)	I(1)
ΔM2	-18.5425 (c) (0)*	-14.64197 (4)*	0.305802 (c) (3)*	
CBP	-2.04528 (ct) (5)	8.44809 (10)	0.222379 (ct) (11)	I(1)
ΔCBP	-3.38902 (c) (4)*	-14.79670 (c) (9)*	0.292644 (c) (10)*	
NEER	-1.60585 (c) (1)	-1.736139 (c) (0)	0.407334 (ct) (12)	I(1)
ΔNEER	-17.26841 (0)*	-17.30158 (4)*	0.179276 (c) (0)*	
TB6	-2.19832 (ct) (3)	-0.59605 (c) (7)	0.259344 (ct) (8)	I(1)
Δ TB6	-6.42055 (2)*	-15.77434 (c) (7)*	0.126372 (c) (8)*	
MASI	-1.60184 (c) (1)	-1.447744 (c) (8)	0.293623 (ct) (8)	I(1)
ΔMASI	-12.94319 (c) (0)*	-13.70572 (c) (7)*	0.190549 (c) (8)*	
IPI*	-2.679047 (ct) (3)	0.809312 (10)	0.229790 (ct) (12)	I(1)
ΔIPI*	-5.290999 (2)*	-17.02066 (9)*	0.074807 (c) (10)*	
I	-2.083210(1)**	-1.929100(9)***(10%)	0.266701 (ct) (12)	I(1)
Δi*	-8.960171 (0)*	-9.298343 (7)*	0.083756 (c) (9)*	

Δ is the first difference operator, numbers in parentheses indicate the optimal lag, *(ct)* denote the model with constant and trend, (c) represents the model with only a constant and otherwise the model is without constant and trend.
*,**, *** Stand for stationarity of the variable respectively at the 1%, 5% and 10% significance level.

Appendix 2

A2: The Saikkonen and Lütkepohl (2000) cointegration test

r0	LR	Pval	90%	95%	99%
0	162.19	0.0000	106.73	111.65	121.28
1	115.99	0.0000	79.51	83.80	92.26

2	67.55	0.0093	56.28	59.95	67.24
3*	36.02	0.1240	37.04	40.07	46.20
4	16.50	0.3506	21.76	24.16	29.11
5	6.81	0.3494	10.47	12.26	16.10
6	0.16	0.7514	2.98	4.13	6.93

The critical values are tabulated by Lütkepohl and Saikkonen (2000)

Appendix 3

A3: Diagnostic tests of the residuals

Tests LM and MARCH-LM				
Tests	LM_1	LM_7	LM_8	MARCH-LM(7)
Test statistic	101.4724	73.45941	56.30962	5497.7798
p-value	0.0000	0.0134	0.2203	0.4603

The Ljung-Box and the normality Jarque Bera tests							
	u_1	u_2	u_3	u_4	u_5	u_6	u_7
LB(8)	23.619	5.1548	2.3446	1.4009	1.0814	2.5110	2.0457
Probability	0.003	0.741	0.969	0.994	0.998	0.961	0.980
JB	5.602518	10.29030*	70.11933*	17116.69*	185.5792*	3.793546	13.91475*

* denote a rejection of the normality hypothesis at 5% significance level. The numbers in parentheses indicate the order of autocorrelation.

Appendix 4

A4: Roots of Characteristic Polynomial