

NBP Working Paper No. 211

---

## Modelling less developed emerging markets: the case of monetary transmission in Tunisia

Jan Przystupa, Ewa Wróbel



NBP Working Paper No. 211

---

# Modelling less developed emerging markets: the case of monetary transmission in Tunisia

Jan Przystupa, Ewa Wróbel

Jan Przystupa – Narodowy Bank Polski and Institute for Market, Consumption and  
Business Cycles Research; jan.przystupa@nbp.pl

Ewa Wróbel – Narodowy Bank Polski; ewa.wrobel@nbp.pl

The authors wish to thank Ryszard Kokoszcyński, Sylvia Kaufman and Tomasz Łyziak for helpful comments to this and earlier versions of the paper. The estimates were performed during and shortly after the twinning project realized by the Banque Centrale de Tunisie, Banque de France and Narodowy Bank Polski over the period 2011–2013, aimed at introducing of inflation targeting in Tunisia. The usual disclaimer applies.

Published by:  
Narodowy Bank Polski  
Education & Publishing Department  
ul. Świętokrzyska 11/21  
00-919 Warszawa, Poland  
phone +48 22 185 23 35  
www.nbp.pl

ISSN 2084-624X

© Copyright Narodowy Bank Polski, 2015

---

# Contents

1 Introduction	5
2 A general background – economic reforms and stylized facts	10
2.1 Economic reforms	10
2.2 GDP, inflation and the labour market	13
2.3 Monetary policy instruments and framework	19
2.4 Financial sector	22
3 Monetary transmission: results from structural vector autoregression models	26
4 Structural models	53
4.1 Specification	53
4.2 SIMOT and GPM-T. Comparison to the core (IMF) GPM	58
4.3 Reaction functions	62
5 Conclusions	65
6 Literature	67

## Abstract

Our paper is a case study devoted to a country which belongs to a group of less developed EMEs (LDEMEs), not depending on natural resources. In spite of many features which distinguish such countries from developed market economies, they are frequently modelled basing on assumptions which are better-suited for mature economies, e.g. New Keynesian DSGE models. From the point of view of monetary transmission analysis, the most important distortions which make LDEMEs special are: underdeveloped shallow financial markets, uncompetitive labour market, informal economy, weak institutions, problematic central bank independence, state ownership and controls, especially of prices and in the financial sector. In the paper we propose a complex way of proceeding in modelling the LDMEs, starting from the stylized facts and assessment of a distance of the modelled economy from theoretical assumptions and pointing at the most problematic sectors, through structural VARs providing reactions to shocks with a relatively small number of assumptions, to a suite of structural models, estimated with classical and Bayesian methods, to have a range of possible reactions. We show that to be applicable, the standard NK models need to be adjusted with specific features of LDEMEs.

JEL: E51, E52

Key words: (LDEMEs), monetary transmission, VAR, structural models.

## 1. Introduction

The paper is devoted to a group of less developed EMEs (LDEMES). These countries are frequently modelled using standard assumptions of New Keynesian (NK) and DSGE models (e.g. Peiris and Saxegaard (2007) for Mozambique or Ben Aïssa, Rebei (2009) for Tunisia). However, there are two problems with this approach. The first one is specification: LDEMES have a bunch of special features which put a question mark on a use of conventional models. Good examples are non-competitive labour markets or underdeveloped financial sector, where in-depth credit risk analysis is replaced by a requirement of collateral considerably limiting access to credit of medium and small enterprises. Secondly, as pointed by Tovar (2008), the estimation of DSGE models is performed under a presumption that a steady state exists. This, however, may not be true, as LDEMES are subject to many structural changes. For instance, in Tunisia the revolution in 2011 seemingly changed not only potential GDP (the relation between capital and labour), but also behaviour of the labour force (a sharp increase in the number of strikes).

There exist models which are better adjusted for LDEMES characteristics e.g. Agénor and El Aynaoui (2007), Agénor and Montiel (2007) and Agénor and El Aynaoui (2010), however, they need data which in many developing countries are not available on quarterly frequencies and therefore can be rather used as an analytical framework than a basis for estimations of the monetary transmission.

These models take into account such features as *inter alia* underdeveloped financial markets, where credit is the only source of external financing, monetary authorities use interest rate as their instrument, but resort also to reserve requirements and conduct an active exchange rate policy. An important conclusion for the LDEMES is that monetary policy tightening may initially lead to price increases due to the operation of a cost channel. Secondly, reserve requirements increases, if they result in lower deposit rates, may eventually lead to higher consumer demand and prices. On the other hand, as shown in Castillo and Montoro (2012) big scale of informal economy and shadow labour market cushions the impact of interest rates

---

on wage rates, aggregate demand and inflation. In countries having shadow financial sector monetary transmission is weaker because some parts of the economy are excluded from the impact of central bank's monetary policy, but what is more, interest rates in formal and informal financial sectors may change in opposite directions and this way frustrate monetary policy, Ngalawa and Viegli (2013).

The role of government and quality of institutions in LDEMEs are also factors which undermine standard NK model assumptions. Governments usually control a considerable part of prices from the consumer basket, especially foodstuffs, fuels and energy. Likewise, controls may affect interest rates and loans in the banking sector: floors and ceilings on some rates are not unusual, as well as loans allocation to the preferred sectors. State-owned banks, having explicit or implicit guarantees and privileges may distort credit channel operation, Kishan and Opiela (2000). Capital controls aimed at avoiding excessive volatility of exchange rates put another question mark on a usually adopted assumption of uncovered interest rate parity (UIP). Recently, Benes et al. (2013) develop a New Keynesian model featuring sterilized interventions in a genuine emerging market economy. In particular, interventions are modelled as an independent central bank instrument. They operate alongside interest rate policy.

Many LDEMEs have weak institutions resulting in a big scale of state capture, corruption, and non-performing loans (NPL). State capture may weaken competition and negatively impact effectiveness of monetary transmission, whereas corruption induces banks to more risk taking, Chen et al. (2014). Furthermore, *de facto* central bank independence may be problematic both with respect to monetary policy instruments and bank's management. There is a vast literature showing that lack of independence erodes central bank credibility and has a negative impact on expectations of private agents.

Monetary policy in LDEMEs happens to be eclectic and *de facto* has multiple other targets besides inflation, for instance trade competitiveness and banking sector stability. Inflation may even have less weight, because administrative price con-

trols leave less space for the monetary policy. In this vein, Ostry et al. (2012) point at multiple targets of monetary policy in emerging markets, including inflation and exchange rate.

In the paper we suggest a complex way of proceeding in analyses and modelling the LDMEs. We start from stylized facts which provide a broad assessment of a distance of the modelled economy from the theoretical assumptions and point at sectors which are the most problematic. Then, we use structural vector autoregression models (SVARs) to get knowledge on reactions to shocks with a relatively small number of assumptions. Finally, basing on the narrative approach and SVARs we build two structural models, one modelled with classical and the other with Bayesian methods, to have a range of possible reactions of the analysed economy. We show that standard NK models need to be adjusted to reflect specific features of LDMEs.

For this case study we have chosen Tunisia. It can be treated as a genuine small trade-open less developed emerging market economy. It is a country which has been introducing market-oriented reforms since late 1980s, nonetheless the state plays a significant role. It controls, *inter alia*, about 36% of consumer price index, employs about 13% of active labour force and has an important role in wage negotiations. Three state-owned banks account for 37% of banking sector assets. Tunisia's financial sector is still underdeveloped, in spite of a relatively high level of loans/GDP ratio. There is no efficiently working securities market, and therefore no yield curve. Banks are burdened with a sizable portfolio of non-performing loans. Loans are concentrated in big enterprises and tend to be extended on the basis of collateral. The size of the informal economy is large, 30% (as a share of formal – officially measured) GDP (data for 2008), IMF (2011), more than one third of employment in the private sector is informal. Before 2011 there was a significant state capture: firms connected to the president of the state family outperformed their competitors in terms of output, employment, market share, profits and growth. Sectors in which they were active were disproportionately subject to authorization

---

requirements and restrictions on FDI. Regulation was endogenous to state capture, Rijkers et al. (2014).

Tunisia's monetary policy has been eclectic, showing elements of exchange rate and monetary aggregates targeting. CBT used not only interest rate but also reserve requirement as its policy instruments. In some periods the central bank was losing its independence and was unable to increase the interest rate. Finally, the Tunisian revolution in 2011 brought about a significant structural break into economic processes.

Thus, Tunisia shares a lot of typical features of LDEMES and can be used as a noteworthy example. The literature on Tunisia is scarce and generally does not cover the most recent period. Moreover, the conclusions are contradictory, for example using a structural VAR Boughrara concludes that credit channel is the strongest monetary transmission channel in Tunisia. What is dubious in his estimation is the use of money market rate as a proxy for the actual policy instrument. Taking into account uncertainty about policy instruments, Chailloux et al. (2009) have built two VAR models with money and alternatively interest rate as policy instruments. Using Cholesky decomposition they show that interest rate had a statistically significant albeit small impact on the real sector and consumer prices. Money (monetary base and *m3* aggregate) was found not to exert any meaningful impact on the economy. Recently, Jardak et al. (2014) show that exchange rate significantly affects GDP and prices.

In this paper we reestimate VAR models using observations up to the end of 2013, and use a richer set of variables. Our aim is to identify monetary policy shocks using non-recursive decomposition and sign restrictions. We demonstrate that the central bank of Tunisia used monetary policy instruments in such a way that various policies were separated. Capital controls made this separation fairly effective. Basing on SVARs we build two small structural models. They have a similar structure, but are estimated with 2 different methods – the first one is estimated with classical and the other with Bayesian econometrics. Models are tailored to

depict the main features of the Tunisian economy, which despite economic reforms implemented since the end of 1980s, is still far from being a mature market economy.

Thus, in the paper we propose a comprehensive method of analysis and modelling of a LDEME. It is constructed in a following way: chapter 2 is devoted to the narrative approach, in chapter 3 we present results obtained from SVAR models. The next one brings responses from the structural models. The last part concludes.

## 2. A general background - economic reforms and stylized facts

In what follows, we provide an exemplary analysis for Tunisia, starting with a short history of economic reforms, developments in GDP, inflation, labour market, monetary policy framework and the features of the financial sector.

### 2.1. Economic reforms

Tunisia undertook economic reforms and started a transition to the market economy in the late 80s, after a period of experiments with multiple economic models. The main reforms, realized over 1991-1997, were aimed at increasing efficiency and enhancing the growth prospects through liberalizing external trade and payments, as well as domestic prices, reforming the financial sector, revamping direct and indirect tax system, and reforming the public enterprise system (IMF, Staff Country Reports, 1996).

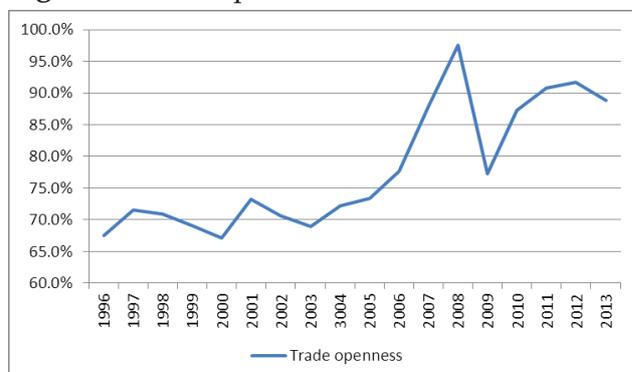
Trade liberalization led to significant reductions in quantitative import restrictions, e.g. in 1990 74% of imports was subject to such restrictions, while in 1995 8%. In 1990 the country joined GATT and became a founding member of the WTO. Then, in 1993, it established convertibility of the dinar (TND) for current account transactions. In 1994 spot foreign exchange market was created.

In 1995 Tunisia concluded an Association Agreement with the European Union, effective since 1998. The authorities followed a gradualist approach toward greater trade and capital account openness due to the lack of technical preparedness of the banking system and low level of international reserves.

Thanks to the reforms and the Association Agreement with the EU, trade openness (exports of goods plus imports of goods related to GDP in current prices) has grown significantly (Figure 1). Tunisia's main trade partner is Europe (in 2010

the share of Europe in Tunisian exports amounted to 73.2%, and of imports - to 61.2%)<sup>1</sup>.

**Figure 1.** Trade openness, in % of GDP



Source: Own calculations, Institut National de la Statistique

The process of capital account liberalization has been slower. It comprised several steps aimed first at liberalizing medium- to long-term flows, such as non-resident direct investment and loans to listed firms<sup>2</sup>, as well as limited non-resident investments in local currency government securities. As a result, financial openness has stayed limited. For example, no more than 25% of issued treasuries can be bought by foreign investors. On the other hand, there are no restrictions for investment in equities. There are no limits on capital inflows into the real sector, but there are ceilings on Tunisian FDI abroad. Deposits and loans in foreign currencies are allowed for residents only if they are exporters or importers. At the end of the working day, banks have to transmit to the central bank residents' deposits in foreign currencies, obtained from their correspondents.

New banking law introduced in the 90s anticipated creation of universal and investment banks. The law stipulated banks to strengthen capital base to meet the international prudential standards. Besides, new financial instruments were created, with treasury bills of maturities from one to ten years and treasury bills negotiable on the stock market (IMF, Staff Country Reports, 1996). Shortly afterwards, in 1997, lending requirement to priority sectors (mostly tourism) was removed.

<sup>1</sup> 27 countries, source: Pocketbook on Mediterranean Statistics, Eurostat, 2012.

<sup>2</sup> Resident financial institutions can contract foreign currency loans from non-residents for maturities of over 12 months without limits. Resident companies can contract such loans up to an annual limit of the equivalent of TND 10 million a year.

---

In the same period Tunisia liberalized producer and consumer prices, although one third of consumer basket prices remains under state control, of which food-stuffs have a share of 8,3%, manufactured goods – 8.4% and services – 18.6%.

Many controls were also removed from the financial sector – this included liberalization of interest rates on loans and increases in preferential rates, which ended up much closer to the money market rates. Nonetheless, there still exist administratively fixed upper and lower limits on some retail deposit rates. The upper limits are aimed at reducing bargaining power of public institutions and firms which dispose of considerable amounts of funds and impact rates offered by banks. The lower limits are to protect households' deposits from inflation.

Although after 1997 the pace of reforms slowed down, there were two noteworthy exceptions: privatisation and monetary policy. The privatisation process gained its momentum in mid-2000s: the year 2007 brought a record revenue from the sale of Tunisie Télécom. In 2006 a new central bank law was adopted, which named price stability as the main task of the central bank and guaranteed its independence. Since 2009, central bank introduced standing facilities, what made liquidity management more efficient.

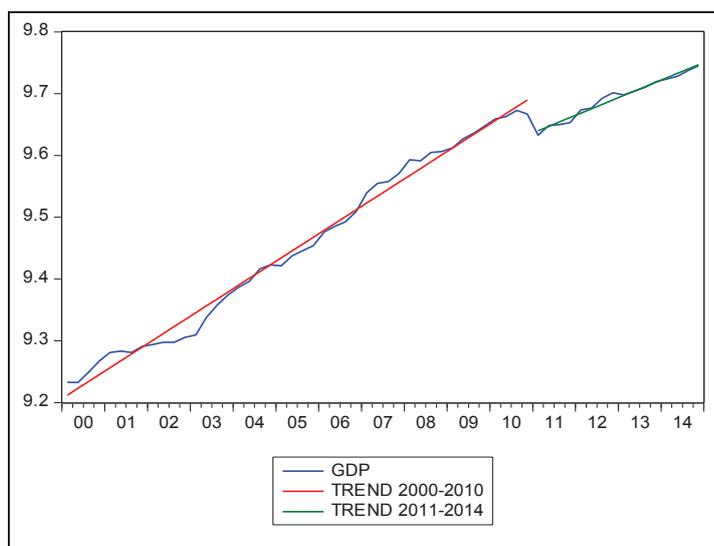
In spite of market-oriented reforms, there persisted significant entry barriers, especially in sectors which were subject to the penetration of the family of Ben Ali, Tunisia's president since the late 1980s. In particular, these sectors were subject to prior authorization by the government and to FDI restrictions. The entry regulations were dictated by president's private business interests. The most affected were telecommunications, transports and real estate. 220 firms confiscated after the revolution appropriated 21% of all net private sector profits and accounted for approximately 3% of private output, Rijkers et al., 2014.

The next stage of broad market-oriented and social reforms started in 2014, two years after the social unrest. The aim of the Tunisian authorities is to achieve short-term stabilization, lay the foundations for stronger growth and social cohesion. Key elements of the strategy are to build up fiscal and external buffers with appropriate fiscal, monetary and exchange rate policies, lay building blocks to support growth by addressing critical vulnerabilities of the banking sector and improving the investment climate through reforms of the tax and investment regimes, strengthen social safety nets to protect vulnerable, IMF, 2013.

## 2.2. GDP and inflation. Labour market

Over the period 2000-2010 GDP in Tunisia was growing at an average rate of 4.5%. The European financial crisis which outburst after the Lehman Brothers collapse depressed demand for Tunisian exports and negatively affected investment. As a result, economic growth fell from 4.3% in 2008 to 3.3% in 2009-2010. In 2011 output dropped by 1.9% due to the social unrest which exacerbated the slowdown resulting from the financial crisis. Thus, over 2011-2014 the average GDP growth rate fell to about 1.7% as a result of a juxtaposition of the financial crisis, the revolution and political, economic and social turmoil accompanying the revolution (Figure 2). Besides the revolution of 2011, GDP in Tunisia was hit by another negative exogenous shock. In 2002 it was a global slowdown and a terrorist attack on tourists. GDP growth plummeted then to 1.7%.

**Figure 2.** GDP and GDP (linear) trend 2000-2010 and 2011-2014



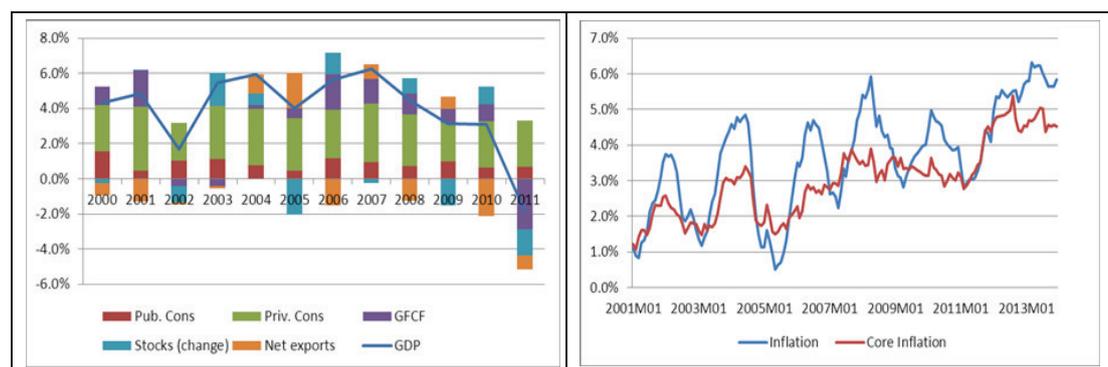
Source: Own estimates, data: Institut National de la Statistique, Banque Centrale de Tunisie

Over the period 2000-2013 the sector of market services was the main contributor to the total value added. Its share increased from about 42% in 2000 to 47% in 2010. The second biggest sector was industry (about 17% in the total value added). However, its role was diminishing because of falling production of textiles as a result of the dismantling of the multifibre agreements and growing competition from

Asia. Other industries performed somewhat better – production of electrical and mechanical appliances in 2010 gained some 5% in the value added, up from 3% in 2000. The third contributor, but the most volatile was agriculture, which heavily depends on weather conditions (about 9% of the total value added in 2010, down by 3 pp from 2000).

On the demand side, (Figure 3, LHS), private consumption was the main factor sustaining economic growth. Net exports tended to have a negative contribution, while this of investment was positive albeit small. A striking difference is 2011, when investment fell down in the aftermath of the revolution and the related uncertainty.

**Figure 3.** GDP and contribution of its components, 2000-2011, in %, LHS panel and Inflation (CPI) and Core inflation (CPI less foodstuffs and energy), y/y in %, RHS panel



Source: Banque Centrale de Tunisie, Institut National de la Statistique

Over the period 2000-2013 inflation was reasonably low, there was however a clear-cut upward trend in both headline and core inflation (Figure 3, RHS). To some extent, it reflected the impact of world oil and food price increases. A vast system of subsidies reduced the scale and increases the length of pass-through from world to domestic prices. Nonetheless, world food and oil prices had a significant, but asymmetric impact on CPI: falls were transmitted to CPI less than increases (Belke and Dreger (2013)).

The inflationary pressure got even more pronounced after the revolution. A civil war in the neighbouring Libya caused a considerable inflow of temporary im-

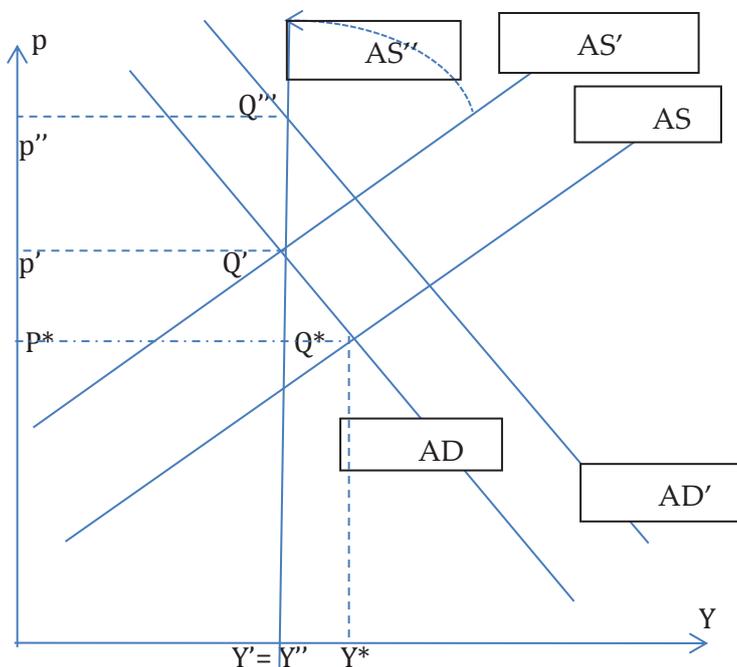
migrates. Together, the revolution and the civil war, increased uncertainty and country risk and had a negative impact on investment. On the other hand they sustained consumer demand and eventually increased inflation. The supply side of the economy was hit by a negative shock: output fell because of strikes and social turmoil, long-lasting curfew, rising production costs, and obstructive actions of unemployed persons on production of phosphates. Many domestic enterprises halted production, numerous production links got undermined. 5% of total foreign enterprises closed or temporarily suspended their activity and as a result 11 000 of jobs got wiped out, OECD, 2012.

Within the aggregate demand/aggregate supply framework (Figure 4), the social turmoil moved the AS curve to AS' what resulted in higher prices. Also, the AS curve became steeper than in the past (with some exaggeration we depict it as a vertical line, AS''). Vertical AS curve means that any increase in demand is fully reflected in prices. Uncertainty and problems with cash flow in the aftermath of the revolution necessitated looser monetary policy – central bank lowered the interest rate and the reserve requirement ratio. High rate of growth of credit to the economy (see Figure 6), additional demand of immigrants<sup>3</sup> as well as fiscal and monetary expansion sustained private consumption. The aggregate demand curve moved to AD', to a new equilibrium Q'' with even higher price level p''. On the other hand, central bank intervened in the foreign exchange market to counteract undergoing depreciation of the domestic currency and higher inflation from the exchange rate pass-through. This policy was somewhat reducing domestic demand, but stimulated imports of consumer goods and increased negative trade balance.

---

<sup>3</sup> Before the civil war 2 million of foreign workers worked in Libya, mostly Egyptians, Tunisians, Chinese and Indians. Many of them fled from Libya to Tunisia, at least for a short stay before the repatriation. On the other hand, there was a significant drop in tourist arrivals, from 6.9 million in 2010 to 3.1 million in 2011. The number of hotel days fell by 50% comparing with 2009. (Institut National de la Statistique)

**Figure 4.** Aggregate supply and aggregate demand shocks in Tunisia in 2011



Source: own illustration

Tunisian labour market remains under a significant influence of the public sector. It employs about 13 percent of the active population (2003)<sup>4</sup>, and plays an important role in wage bargaining. The system of wage negotiations is centralized and comprises representatives of the government, employers and trade unions. Once the wage pattern for 3 years is settled on the central level, it is renegotiated at a branch level. Wages are indexed to the past inflation, with no escape clauses, what may lead to higher unemployment, inertial behaviour of the economy and higher inflation persistence, understood as duration of shocks hitting inflation.

Estimations of inflation persistence show, on one hand, that shocks affecting inflation die out and do not exert a long-run impact (Table 1). Ng-Perron (2001) test of quarter on quarter headline and non-food non-energy seasonally adjusted

<sup>4</sup> This is sharply down from about 20% at the end of the 1990s as a result of market-oriented reforms, see Employment Policy Reforms in the Middle East and North Africa, European Training Foundation, 2006.

inflation rejects the null of a unit root (non-food non-energy inflation is trend stationary). On the other hand, a degree of persistence of the core inflation is non negligible and higher than this of headline inflation, seemingly due to high variability of food prices.

To evaluate briefly the degree of inflation persistence with a univariate method we follow Marques (2004). The mean, representing long-term inflation level, is assumed to be time varying. For quarter-on-quarter inflation we use Hodrick-Prescott filter (with a smoothing parameter  $\lambda=1600$ ) to obtain the level of long-term inflation and calculate the measure of persistence as the ratio  $\gamma = 1 - \frac{n}{T}$ , where  $n$  stands for the number of times the series crosses the mean during a time interval with  $T+1$  observations ( $\gamma$  close to 0.5 means that there is no persistence<sup>5</sup>). Another indicator of persistence is a sum of autoregressive coefficients. We start with the autoregressive representation of inflation:

$$y_t = \alpha_t + \sum_{j=1}^p \beta_j y_{t-j} + \varepsilon_t$$

Which can equivalently be written as:

$$(y_t - \mu_t) = \alpha_t + \sum_{j=1}^p \beta_j (y_{t-j} - \mu_{t-j}) + \varepsilon_t$$

And finally as:

$$(y_t - \mu_t) = \sum_{j=1}^p \delta_j \Delta(y_{t-j} - \mu_{t-j}) + \rho(y_{t-1} - \mu_{t-1}) + \varepsilon_t$$

Where  $\mu_t$  is the mean and  $\rho = \sum_{j=1}^p \beta_j$ . The results are presented in Table 2, the number of lags was determined basing on Schwarz criterion. The obtained estimates are close to these from the structural models (Table 7, Phillips curve, parameter  $\beta_2$ ).

---

<sup>5</sup> Under the assumption of no persistence the following result holds:  $\frac{\gamma-0.5}{0.5\sqrt{T}} \cap N(0; 1)$ , see Marques (2004)

**Table 1.** Ng-Perron (2001) Unit root test, q/q CPI headline and core inflation,  $H_0$  : Variable has a unit root.

Variable	MZa	MZt	MSB	MPT
CPI headline#	-15.1425**	-2.73824**	0.18083**	1.66883
CPI core##	-26.7692**	-3.61988**	0.13523	3.63157

\*\*significant at 1%, #with constant, ##with trend and constant

Source: Own estimates

**Table 2.** Inflation persistence, headline and core inflation, q/q, t-statistics in parentheses

	2000.2-2013.4 $\rho$	2000.2-2013.4 $\gamma$	lags
CPI	0.24 (1.64)	0.64	1
Core inflation	0.67 (6.5)	0.8	1

Source: own estimations

The unemployment rate in Tunisia is relatively high – over 2000-2010 it oscillated within the range of 12-13% Jardak ed.(2014), to jump to nearly 19% in the aftermath of the revolution. Since then it remains on an increased level of 15-16%<sup>6</sup>, reflecting considerable structural mismatches, e.g. between demand for unskilled workers and supply of high school and university graduates.

Tunisia has a significant proportion of informal employment. According to a recent estimate of informal sector understood as unregistered activities, activities without paying contributions, social security and medical coverage, as well as activities beyond the control, regulation and accounting of the State, in 2010 37% jobs in the private sector was informal; in the non-agricultural sector they amounted to

<sup>6</sup> Data from the Institut National de la Statistique

about 33%, whereas in the private agricultural sector to 52%.<sup>7</sup> The informal sector has grown as a result of adoption of the market-oriented reforms, downsizing of the public administration and lay-offs in the privatised enterprises. Besides agriculture, informal employment is concentrated in manufacturing (food, wood, metals), construction, commerce, automobile repair and transportation. It is countercyclical and highly correlated with production and value added<sup>8</sup>.

### 2.3. Monetary policy instruments and framework

Tunisia was conducting discretionary and eclectic monetary policy with seemingly dominating elements of real exchange rate targeting and liquidity management. Trade liberalization in the late 80s led Tunisia's monetary authorities to pursue real exchange rate targeting, Fanizza et al. (2002). The real exchange rate rule was operative up to the end of 2000. Since 2001 Tunisia had a crawling peg with respect to the euro. Over the period 2001-2005, the authorities aimed at some 3.3% of yearly real depreciation which was approximately equal to a gap between unit labour costs in Tunisia and its main trading partners<sup>9</sup>, Jardak ed. (2014). Since then, the rate of depreciation slowed slightly below 3% and the central bank allowed for more exchange rate variability (see Figure 6). Owing to restrictions on capital flows, BCT had enough space for an interest rate policy independent from the exchange rate policy.

Over the period 2000 to the late 2008, interest rate policy was aimed at stabilization of the banking sector rather than price stability. Short-term money market rate (Taux du marché monétaire, TMM) was flat over long periods in spite of an

---

<sup>7</sup> Survey of informal workers in Tunisia, Global Fairness, ISTIS, TAMSS, Study Report 2013, June.

<sup>8</sup> Employment Policy Reforms in the Middle East and North Africa, European Training Foundation, 2006.

<sup>9</sup> Tunisia's tax policy enhanced development of the off-shore economy. Tax incentives and privileges were further strengthened by the exchange rate policy, aimed at preserving competitiveness. As a result, there exist in parallel two sectors, less developed on-shore and more technologically advanced off-shore sector.

---

upward trend in inflation; only since 2006 real interest rate tends to increase with the current output gap, before it reacted to the gap lagged by 1 to 2 quarters (Figure 7). Being the aim *per se*, the interest rate stability led the central bank to provide liquidity the banking sector demanded. This undermined the usual effects of reserve requirement tightening.

Since 2007 monetary authorities allowed for more variability of the money market rate. Introduction of the standing facilities in 2009 made this policy more pronounced. It is worth to note that since 2013 money market rate has been close to the upper limit of the corridor between deposit and credit rates, what reflected a more restrictive liquidity management aimed at better inflation control. The central bank, being *de facto* not fully independent in its monetary policy, adopted this measure as a substitute for an increase in its main interest rate.

Up to 2012 in periods requiring monetary tightening, interest rate policy was replaced by an active reserve requirement policy. Capital flows from the privatization process, and possibly from the exchange rate policy led to surplus liquidity in the banking sector. To absorb liquidity and avoid excessive loan creation, central bank increased the reserve requirement from 2% at the end of 2006 to 12.5% in mid-2010. Nonetheless, loans were increasing at a two digit pace in 2008 to touch the rate of 19% in January 2011, Figure 5. At the end of 2012 monetary authorities introduced reserve requirement on consumer loans: banks which extended more loans than in September 2012, had to pay 50% of the increment on a non-remunerated account at the BCT. In March 2013 this levy was reduced to 30%. The aim of this instrument was to halt fast growing imports of consumer goods, which was significantly deteriorating current account balance.

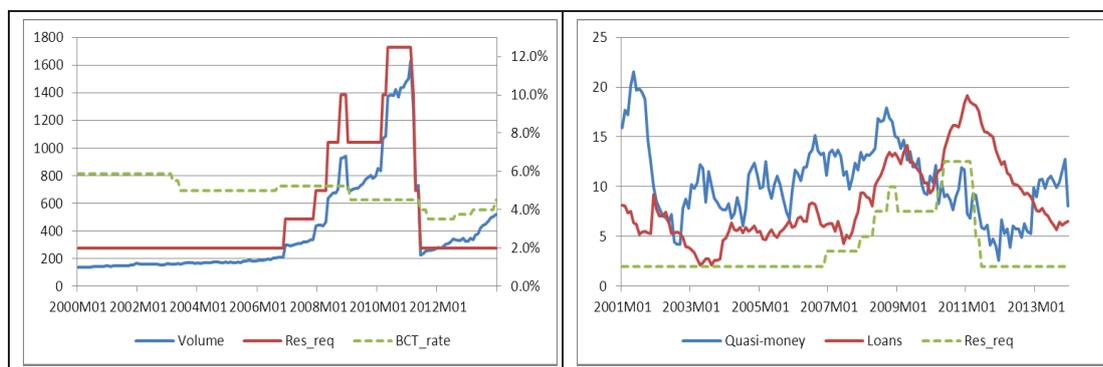
As it is clear from Figure 5, the policy of reserve requirement has not been successful, as loans were quickly increasing in periods of reserve tightening. Up to the end of 2008, central bank generally provided banking sector with liquidity in a flexible way (daily and then weekly fine tuning) to the amount banks needed to meet the required reserve. It offered practically unlimited access to non-reservable

sources of finance and to a big extent offset increases in the required reserve. It also regularly mopped excess liquidity.

Up to the end of 2002 BCT officially targeted credit growth (credit to the economy was to grow in line with GDP), and since then - monetary aggregates,  $m2$  or  $m3$ , although not too strictly. Monetary targets were abandoned if they conflicted with other targets, like the exchange rate. Nonetheless, monetary policy was programmed as if there was a stable relationship between money and prices. Reserve money has served as the operational target.

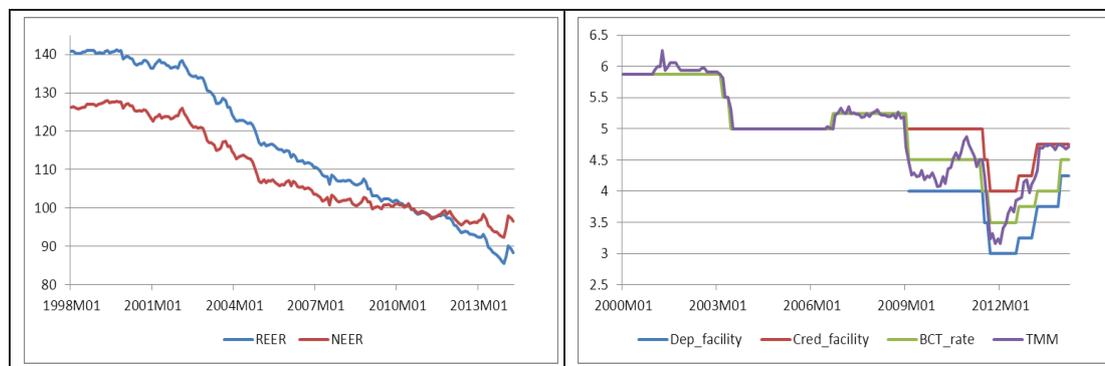
Since 2011 central bank has started preparations for the inflation targeting adoption, but owing to unstable economic situation after the revolution, it has not been implemented yet (1Q2015).

**Figure 5.** Reserve requirement: volume of the required reserve, million TND (LH axis), reserve requirement ratio on demand deposits and central bank rate (RH axis, in %), LH panel; quasi-money and loans to the economy, y/y in %, RH panel .



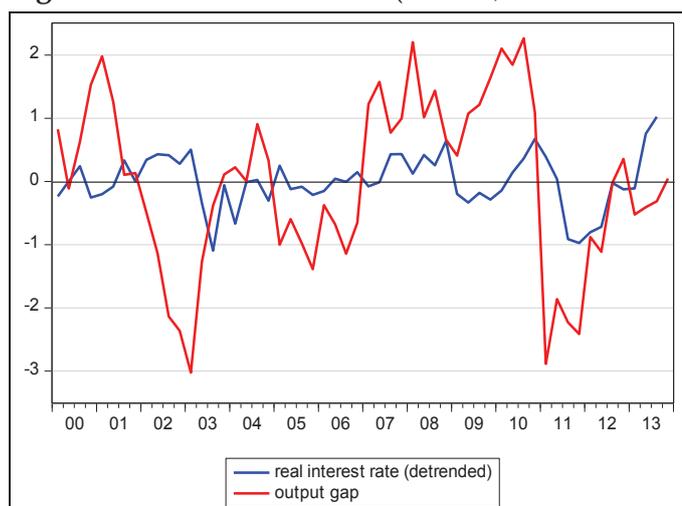
Source: International Financial Statistics, International Monetary Fund, Banque Centrale de Tunisie

**Figure 6.** Nominal and real effective exchange rate, 1998.01-2014.04, LH panel; Interest rates: BCT main rate, TMM, rates on deposit and credit standing facilities, upper RH panel



Source: International Financial Statistics, International Monetary Fund, Banque Centrale de Tunisie

**Figure 7.** TMM in real terms (ex ante, detrended HP) and output gap (HP filter)



Source: Own estimates, data Banque Centrale de Tunisie, Institut National de la Statistique

#### 2.4. Financial sector

Tunisia's financial sector is dominated by banks. In 2012 financial sector assets in relation to GDP amounted to 111% (Rapport Annuel, BCT, 2012). Banking sector assets to GDP amount to about 90%. The respective figures for Morocco (2007), i.e. a country which is usually compared with Tunisia because of their geographical, cultural and economic proximity are 197% and 109% (FSSA, 2008). Stock exchange capitalisation is relatively low (about 21% in relation to GDP in 2011, see Table 3),

of which some 70% is due to financial institutions. It is much less than in Morocco, where the stock market capitalization in 2011 was about 66%. The shallowness of the stock exchange market results from a familial nature of the ownership and a small size of the Tunisian firms<sup>10</sup>. Capital market is not liquid, as reflected by low figures for the value of stocks traded to GDP. These factors can make demand and supply of credit inelastic with respect to the interest rate. The ratio of credit to the economy and money supply ( $m3$ ) have been increasing over 2000-2011, the process even accelerated in 2011, especially markedly in the case of credit. In the case of the latter, this results from high rates of growth accompanying the sizeable fall in GDP, while in the case of money supply mostly due to output fall.

As it is pointed in Pearce (2011), financial inclusion in the region of Middle East and North Africa is generally relatively low: the number of bank deposits and loan accounts per adult are much lower than in Latin America and Caribbean or Europe and Central Asia. Tunisia overperforms some countries of the region (e.g. Egypt, Syria, Yemen), nonetheless its financial inclusion indicators are lower than for countries with a comparable level of loans/GDP ratio.

Out of 21 universal banks in Tunisia, 3 are state-owned (i.e. under majority government ownership) and to some extent their mission is to fulfil the government policy with respect to strategic sectors: agriculture, housing and tourism. Public banks possess about 37 percent of banking sector assets<sup>11</sup> and 40 percent of loans. As of 2012, there was 8 off-shore banks, whose role in lending to the economy is diminishing: in 2000 they provided 13.3% of total loans related to GDP, while in 2011 – only about 6 % (source: FRED, Bank of St. Louis).

Concentration measures of the banking sector (assets of 3 and 5 largest banks related to total banking sector assets) show that the market is rather competitive (the respective figures for Morocco are much higher), also the Lerner index is close to the world average of 0.2-0.3, whereas in Morocco it is twice as big. This means that the financial market structure should rather not hamper interest rate transmission. However, it may be impaired on the liability side, as institutional depositors (mostly public) have a significant bargaining power and in fact exert an impact on deposit rates.

---

<sup>10</sup> In this context, a parallel stock exchange market was launched in 2008, designed for small and medium size firms, with less restrictive conditions of admission.

<sup>11</sup> The fact that public banks' share in total assets is higher than their share in capital may simply indicate that they are undercapitalized (the volume of assets is the heritage from the past, it is related to the NPL problem - in general, public banks were involved in acquisition of firms that had not paid back their loans).

---

The main recipients of loans to the economy are services and industry. Within services, trade uses mostly short-term credit, whereas real estate, hotels and restaurants rather medium and long-term. Outstanding credit to services is by 65% larger than credit to the industrial sector. The share of private persons in total credit amounted to about 27% of the total credit in 2012, what means that it has increased by 10 pp since 2002 (there is no respective data for the pre-2002 period).

Tunisian banking system suffers from a weak internal risk management, Chailloux et al. (2009). This is a result of a legacy from the 'priority sectors' era when the government implicitly guaranteed this type of loans, the lack of interest rate volatility and the existence of a fund designed to compensate banks for exchange rate losses (*fonds de péréquation de change*), eliminating incentives to use hedging instruments. Together with administrative allocation of loans to the preferred sectors, weak internal risk management led to an increased ratio of non-performing loans (Table 2), higher in public than in private banks.

The weakness of risk management has pushed banks to indexation of lending rates to the overnight money market rate, thus transferring entirely the interest rate risk to their customers. A noteworthy by-product of the indexation is a relatively quick interest rate pass-through.

To reduce the risks of credit crunch, the Tunisian authorities adopted a bunch of measures. They included a change in procedures for realizing real estate collateral, more favourable tax deductibility rules for NPL provisions and write-offs, and the establishment of asset recovery companies. As a result the NPLs ratio fell from 21.6 in 2000 to 15.5% in 2008. According to the official figures, in spite of the revolution, in 2012 the ratio of NPLs fell down even further, since BCT allowed banks to reschedule loans due from firms affected by the social unrest in 2011. Had they been classified, the NPL ratio would have been higher by about 5 pp, FSSA, 2012. Moreover, loans to the public sector enterprises are never classified, since banks treat them as if they had implicit state guaranties. Practically all indicators of financial soundness are of poor quality and do not comply with international standards.

The level of self-financing of non-financial enterprises is high, estimations point at a range of 65-75% in the 2000s, Chaari, Couppey-Soubeyran (2008). According to a survey conducted on a sample of 100 Tunisian entrepreneurs, two top sources of finance were retained profits at 65%, followed by own savings at 56%, whereas banking credit came in the third place at 40%, Adly (2014)<sup>12</sup>. Loans are concentrated in the bigger units; whereas micro, small and medium enterprises find

---

<sup>12</sup> Survey data, more than one answer is possible.

it difficult to obtain bank loans, due to the lack of credit information sharing mechanisms between financial institutions and weak enforcement of creditor rights. Owing to the feeble internal risk management, most bank loans are granted on the basis of collateral, rather than on an in-depth financial analysis aimed at assessing counterparty risk factors, FSAP, 2007. The levels of collateral to secure a loan is on average 150% of a loan value compared to 130% in the OECD countries (Horj, 2012). According to business surveys, in 2010 71% of enterprises, which had an access to bank credits, perceived the level of collateral as too high. The same survey reports that for 56% of enterprises financing their activity with loans, the ratio of collateral was below 100%, for 19% it was within a range of 100-150%, and for 25% it exceeded 150% (ITCEQ, 2010).

About 52% of loans to the enterprise sector is short-term (2012), they presumably finance working capital or low value investment. Demand for this type of credit seems more rigid to changes in monetary policy instruments than this for long-term which usually serves investment financing. Loans to private persons have longer maturities, not only these for housing, but even those for consumption.

**Table 3:** Selected indicators of financial sector development

	2000	2004	2008	2013
M3/GDP	53.1	55.3	61.8	72.4
Financial sector assets/GDP	117.7	127.2	92.6	111.0#
Banking sector assets/GDP	91.7	101.7	91.5	90.1#
Bank credit to the economy/GDP	58.9	56.3	56.0	71.3
Bank deposits/GDP*	43.7	45.6	45.4	53.5**
Assets of 3 and [5] largest commercial banks/total banks' assets	45.1 [63.8]	46.2 [66.6]	43.7 [63.4]	45.0** [68.2]**
Lerner index in banking market	0.2	0.2	0.3	0.3***
Stock exchange capitalisation/GDP	13.2	8.5	14.5	20.8**
Stocks traded/GDP	3.22	0.70	3.3	2.8#

\*\*Data for 2011, \*\*\*Data for 2010,\*\*\*\*Demand, time and saving deposits in deposit money banks as a share of GDP in real terms, # data for 2012

Source: The World Bank, IMF, Federal Reserve of St. Louis, Central Bank of Tunisia, <http://www.indexmundi.com/tunisia> and own calculations

**Table 4:** Financial soundness of the banking sector

	2000	2004	2008	2011
Capital adequacy ratio	11.3	11.6	11.7	11.8
Private banks	10.6	12.4	11.0	12.1
State-owned banks	11.8	10.1	9.6	9.3
Gross NPLs	21.6	23.7	15.5	13.8*
Private banks	15.4	20.4	15.3	10.6*
State-owned banks	26.8	27.4	15.9	17.8*
Provisioning rate,% of NPLs	44.1	45.1	56.8	59.6
Private banks	39.9	43.5	55.0	67.9
State-owned banks	46.2	47.6	58.1	49.2
Return on assets	1.4	0.6	1.0	0.6
Return on equity	16.5	7.1	11.2	6.6

\*Own estimates for 2012

Source: FSSA, IMF, 2007 and 2012, Country Report, Tunisia: Request for a Stand-by, IMF 2013, Raport Annuel 2012, Banque Centrale de Tunisie.

All in all, although Tunisia made a considerable progress on its way to market economy, there persists a considerable number of rigidities and distortions. Wage setting mechanism, privileged public sector, the informal labour market serving as the employer of the last resort, entry barriers into some sectors, especially services, credit constraints and the big role played by the collateral, as well as price controls and weakness of institutions, including central bank make the application of standard models problematic. They also impair monetary transmission, thus we rather expect weak reactions of the real sector and inflation to monetary policy instruments. Furthermore, although there be no exchange rate channel, as there is no relationship between the interest rate and the exchange rate due to capital controls, we expect that the exchange rate may play a significant role in price and output dynamics.

### 3. Monetary transmission: results from the structural vector autoregression models

Our next step was to verify stylized facts using structural vector autoregression (SVAR) models with a limited set of assumptions<sup>13</sup>.

<sup>13</sup> We have first checked unit roots and cointegration of the time series. Dickey-Fuller test shows that output may be stationary around the deterministic trend, whereas other variables are rather integrated of order one. Both in the case of Model I and Model II, it is impossible to reject  $H_0$  of no cointegration with the Johansen test, even using Bartlett correction for a small sample. Trace stability tests show however that basing on a 5% test, the series have been cointegrated only since 2007 – with a visible break in increases of the value of the

Eclectic monetary policy, multiplicity of policy instruments (liquidity management, interest rate, exchange rate and reserve requirement) and their changing role within a relatively short period make the choice of a unique “true” instrument problematic and the identification of a true monetary policy shock non-trivial. Moreover, even a “true” monetary policy shock may have an impaired impact on the real economy and therefore be easily discarded owing to factors distorting transmission as administrative controls of prices and some retail interest rates, high concentration of loans and a significant shadow labour market to name only the few. Cost channel previewed by Agénor and Montiel (2007) may additionally induce non-standard price reactions (price puzzle). There is also some vagueness concerning the role of the exchange rate in the monetary transmission owing to capital controls. Reactions of the exchange rate to the interest rate may have either the expected positive sign i.e. the domestic currency will appreciate after a positive shock to the interest rate, or negative (depreciation), or may even be nil. The first is true if, for example, after the interest rate shock, domestic investors tend to sell equities and buy treasuries. Then prices on the stock exchange will fall attracting foreign investors. On the other hand, the opposite can be true (i.e. depreciation after a positive shock to the interest rate) if foreign investors sell equities because they expect a deterioration in fundamentals. Finally, both effects may offset.

Reserve requirement increases are commonly expected to reduce aggregate demand and prices through lower liquidity and credit supply. However, in LDEMES the opposite effect, i.e. expansion of demand and higher inflation cannot

---

trace test in 2009, being probably a somewhat lagged effect of the financial crisis in Europe, and even bigger in 2011 (impact of the revolution). For a test with Bartlett correction we should have waited until the end of 2011 to have a cointegrating relation. On the other hand, VAR settings with exogenous deterministic trend show no roots lying outside the unit circle. Thus, the question whether the series are cointegrated or not is difficult. Taking into account that the period under consideration is relatively short and that there were changes in monetary policy as well as other breaks which might affect equilibria in the economy and make conclusions about the long-run problematic, we have decided to use a VAR and impose short-run restrictions rather than a VECM and conclude about the long-run.

---

be ruled out as suggested by Agénor and Montiel (2006). An increase in the required reserve ratio increases cost of deposits for the banking sector and therefore reduces banks' demand for deposits. As a result banks lower deposit rates<sup>14</sup>. This expands consumption to the extent that spending depends on the interest rate. Alternatively, resources can be reallocated, thus required reserve increase may lead to higher prices of other financial or non-financial assets, like land, real estate and stock exchange indexes. This can additionally expand consumption through the wealth effect. To restore equilibrium loan rates should rise. In fact, however, they may remain flat or even fall. The former occurs if the central bank is ready to elastically provide banks with funds at a policy rate, i.e. if the refinancing rate of the central bank is not altered and the marginal cost of funds does not change. The necessary condition for the loan rate to be unaffected is for deposits and loans from the central bank to be perfect substitute, i.e. if there is no risk resulting from the maturity mismatch between short-term central bank credits and longer-term loans to the non-financial sector, or if banks are not risk averse (Agénor and Montiel (2006), Glocker and Towbin (2012a)). Another reason for the loan rates to fall is a positive impact of higher prices on the value of collateral as in Agénor and El Aynaoui (2010).

Theoretical models show that the overall macroeconomic effect of required reserve changes is ambiguous and depends on the relative strength of the reaction of depositors (semi-elasticity of demand for deposits with respect to deposit rates) and borrowers (semi-elasticity of loan demand with respect to loan rates). Importantly, macroeconomic effects of the required reserve change depend on the weight of bank lending as a source of external funds and on the degree to which lending can be easily substituted with other sources of financing, e.g. capital markets, funds from abroad (Glocker and Towbin (2012b)).

---

<sup>14</sup> Although, as it is argued by Walsh (2012), in the DSGE (calibrated version) model used by Glocker and Towbin (2012a), the impact of the required reserve on deposit rates is rather small.

Thus, identification basing on the expected shape of response functions, as in Uhlig (2005) may be not valid for less developed economies. For them to obtain “true” monetary policy innovations through structural VARs it would be more appropriate to rely on an identification of a monetary policy rule exploited by a central bank (or rules if it uses more than one instrument). By imposing sign and zero restriction on a systematic part of monetary policy and leaving the remaining equations non restricted it is possible to discriminate between systematic and non-systematic impact (shocks) or to separate demand and supply shocks affecting banks’ reserves. The former idea has recently been suggested in Arias et al. (2014), while the latter was already exploited in a number of papers, e.g. Strongin (1995), Bernanke and Mihov (1998).

We use elements of both methods. In our quest for a true monetary policy shock we rely on the analysis of monetary policy procedures of the BCT. Firstly, we impose excluding restrictions to gauge monetary policy rules for the interest rate, exchange rate and liquidity management and estimate SVAR with classical methods. Secondly, we redo the exercise using zero and sign restrictions. We restrict behaviour of money market variables, while prices, output, credit to the economy and exchange rate remain unrestricted. To circumvent identification problems and to pose our inference on more solid grounds, we employ a suite of VAR models with differing short-run assumptions, since even this based on monetary policy procedures are not straightforward and more than one set assumptions is plausible. We compare the results and determine which reactions can be considered as “true” responses to the exogenous monetary policy shock and which (if any) are implausible. Such a complex method is supposed to strengthen robustness of our analysis, bearing in mind changing monetary policy procedures.

Our approach means the use of rather *ad hoc* than theory-based assumptions, but we note that, generally, in a VAR setting employing solely short-run restrictions the number of valid assumptions based on economic theory is limited. In what follows, we shall presume that owing to real and nominal rigidities output and

prices react to the monetary policy innovations with a lag (i.e. we keep a block recursive structure between slowly moving real sector variables and monetary policy variables).

The details of our method are as follows. We start with a standard Cholesky factorization, seemingly the most popular in the literature. It is used as a first approximation as the set of implied assumptions does not fit well the Tunisian monetary policy. Then we pass to a more country-specific non-recursive decomposition with overidentifying assumptions which are formally tested. Bearing in mind that changes in banks' reserves are due to demand and supply shocks, we impose restrictions in a way that supposedly makes it possible to separate one from another. To further verify whether the identification was proper, we propose a VAR model with sign restrictions, which is agnostic about output, CPI, credit and exchange rate reactions (besides zero restrictions on the first two variables reflecting lags in their response to the monetary policy shocks), while restrictions are imposed on the interest rate and banks' total reserves. Finally, since in the case of the Bayesian VAR we are less constrained by the number of observations, we build also a 7 variable model containing additionally the reserve requirement ratio to verify the role of this instrument, but also to check correctness of our previous identification of the exchange rate shock.

We consider a following model:

$$(1) \begin{pmatrix} Y_t \\ M_t \end{pmatrix} = C(L) \begin{pmatrix} Y_{t-1} \\ M_{t-1} \end{pmatrix} + B \begin{pmatrix} v_t^Y \\ v_t^M \end{pmatrix}$$

Where  $Y_t$  and  $M_t$  are vectors of macroeconomic non-policy and policy variables, matrix  $A$  describes contemporaneous relations between the variables,  $C(L)$  is a matrix of finite-order lag polynomial and  $v \equiv \begin{pmatrix} v^Y \\ v^M \end{pmatrix}$  is a vector of structural shocks to the non-policy and policy variables. Since (1) is not directly observable, a VAR models are estimated as the reduced form of the underlying structural model:

$$(2) \begin{pmatrix} Y_t \\ M_t \end{pmatrix} = A^{-1}C(L) \begin{pmatrix} Y_{t-1} \\ M_{t-1} \end{pmatrix} + \begin{pmatrix} u_t^Y \\ u_t^M \end{pmatrix}$$

Where  $u$  is a vector of VAR residuals, normally and independently distributed with full variance-covariance matrix  $\Sigma$ . The relation between the residuals and structural shocks is

$$(3) \ A \begin{pmatrix} u_t^Y \\ u_t^M \end{pmatrix} = B \begin{pmatrix} v_t^Y \\ v_t^M \end{pmatrix} \text{ and}$$

$$(4) \ u_t = A^{-1}B(v_t)^{15}$$

We use a VAR with a following representation:  $Y_t$  is a vector of endogenous variables of monthly frequency containing natural logarithm of manufacturing output ( $y_t$ ) as a measure of real sector activity, consumer prices ( $cpi_t$ ), the volume of credit ( $cr_t$ ). Vector  $M_t$  is a vector of monthly endogenous policy variables and contains a short-term interest rate ( $tmm_t$ ), excess or total reserves of banks ( $ex\_res_t$  or  $tot\_res_t$ , depending on the model), reserve requirement ratio on sight deposits ( $rrr_t$ )<sup>16</sup> and the nominal effective exchange rate ( $e_t$ ). Total reserves have been calculated as *m0-cash in circulation*, while excess reserves as *m0-cash in circulation-reserve requirement*. Reserves measure banking sector liquidity, excess reserves do not contain effects of reserve requirement changes. In general, higher reserves make it possible for banks to extend more loans. Additionally, we have a vector of exogenous variables containing industrial output in the euro area and short-term Euribor and Libor rates to pin down tight trade relationships with the EU and a possible impact of foreign interest rates on the exchange rate. Furthermore, we use three dummy variables: one for the financial crisis 2008, the second for the Tunisian revolution and the last one to eliminate the impact of a significant credit write-off at the beginning of the process banking sector healing (January 2001) and the linear trend.

The first setting is a 6 variable model with a following ordering [ $y$ ,  $p$ ,  $cr$ ,  $TMM$ ,  $NEER$ , *excess reserves*], thereafter Model I. In the recursive decomposition monetary policy instruments react simultaneously to output, prices and credit to the

<sup>15</sup> See for example Favero (2001)

<sup>16</sup> We do not dispose data on a weighted average of the reserve requirement, as various ratios were applied on sight, savings and longer term deposits. Neither have we data on the effective required reserve.

---

economy. Furthermore, output, prices and loans to the economy react to the monetary policy innovations with a lag. In this setup, interest rate does not contemporaneously affect the exchange rate and liquidity in the banking sector. Exchange rate is supposed to react contemporaneously to developments in output, prices, loans to the economy and the interest rate, but it does not contemporaneously affect liquidity. Finally, liquidity is contemporaneously affected by all other variables.

In the non-recursive decomposition (see Table 3, Model II.1) we assume, as before, that output, prices react to the monetary policy shocks with a lag. Inflation reacts contemporaneously to developments in output (the Phillips curve). The demand for loans depends on output, prices and the interest rate. As in a usually adopted set of assumptions, in the Model II.1 interest rate may contemporaneously respond to output and to prices. However, we do not expect to obtain statistically significant estimates owing to the fact that over the long periods central bank conducted passive interest rate policy. Exchange rate in this setting is controlled by the central bank with the aim of preserving price competitiveness, i.e. it responds contemporaneously solely to price developments. Central bank's exchange rate policy is allowed to affect banking sector reserves. Finally, supply of reserves depends contemporaneously on loans to the economy, what reflects that in the liquidity management the central bank targeted credit and monetary aggregates, but not directly prices or real sector activity. This set of assumptions allows for feedbacks in the monetary sector and reflects the fact that liquidity management and exchange policy had different targets. Thus, matrix A is shown in Table 3 (the upper panel).

We repeat the estimation using total reserves instead of excess reserves as it is not clear whether the monetary authorities was more sticked to this or the other aggregate (thereafter Model II.2). Furthermore, we use a slightly modified set of assumptions to obtain the robustness check. The modifications are in credit demand, interest rate and liquidity equations. This setting allows for more feedbacks in the monetary sector. In the credit demand we impose zero restriction on the interest rate, as it was insignificant in two previous models. The same applies to out-

put in the interest rate equation. Liquidity is allowed to react not only to loans as in previous models, but also to the interest rate and the exchange rate.

Next, we re-estimate the model using sign restrictions to obtain structural shocks (Model II.3). Exogenous demand shocks to reserves should not be related to developments in output, prices and credit to the economy, but rather emerge from a shift in banks perception of risk affecting their propensity to extend loans or, if for example, there arises a new way of refinancing for a banking sector, e.g. a development of capital market. Supply shocks are due to the non-systematic part of the central bank policy. Demand and supply shocks to banks' reserves are identified by a positive or negative co-movement of reserves and the interest rate. The restrictions on matrix  $B$  of equation (1) are presented in Table 4 (upper panel). To identify a monetary policy shock we restrict for 2 months total reserves to be positive and the interest rate to be negative (liquidity effect). The orthogonal demand shock was identified imposing a positive sign on banks reserves and the interest rate. In both cases output and prices are restricted to zero at impact, other variables are allowed to react at once.

Reserve requirement shock identification is obtained in a way similar to Glocker and Towbin (2012b). We use Model III and assume that a positive shock to the reserve requirement should increase demand for total reserves. We leave the interest rate, credit to the economy and the exchange rate unrestricted, since we want to verify how they react to the shock. As the orthogonal shock we identify the exchange rate innovation. The exchange rate shock should be unrelated to current economic developments. We assume that the central banks intervenes in the market to depreciate the domestic currency. It offers a higher price of foreign currencies and buys them from commercial banks. This transaction increases liquidity of the banking sector. To avoid a fall in the interest rate, the central bank has to sterilize the additional liquidity through open market operations. It sells securities and absorbs cash. We want that the interest rate does not fall. Other variables are unrestricted, our aim is to verify the impact of the exchange rate shock on output, prices

and credit to the economy, as some responses obtained with classical estimation were not conclusive.

All variables besides the interest rates are in log-levels and are seasonally adjusted. To determine the number of lags we have used Schwartz and Akaike criteria, which suggest respectively 2 and 3 lags. However, we use more lags, namely 3 or 4, depending on the model to obtain serially uncorrelated and non-skewed distribution of residuals.

The results are presented in Table 5 and Fig.8 - Fig.15.

**Table 5.** Vector Y and M, Matrices A for model I and model II and estimations results

Model I					
$Y_t = \begin{pmatrix} y_t \\ cpi_t \\ cr_t \end{pmatrix}$		$M_t = \begin{pmatrix} tmm_t \\ e_t \\ ex\_res_t \end{pmatrix}$			
LR test for over-identification:					
Chi-square(6)	5.098667	Probability		0.5312	
1	0	0	0	0	0
$\alpha_{21}$	1	0	0	0	0
$\alpha_{31}$	$\alpha_{32}$	1	$\alpha_{34}$	0	0
$\alpha_{41}$	$\alpha_{42}$	0	1	0	0
0	$\alpha_{52}$	0	0	1	$\alpha_{56}$
0	0	$\alpha_{63}$	0	0	1
Coefficient    Std. Error    z-Statistic    Prob.					
$\alpha_{21}$	-0.003222	0.004921	-0.654615	0.5127	
$\alpha_{31}$	-0.020765	0.011733	-1.769752	0.0768	
$\alpha_{41}$	0.000489	0.002388	0.204754	0.8378	
$\alpha_{32}$	0.269425	0.188059	1.432660	0.1520	
$\alpha_{42}$	-0.050547	0.038065	-1.327906	0.1842	
$\alpha_{52}$	-0.697601	0.213190	-3.272209	0.0011	
$\alpha_{63}$	8.952342	2.614748	3.423787	0.0006	
$\alpha_{34}$	-0.398141	0.386064	-1.031283	0.3024	
$\alpha_{56}$	-0.002652	0.002557	-1.037187	0.2996	
Model II.1					
$Y_t = \begin{pmatrix} y_t \\ cpi_t \\ cr_t \end{pmatrix}$		$M_t = \begin{pmatrix} tmm_t \\ e_t \\ tot\_res_t \end{pmatrix}$			

matrix A as in Model I)				
LR test for over-identification:				
Chi-square(6)	5.098667		Probability	0.5312
	Coefficient	Std. Error	z-Statistic	Prob.
$\alpha_{21}$	-0.005959	0.004949	-1.204024	0.2286
$\alpha_{31}$	-0.010108	0.011129	-0.908220	0.3638
$\alpha_{41}$	0.000834	0.002377	0.350975	0.7256
$\alpha_{32}$	0.189815	0.177285	1.070676	0.2843
$\alpha_{42}$	-0.061809	0.037574	-1.644996	0.1000
$\alpha_{52}$	-0.782044	0.211636	-3.695233	0.0002
$\alpha_{63}$	4.088957	2.414484	1.693512	0.0904
$\alpha_{34}$	-0.244350	0.367650	-0.664628	0.5063
$\alpha_{56}$	-0.002485	0.003045	-0.816052	0.4145

Model II.2					
LR test for over-identification:					
Chi-square(5)	2.223958		Probability	0.8174	
A =					
1	0	0	0	0	0
$\alpha_{21}$	1	0	0	0	0
$\alpha_{31}$	$\alpha_{32}$	1	0	0	0
0	$\alpha_{42}$	$\alpha_{43}$	1	0	0
0	$\alpha_{52}$	0	0	1	$\alpha_{56}$
0	0	$\alpha_{63}$	$\alpha_{64}$	$\alpha_{65}$	1

	Coefficient	Std. Error	z-Statistic	Prob.
$\alpha_{21}$	-0.005959	0.004949	-1.204024	0.2286
$\alpha_{31}$	-0.009904	0.011140	-0.889027	0.3740
$\alpha_{32}$	0.174712	0.176062	0.992331	0.3210
$\alpha_{42}$	-0.062273	0.037469	-1.661962	0.0965
$\alpha_{52}$	-0.877348	0.245524	-3.573367	0.0004
$\alpha_{43}$	-0.010666	0.016712	-0.638213	0.5233
$\alpha_{63}$	6.123627	2.833249	2.161344	0.0307
$\alpha_{64}$	0.334916	12.63269	0.026512	0.9788
$\alpha_{65}$	11.60120	7.314143	1.586132	0.1127
$\alpha_{56}$	-0.019527	0.011043	-1.768297	0.0770

Source: Own estimations

**Table 6.** Identification of monetary policy innovations with sign restrictions Model II.3 and Model III

Variable → Shock ↓	$y_t$	$p_t$	$cr_t$	$tmm_t$	$neer_t$	$tot\_res_t$	$rrr_t$
Model II.3							
Total reserves supply	0	0	?	↓	?	↑	-----
Total reserves demand	0	0	?	↑	?	↑	-----
Model III							
Reserve requirement ratio	0	0	?	?	?	↑	↑
Exchange rate (depreciation)	0	0	?	0 or ↑	↓	↑	?

Symbols ↑↓ stand for a positive (negative) sign, 0 for a lack reaction at impact, and ? for unrestricted variable. The symbol ----- means that a variable does not enter into a model.

In Model I, Model II.1 and Model II.2 there are a few coefficient estimates which are statistically significant<sup>17</sup>, namely the coefficient at prices ( $\alpha_{42}$ ) in the equation for the interest rate (-0.06\*) in Model II.1, at prices ( $\alpha_{42}$ ), in the exchange rate equation in all models. The obtained value of the latter ranges from -0.7\*\*\* in Model I, through -0.8\*\*\* in Model II.1 to -0.9\*\*\* in Model II.2. The coefficient at credit in all equations of liquidity supply is also significant and ranges from 8.95 for excess reserves model to 4.1-6.1 for total reserves models. This means that, for example, a unit increase in the interest rate reduces inflation at impact by 6 basis points, while the exchange rate appreciation – by some 70-90 basis points. Of our special attention is coefficient  $\alpha_{56}$ , since it shows the impact of exchange rate on liquidity. The evidence is somewhat blurred: it is significant in Model II.2 (-0.02\*), what might suggest that indeed exchange rate depreciation was increasing liquidity at impact and therefore was one of the underlying causes of surplus liquidity of the banking sector. However, coefficient  $\alpha_{56}$  is insignificant in Model II.1, what raises some doubts about robustness of this result. The analogous coefficient in Model I is insignificant too, but in this case one could conclude that surplus liquidity was effi-

<sup>17</sup> \*, \*\*, and \*\*\* represent significance at 10%, 5% and 1% levels, respectively

ciently absorbed by the reserve requirement. All in all, we find this evidence too weak to adopt the hypothesis of a statistically significant impact of exchange rate policy on liquidity of the banking sector.

In general, the results from Cholesky and structural decompositions obtained with classical methods are very similar, supporting our presumption that the central bank tended to separate liquidity management and the interest rate policy from the exchange rate policy, thanks to capital controls. Liquidity and exchange rate seem to have been set basing solely on credit and CPI developments, other variables have been disregarded.

Many reactions to monetary policy shocks are insignificant at standard levels of statistical inference, confidence intervals are wide reflecting weakness of the monetary transmission. In contrast to our conjecture about no role of the interest rate in inflation developments, we find it statistically significant, albeit small. Interestingly, output remains untouched by the interest rate shocks. Contrary to the usual timing pattern, the interest rate impacts inflation before the exchange rate, what might support the hypothesis that prices are led by expectations. We have also checked reactions of deposits and cash in circulation (models which are not presented here) since they might have shed some light on price behaviour. None of them, however, displays any reaction to the interest rate. Thus, the reaction of prices in the VAR is either a product of expectations, of a fall of loans or an artefact. Taking into account a relatively low level of financial inclusion and rigidities in the economy such as wage indexation to past inflation, we suspect that expectations could not exert such impact. As the reaction of loans is close to the statistical significance, we tentatively adopt a hypothesis that prices react to lower credit. In the structural model we check whether the loan rate will have an impact on the real sector and prices.

There is a strong support for the existence of the exchange rate pass-through effect, the impact of the exchange rate on credit to the economy and perhaps on output too, but in the case of the latter variable we have obtained impulse respons-

---

es only close to the statistical significance. Liquidity shocks have an impact on output and loans. A positive shock to total reserves leads to an increase in the interest rate, what makes us suspect that the total reserves innovation may still contain some elements of a demand shock. SVAR with sign restrictions, presented below, resolves this problem. In all settings interest rate shocks do not exert any impact on the exchange rate, however, positive shocks to liquidity lead to exchange rate appreciation, most probably through the effect of positive fundamentals.

What emerges from the impulse response functions is that monetary policy affects prices through the exchange rate and the interest rate, though the latter observation may be disputable. The evidence that monetary policy might have a significant impact on the real sector is somewhat weaker, but at least it seems that output responds to liquidity innovations and the exchange rate, while it is immune to the interest rate. One of possible explanations is a big role of the informal employment which is a factor reducing the impact of the monetary policy on the real sector activity, another a relatively small dependence of manufacturing on bank loans. Liquidity management has a significant impact on loans.

To complete the picture of the economic relationships using our structural VAR models estimated with classical methods, we have also examined shocks to output (verification of existence of the Phillips curve) and loans<sup>18</sup>. There is hardly any statistically significant evidence supporting existence of the Phillips curve in the economy, at least measured with the manufacturing output, as demand shock results in the appreciation of the exchange rate (what we interpret as the effect of positive fundamentals), and an increase in the interest rate. Both rapidly reduce inflation. Positive shocks to loans do not have any meaningful impact on output<sup>19</sup>

Empirical evidence from Model II.3 (sign restrictions) shows a positive short-lived impact of total reserves shock on the real sector, although it is only close to

---

<sup>18</sup> For the sake of space limitations, the respective impulse responses are not reproduced here.

<sup>19</sup> For the sake of space graphs are not presented.

the statistical significance. We obtain also a small and short-lived price effect, which seems to be significant only at impact. This is seemingly the influence of the interest rate drop which was imposed through the sign restriction. Although somewhat longer, other responses, i.e. reactions of the exchange rate and loans to the economy are similar to that obtained from Model I and Model II.1-2. Liquidity demand shock does not exert any impact on the macroeconomic variables: a higher interest rate prevents prices and output from increasing. With no capital inflows this also leaves the exchange rate untouched.

A shock to the exchange rate (depreciation) leads to a significant price reaction. Thus, once again, we obtain a support for the existence of a pass-through effect. Interestingly and contrary to the previous results, exchange rate innovations have some impact on manufacturing. If we had used a broader measure of real sector activity, as GDP, it is very probable that we would have obtained a bigger impact of the exchange rate: services is the sector which in the Tunisian case should be the most dependent on exchange rate developments. Manufacturing may realize intra-corporate trade and is better shielded from the exchange rate movements. After the intervention, the short-term money market rate increases by just some 3 basis points, then falls as expected. Its further slight increase can be considered as a response to a higher inflation.

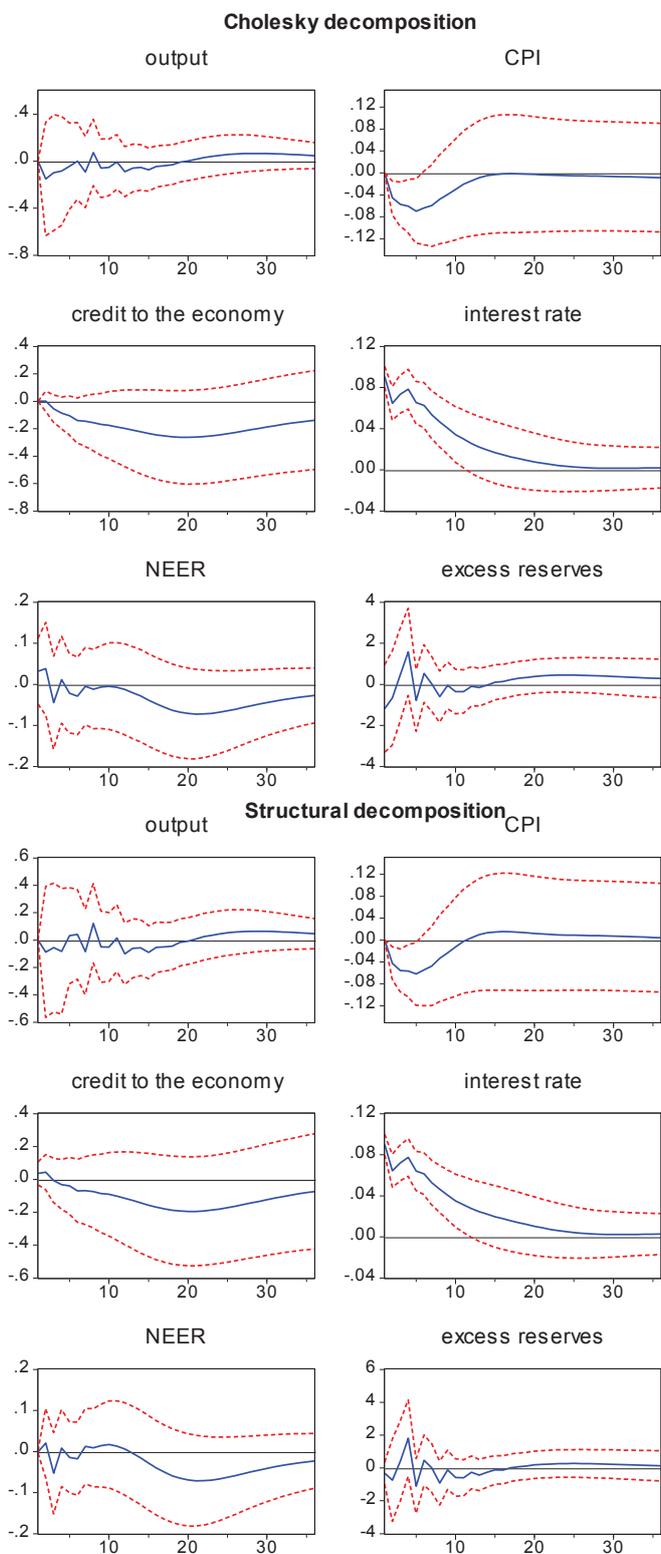
Reserve requirement ratio shock obtained from Model III does not reduce credit to the economy in spite of some increase in the short-term interest rate, suggesting that monetary authorities were too lax in liquidity provision, probably being afraid of a negative impact on banking sector stability and an increase in the ratio of NPLs. We do not observe price increases which could result from lower deposit rates, on the other hand, there is exchange rate appreciation, which is statistically significant and prolonged. The effect could be attributed to increased demand for deposits in foreign currencies which were not subject to the reserve requirement increases and were allowed for exporters, importers and non-residents. Exchange rate appreciation might be a factor which restrained prices from rising.

---

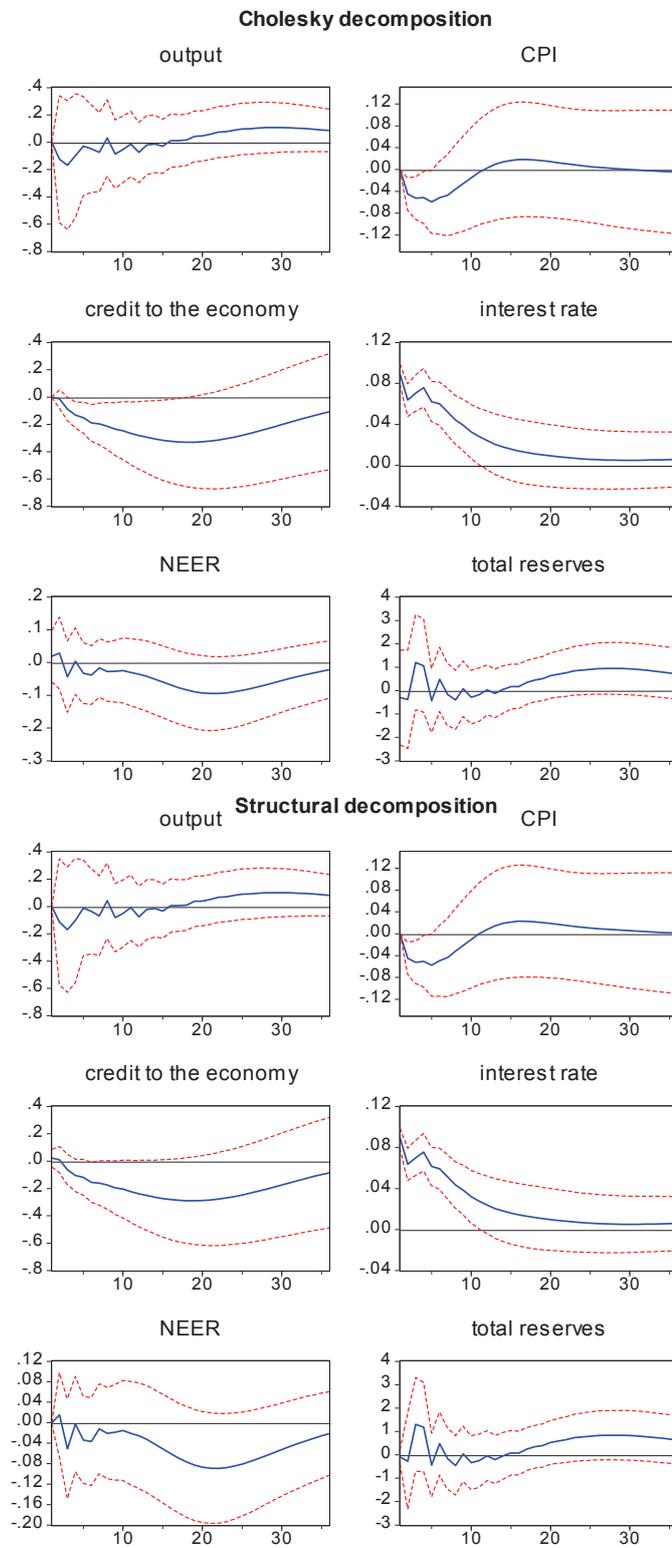
Impulse response functions confirm feeble monetary transmission. Liquidity channel seems to operate, but it is dampened by the exchange rate appreciation. We ascribe this effect to expectations of better fundamentals which induce the inflow of long-term capital (FDI) and transactions in the stock exchange. Exchange rate is the most important monetary policy instrument affecting prices by the pass-through effect. It has also some impact on the industrial production through the production costs. Reserve requirement channel does not operate in the usual way as loans tend to increase after the reserve requirement shock. This is probably a problem of a specific reserve requirement policy of the BCT.

A by-product of our estimations are two conclusions concerning estimation methods. Firstly, results obtained from recursive and non-recursive decompositions are very similar, what suggests that although BCT used multiple instruments, they were well separated one from another. Secondly, in SVARs obtained with classical methods some impulse response functions suggest that monetary policy shocks might have been mis-specified. A good example was the absence of the liquidity effect after a positive shock to the interest rate or a positive reaction of the interest rate to the unexpected increase in liquidity. Impulses obtained from models with sign restrictions provided information more consistent with the monetary theory.

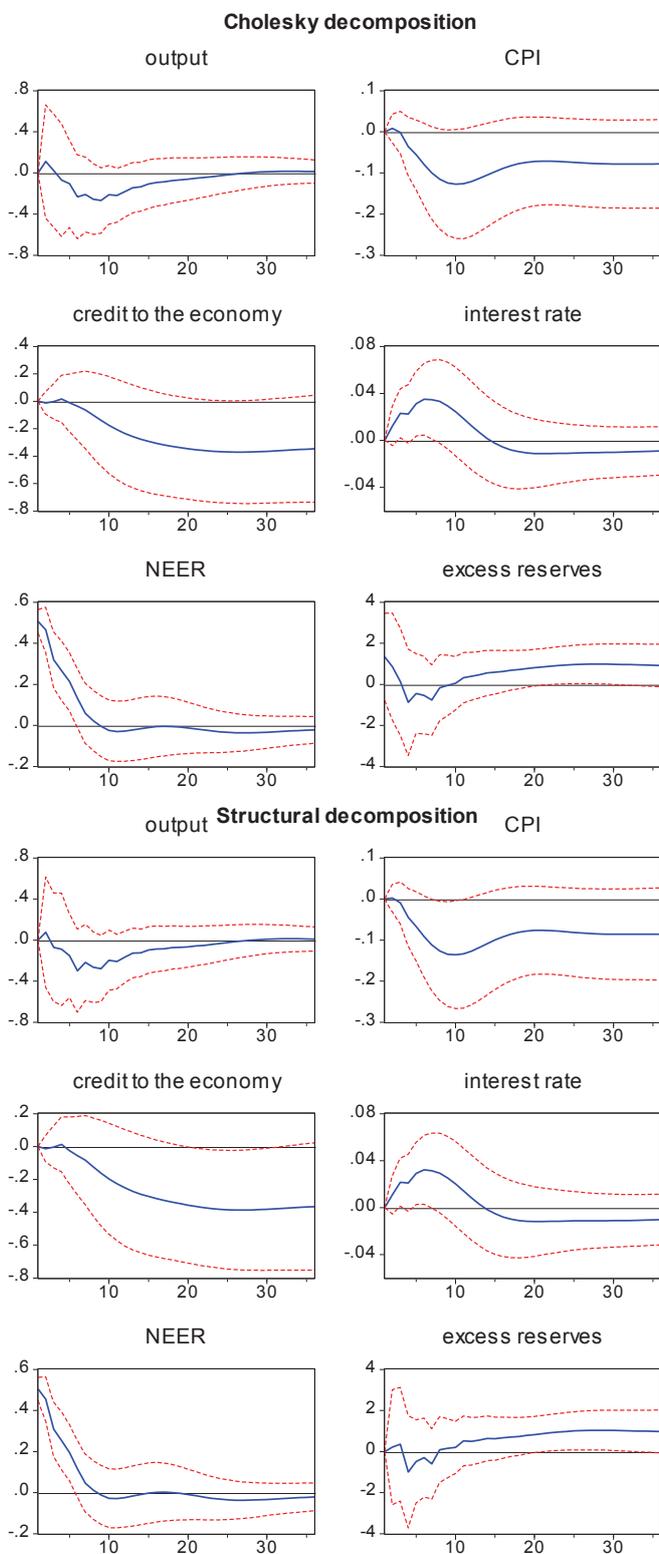
**Figure 8. Panel A.** Responses to the TMM shock, Cholesky and structural factorizations (one S.D. innovation  $\pm 2$  S.E.), model II.1.



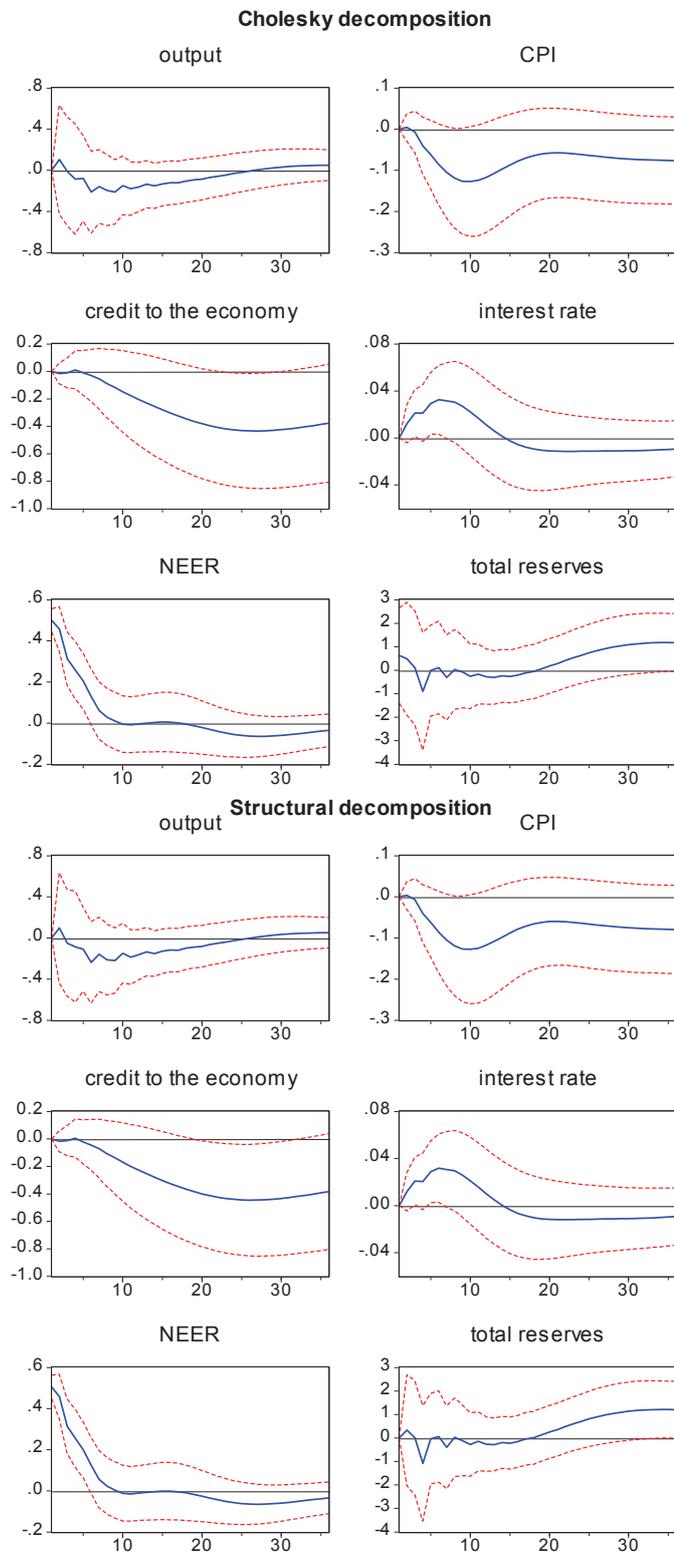
**Figure 8. Panel B.** Responses to the TMM shock, Cholesky and structural factorizations (one S.D. innovation  $\pm 2$  S.E.), model II.2.



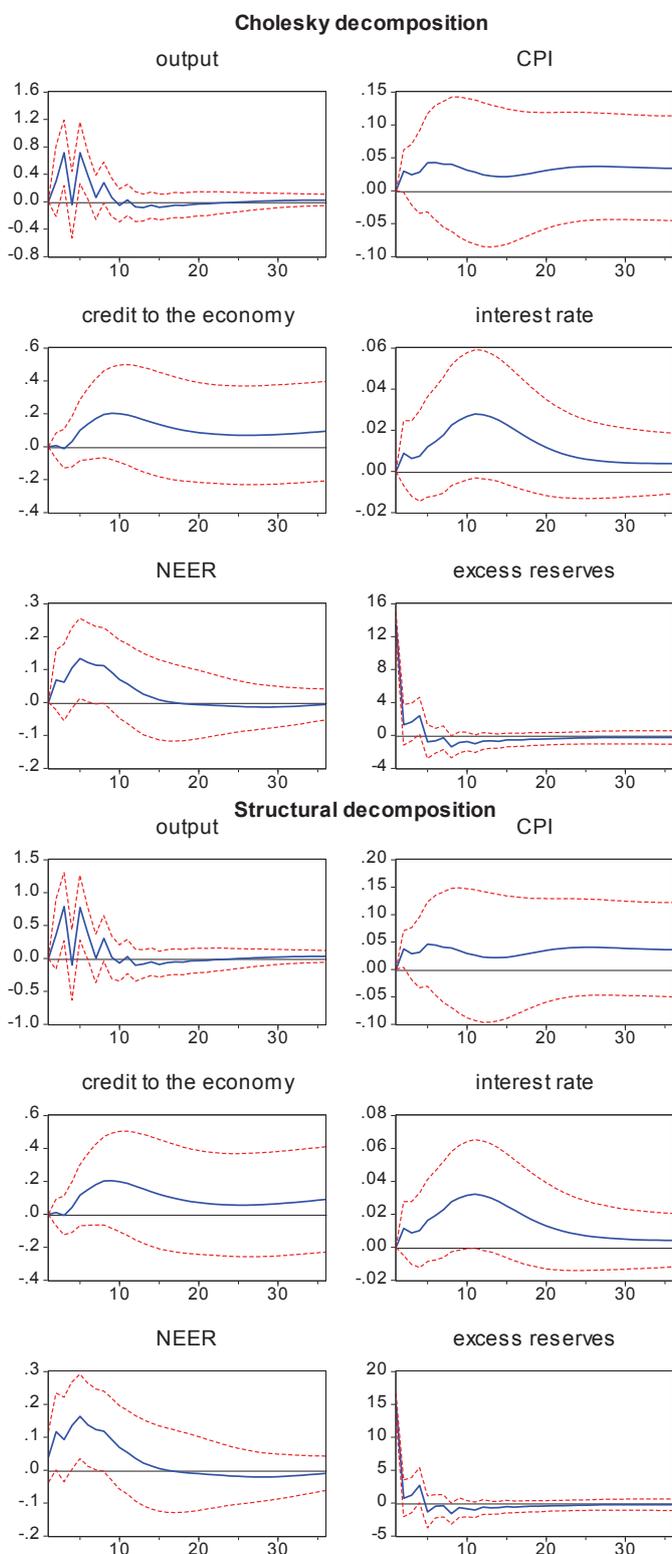
**Figure 9. Panel A.** Responses to the NEER shock, Cholesky and structural factorizations (one S.D. innovation, 95 percent error bands), model II.1.



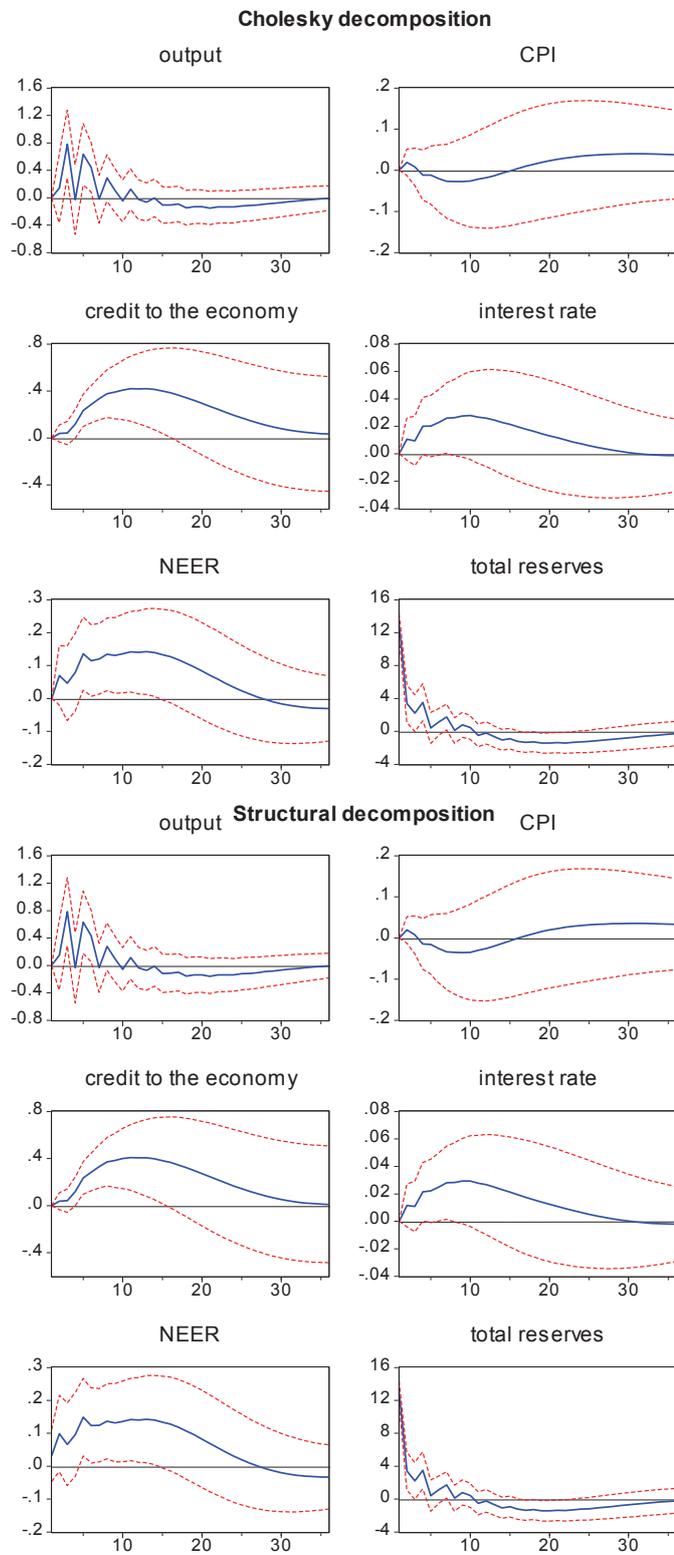
**Figure 9. Panel B.** Responses to the NEER shock, Cholesky and structural factorizations (one S.D. innovation, 95 percent error bands.), model II.2



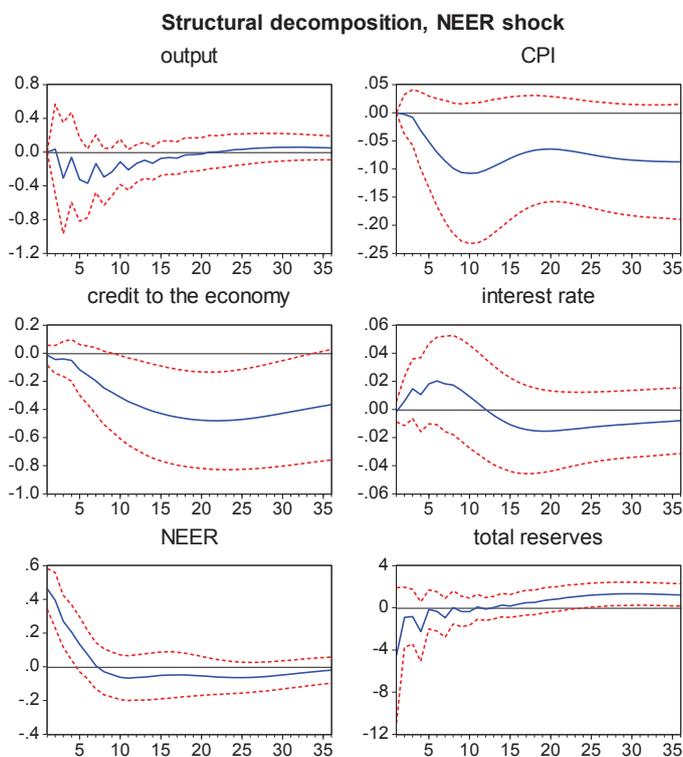
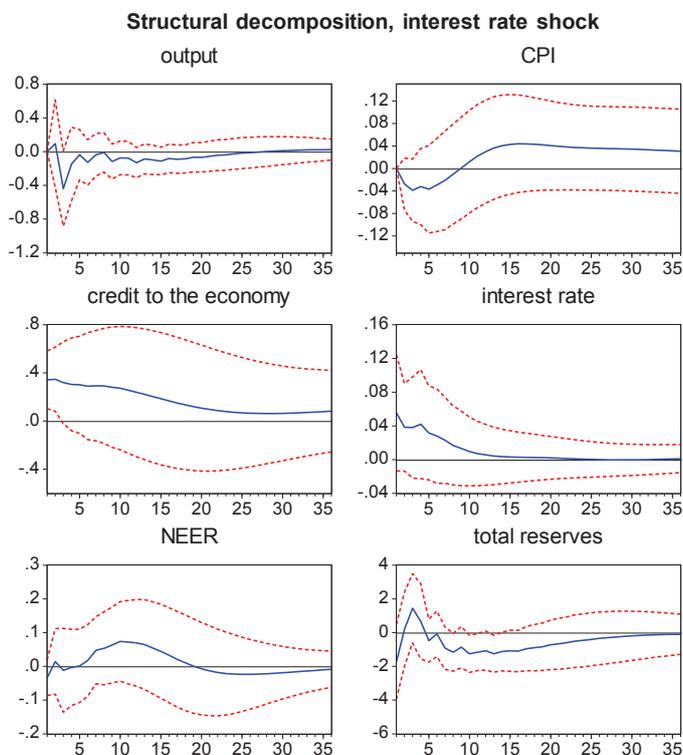
**Figure 10. Panel A.** Response to the liquidity shock, Cholesky and structural factorizations (one S.D. innovation, 95 percent error bands) model II.1.



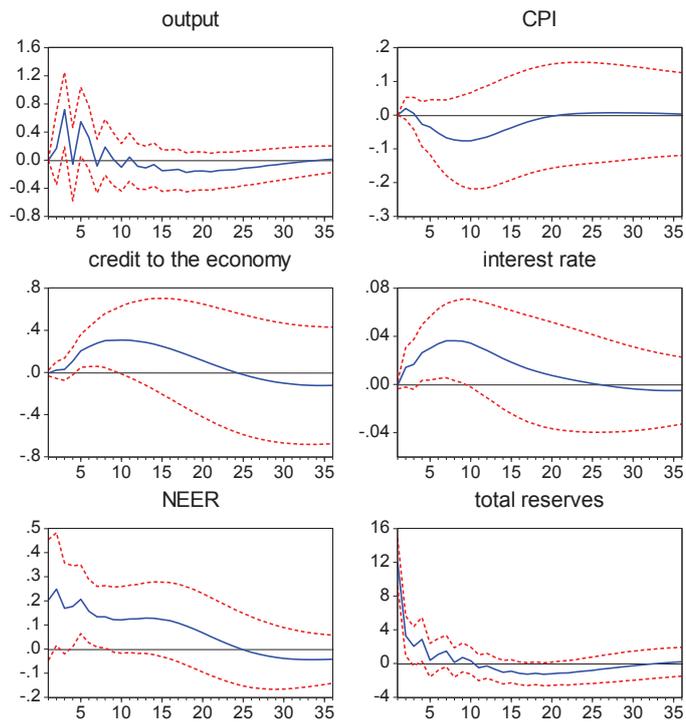
**Figure 10. Panel B.** Response to the liquidity shock, Cholesky and structural factorizations (one S.D. innovation, 95 percent error bands.) model II.2.



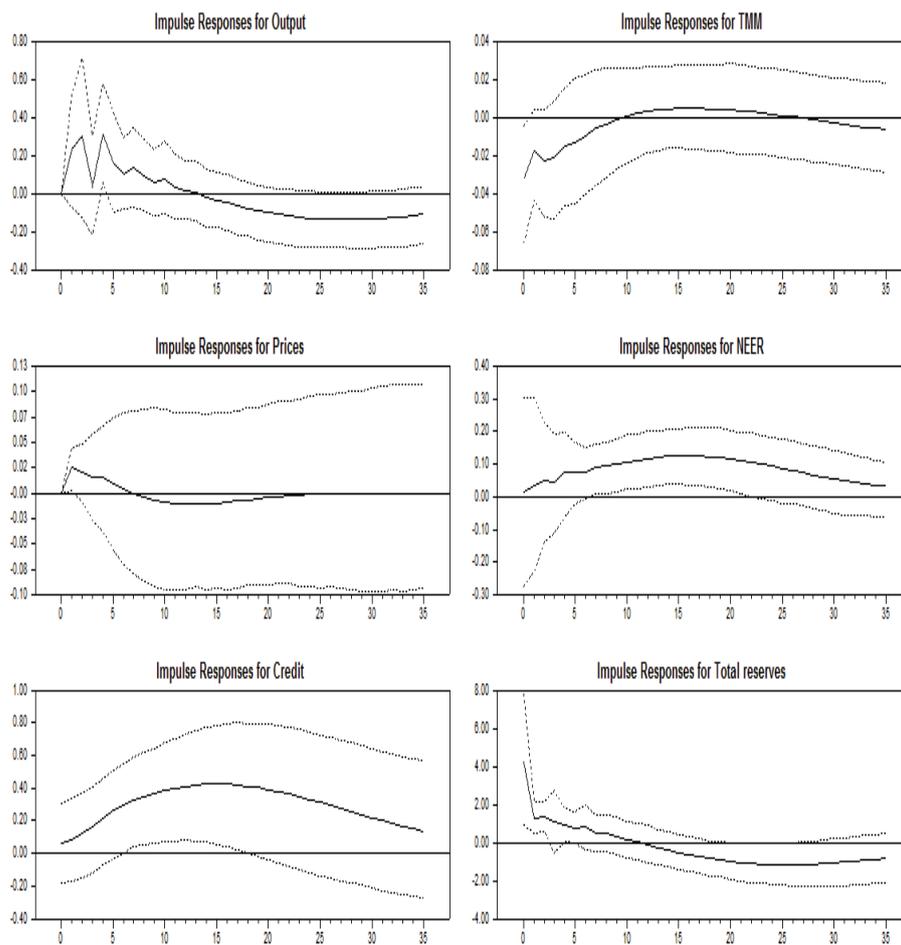
**Figure 11.** Impulse responses to the interest rate shock, exchange rate shock and liquidity innovation (one S.D., 95 percent error bands), Model II.2 (robustness check)



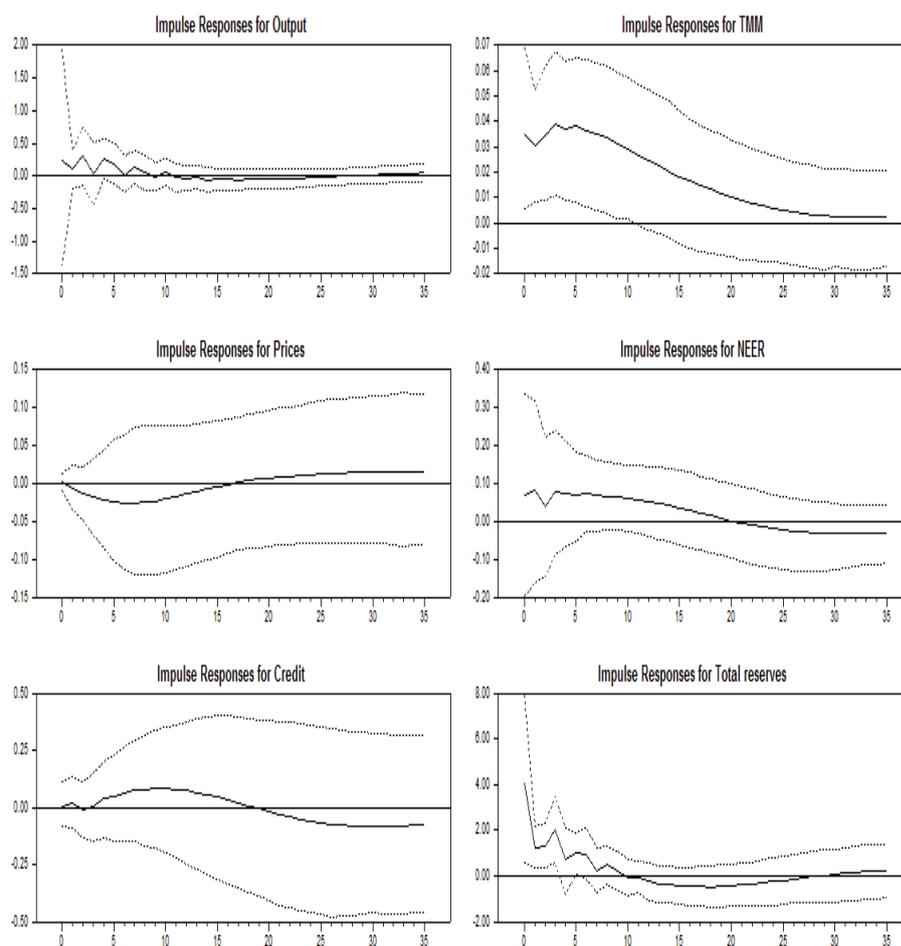
### Structural decomposition, liquidity shock



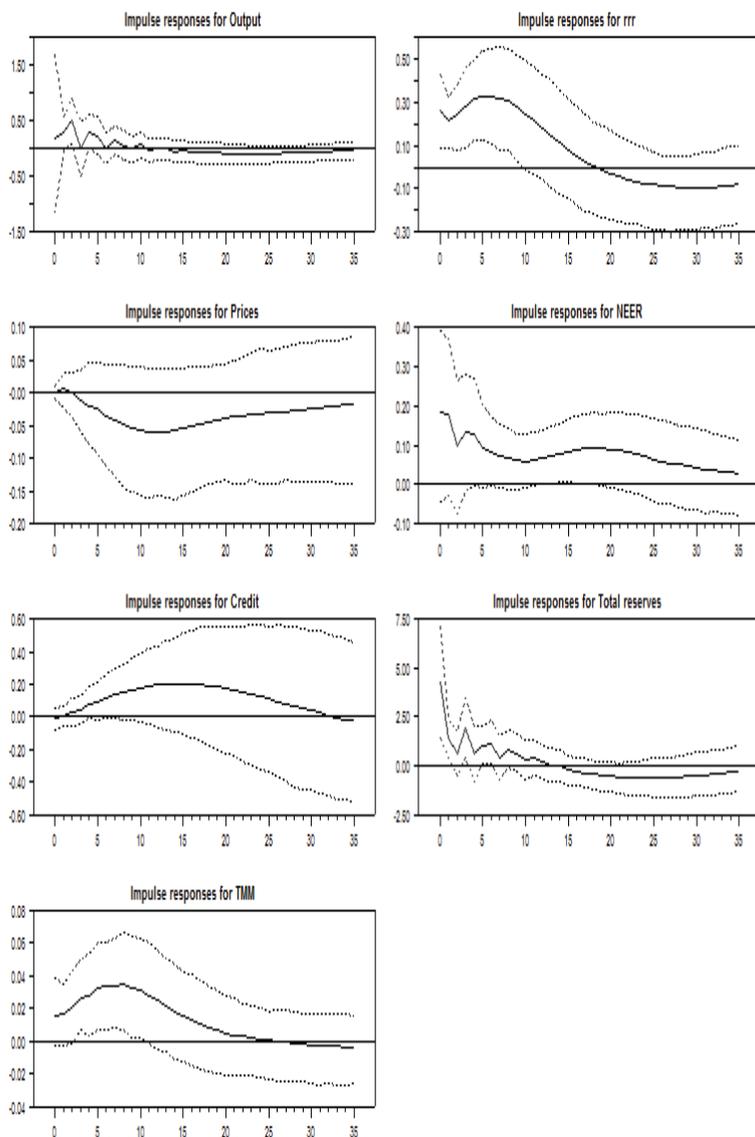
**Figure 12.** Responses to total reserves supply shock, sign restrictions, Model II.2, (solid lines represent the vector of posterior medians of the impulse responses, while dotted lines - 68 percent posterior error bands)



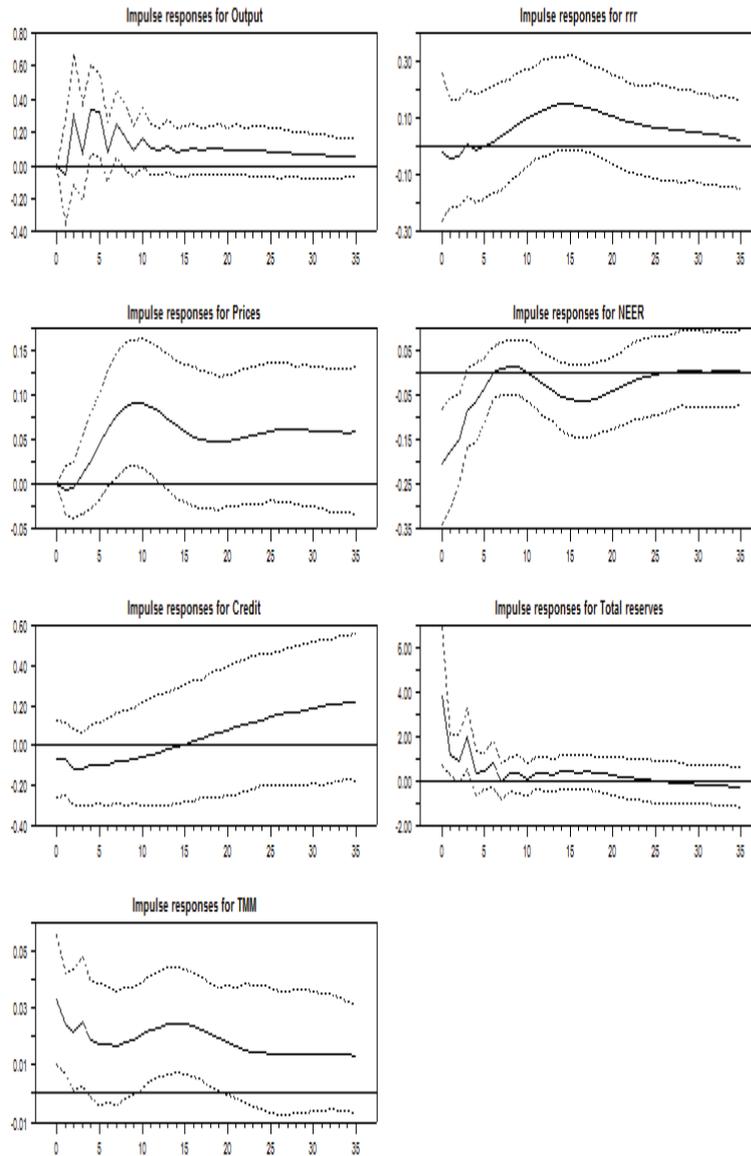
**Figure 13.** Responses to total reserve demand shock, sign restrictions, Model II.2, (solid lines represent the vector of posterior medians of the impulse responses, while dotted lines - 68 percent posterior error bands)



**Figure 14.** Responses to a positive reserve requirement shock, Model III, (solid lines represent the vector of posterior medians of the impulse responses, while dotted lines - 68 percent posterior error bands)



**Figure 15.** Responses to the exchange rate shock, Model III, (solid lines represent the vector of posterior medians of the impulse responses, while dotted lines - 68 percent posterior error bands)



## 4. Structural models

### 4.1. Specification

As shown through the lenses of the narrative approach and SVAR models, Tunisian economy has a handful of specific features, which should be taken into account when building structural models. There is also a significant uncertainty concerning parameters and equilibria (real equilibrium exchange rate, real equilibrium interest rate, GDP potential owing to the revolution) and a problem with model specification owing to capital controls, very weak evidence supporting existence of the Phillips curve, as well as multiple targets and instruments of the monetary policy. The latter makes it difficult to gauge the monetary sector. Moreover, model specification is limited by data availability.<sup>20</sup>

To tackle at least some aspects of uncertainty concerning equilibria and specification, we have built two models: a gap model „SIMOT“, estimated equation by equation with classical methods (OLS, GMM), but having also many calibrations basing on VAR results and with equilibria obtained outside the model (HP filters<sup>21</sup>, calibration)<sup>22</sup>, and a DSGE-like model based on the Global Projection Model (GPM) adjusted to the Tunisian conditions (GPM-T), estimated with Bayesian methods. To see the role of country-specific factors we compare reactions obtained from GPM-T and SIMOT to a standard GPM without any such features, estimated on the Tunisian data. This procedure allows also for a cross-check of models and better understanding of the modelled economy.

---

<sup>20</sup> There is no quarterly data on national accounts for Tunisia, on average retail interest rates, employment, unemployment rate.

<sup>21</sup> There is usually a problem of the end of a sample with HP filtering. To solve the problem, filtered variables are usually forecasted up to 8 quarters with ARIMA and then filtered to reduce mis-estimation of a respective gap at the end of a sample. The most noticeable problem concerns estimation of GDP potential drop owing to the revolution.

<sup>22</sup> A similar approach was used in the model of the Central Bank of Israel, see Argov et al. (2007), A Small Model to Support Inflation targeting in Israel, MPRA Paper No 4784, <http://mpra.ub.uni-muenchen.de/4784/>.

---

Bayesian estimation techniques overcome (at least partially) the problem of a short sample (2000Q1-2012Q4), and besides, they offer a possibility to identify non-observable variables, like potential output, real equilibrium exchange rate and interest rate within the model.

In the models there exist domestic and foreign producers, domestic and foreign consumers, central bank, banking sector and the government. Domestic producers act under monopolistic competition. Thus, there are many firms producing goods which differ in such a way that producers can set their prices. To produce, firms use domestic and foreign inputs. They sale their products on the domestic and foreign market. Exports depend on foreign demand and the exchange rate with respect to the euro and the US dollar.

Consumers (households) derive utility form domestic and foreign goods. They save buying domestic and foreign assets, however owing to capital controls, this is possible solely for exporters, importers and non-residents. For these agents allocation of savings between domestic and foreign market depends on domestic and foreign interest rate differential, expected exchange rate changes and risk premium reflecting macroeconomic risk, domestic and foreign. Thus, we expect to obtain a low coefficient at the interest rate disparity.

Like producers of goods, banks act under monopolistic competition. They set interest rate on loans, taking into account money market rate (refinancing cost) and demand for loans. In the long-run, money market rate and loan rate stay in equilibrium (cointegration). Banks can allocate consumers' savings into loans or treasury bonds, but due to weakness of the financial market, bonds are either traded over the counter or are held up to their maturity. This means that the central bank has a limited impact on the longer rates. Banks extend loans for consumption and production.

Government sector runs fiscal policy with the revenues from treasury bonds and taxes. From its revenue, the government finances public sector and expendi-

tures for social policies. Expenditures stipulated by law (e.g. pensions) have a constant share in GDP. The rest of expenditures depends on the state of the business cycle.

In the GPM and GPM-T, dynamics of the economic processes is driven by shocks, which are unobserved and identified within the model. Shocks have economic interpretation (contrary to residuals in the standard gap models), therefore the reaction functions obtained from the GPM-type models may be closer to reactions of DSGE models. In the core GPM the number of shocks is equal to the number of equations and the economic meaning of a shock is similar to this of residuals in the gap models, whereas in the GPM-T the number of shocks exceeds the number of equations. This is particularly useful, since it makes it possible to employ not only shocks to observable variables, like output or inflation, but also shocks to unobservable variables, e.g. a shock to GDP potential or to the rate of growth of the potential.

Although the models are NK, they are adjusted to incorporate the aforementioned country-specific features. The first one bases on the Global Projection Model (GPM) Carabenciov et al. (2013), while the second one is similar to Argov et al. (2007). They have a similar structure (IS curve, Phillips curve, exchange rate equation, and monetary policy rule). In SIMOT, we have additionally previewed an extension relating retail interest rate on deposits and loans to the reserve requirement ratio. Unfortunately, owing to a lack of data on deposit rates in the Tunisian banking sector, this block may operate only partially.

Moreover, since Tunisia is financially closed and the central bank targeted the real exchange rate to preserve competitiveness of the real sector Fanizza (2002), we have adjusted the UIP condition in the GPM-type model in such a way that it reflects exchange rate interventions. In particular, we smooth real exchange rate shocks, changing their standard error, to feature both indirect (moral suasion), frequently used by the BCT, and direct currency interventions. In the other model we have used a behavioural equation for the exchange rate, with the output gap as a

---

proxy for the macroeconomic risk. This is supposed to better reflect Tunisian stylized facts, restrictions on capital flows and underdeveloped financial market than the usually employed UIP condition. Comparing to GPM-T, SIMOT has two additional variables – the loan rate, which is endogenous and exogenous world energy prices. The additional interest rate reflects the role of credit to the economy in the monetary transmission, whereas world energy prices – cost push inflation. Thus, SIMOT can be categorized as belonging to the class of traditional structural models, but enriched with elements of the financial sector, whereas GPM as a construction in between DSGE models and traditional structural models.

In both models real variables are specified as gaps, i.e. differences between their actual values, which can be affected by demand factors and potentials. Potential values represent the supply side of the economy. Both models exploit expectations, however the GPM and GPM-T are much more forward-looking than SIMOT. This concerns the IS curve and the Phillips curve.

Owing to data limitations, labour market in both models is „hidden” in the output gap. If wages behave in line with the product market, i.e. if the rate of growth of wage rates increases with a positive output gap and decreases when it is negative, the output gap can reflect cost pressures. This may not be the case of Tunisia due to its wage bargaining system and indexation to the past inflation. Thus, models may fail to explain cost-push inflation and the negative supply side shock.

Both models employ short-term interest rate as a sole policy instrument, although theoretically it should have been supplemented with the reserve requirement, as in Blagrove et al. (2013). However, as we have demonstrated, monetary policy was run in such a way that higher reserve requirement ratio did not result in a lower growth of credit to the economy, but even led to some increase in loans. This might produce opaque reactions of the model. Thus, we keep the standard setting with the interest rate as the policy instrument, introduce the exchange rate into the policy rule (GPM, GPM-T), specify the exchange rate equation to allow for central bank’s interventions and introduce loans to the economy through the loan

rate pass-through.<sup>23</sup> The interest rate equation has been treated as a robustness check for the results obtained from the SVAR model.

The core part of the models is following:

The IS curve (output gap  $y_t$ ):

$$\begin{aligned}
 y_t &= \alpha_1 E_t y_{t+1} + \alpha_2 y_{t-1} + \alpha_3 (i_t - E_t \Delta p_{t+1} - r_t^*) + \alpha_4 (X_t^{net} - X_t^{net*}) + \alpha_5 g_t + \varepsilon_t^y + \varepsilon_t^{y*} + \varepsilon_t^{r*} \\
 r_t^* &= \alpha_{31} r_{t-1}^* + \alpha_{32} (dY_t^* - dY_{t-1}^*) + \varepsilon_t^{r*} \\
 X_t^{net} &= \alpha_{41} y_t^{eu} - \alpha_{42} y_t + \alpha_{43} (e_t + p_t^w - p_t) + \varepsilon_t^x = \alpha_{41} y_t^{eu} - \alpha_{42} y_t + \alpha_{43} e_t^r + \varepsilon_t^x \\
 X_t^{net*} &= \alpha_{44} y_t^{eu} - \alpha_{45} y_t + \alpha_{46} e_t^{r*} + \varepsilon_t^{x*} \\
 dG_t &= \alpha_{51} y_t + \alpha_{52} dY_t + \varepsilon_t^G + \varepsilon_t^y \\
 dG_t^* &= \alpha_{53} Y_t^* + \varepsilon_t^{G*} \\
 g_t &= dG_t - dG_t^* + g_{t-1}
 \end{aligned}$$

or (if the estimation results of the IS curve with directly built-in net exports variable are not significantly better than these of the IS curve without direct foreign trade block):

$$\begin{aligned}
 y_t &= \alpha_1 E_t y_{t+1} + \alpha_2 y_{t-1} + \alpha_3 (i_t - E_t \Delta p_{t+1} - r_t^*) + \alpha_4 (e_t^r - e_t^{r*}) + \alpha_5 y_t^{eu} + \alpha_6 g_t + \\
 &+ \varepsilon_t^y + \varepsilon_t^{y*} + \varepsilon_t^{r*}
 \end{aligned}$$

Where  $i$  is a nominal interest rate (short-term money market rate) and  $r^*$  natural interest rate;  $dY$  and  $dY^*$  stand for dynamics of the GDP and potential GDP respectively,  $p$  for domestic prices,  $p^w$  for foreign prices;  $dG$  and  $dG^*$  represent dynamics of public expenditure<sup>24</sup> and potential public expenditure respectively,  $g$  – gap of the public expenditure;  $X$  – net exports;  $e$  – nominal exchange rate,  $e^r$  – real exchange rate,  $e^{r*}$  – equilibrium exchange rate and  $y^{eu}$  – output gap in the euro area;  $\varepsilon$  – a shock.

The Phillips curve:

$$\Delta p_t = \beta_1 E_t \Delta p_{t+1} + \beta_2 \Delta p_{t-1} + \beta_3 y_t + \beta_4 (e_t + p_t^w) + \varepsilon_t^s$$

<sup>23</sup> Data series on loan rates is longer than for deposit rates. Both are biannual, thus we have intrapolated the data series.

<sup>24</sup> Government expenditure is interpreted as a source of subsidies and a risk premium for exchange rate.

Real exchange rate<sup>25</sup>:

$$e_t^r = \delta_1 E_t e_{t+1}^r + \delta_2 e_{t-1}^r - \delta_3 ((i_t - \Delta p_t) - (i_t^w - \Delta p_t^w)) + \delta_4 y_t + \delta_5 \varepsilon_t^e$$

$$e_t^{r*} = \delta_6 y_{t+1} + \delta_7 y_{t+1}^{eu} + \varepsilon_t^{r*}$$

Taylor rule:

$$i_t = \lambda_1 i_{t-1} + (1 - \lambda_1)((r^* - \Delta p_t^*) + \lambda_2(\Delta p_t - \Delta p_t^*) + \lambda_3 y_t) + \lambda_4(e_t^r - e_t^{r*}) + \varepsilon_t^i$$

In a GPM model,  $dY_t^*$  is formed by the state space model and  $y_t^{eu}$ ,  $p_t^w$  by the autoregression processes.

#### 4.2. SIMOT and GPM-T. Comparison to the core (IMF) GPM

Below we present results obtained from estimations of SIMOT, GPM and GPM-T, equations and graphs depicting reactions of the main variables to interest rate and exchange rate changes (SIMOT) or shocks in the case of GPM and GPM-T models.

**Table 7.** Overview of estimation results (main equations)

	model parameter	SIMOT		GPM				GPM-T			
		para- met.	t-stat	prior mean	mode	t-stat	prior	prior mean	mode	t-stat	prior
IS curve (output gap)	$\alpha_1$	-	-	0.20	0.13	1.62	beta	0.20	0.16	1.77	beta
	$\alpha_2$	0.60	est/cal	0.60	0.64	7.87	beta	0.60	0.66	11.60	beta
	$\alpha_3$	-0.05	est/cal	-0.10	-0.07	1.68	gamma	-0.10	-0.04	5.87	gamma
	$\alpha_4$	-0.17	1.63	0.20	0.10	2.06	normal	0.20	0.16	1.83	normal
	$\alpha_5$	0.14	1.55	0.30	0.22	1.60	normal	0.15	0.13	1.75	normal
	$\alpha_6$	0.03	1.88	-	-	-	-	0.30	0.28	18.32	beta
Phillips curve	$\beta_1$	0.25	3.76	0.45	0.62	7.84	beta	0.25	0.29	2.51	beta
	$\beta_2$	0.66	5.11	-	0.38	-	(1- $\beta_1$ )	-	0.71	-	(1- $\beta_1$ )
	$\beta_3$	0.08	4.83	0.10	0.09	4.05	beta	0.10	0.06	5.87	beta
	$\beta_4$	-0.20	est/cal	0.10	0.06	2.55	normal	0.20	0.23	2.28	normal
	$\beta_5$	0.03	1.73	-	-	-	-	-	-	-	-

<sup>25</sup> The exchange rate is modelled in real terms (deflated by consumer prices) because a direct relationship between real exchange rate, real interest rates and economic fundamentals can be derived from the Taylor rule. Also, theories of the international trade point that trade between countries is driven by differences in productivity of production factors and relative prices, as well as technological gaps. These differences are carried over by exchange rate expressed by its nominal value deflated by the various measures of costs or prices, i.e. by the real exchange rate.

Real exchange rate	$\delta_1$	0.60	est/cal	0.50	0.73	54.88	beta	0.50	0.57	27.83	beta
	$\delta_2$	0.40	est/cal	-	0.27	-	(1- $\delta_1$ )	-	0.43	-	(1- $\delta_1$ )
	$\delta_3$	0.03	16.1	1*%	0.25	calibr.	-	1*%	0.19	91.53	beta
	$\delta_4$	0.07	3.15	-	-	-	-	0.10*%	0.02	5.70	normal
	$\sigma_1^*(\varepsilon^B)$	-	-	-	-	-	-	1*%	0.15	10.38	normal
	$\sigma_2^*(\varepsilon^e)$	-	-	-	-	-	-	1*%	0.11	13.69	normal
Taylor rule	$\lambda_1$	0.90	est/cal	-	0.91	calibr.	-	0.80	0.79	9.51	beta
	$\lambda_2$	1.35	est/cal	1.50	1.23	28.87	gamma	1.50	1.35	66.24	gamma
	$\lambda_3$	0.50	est/cal	0.50	0.44	6.05	normal	0.50	0.43	2.86	normal
	$\lambda_4$	-	-	0.30	0.17	2.51	normal	0.30	0.19	8.86	normal

Source: Own estimations

IS curve (output gap):

SIMOT

$$y_t = 0.6 * y_{t-1} + 0.05 * (i_{t-1}^{loan\ rate} - \Delta p_{t-1} - r^*) - 0.17 * (e_{t-1}^r - e^{r*}) + 0.03 * g_{t-3} + 0.14 * y_{t+1}^{eu}$$

Core GPM

$$y_t = 0.13 * E_t y_{t+1} + 0.64 * y_{t-1} - 0.07 * (i_t - E_{t-1} \Delta p_t - r^*) + 0.1 * (e_t^r - e^{r*}) + 0.22 * y_{t-1}^{eu} + \varepsilon_t^y$$

Where  $r^*$  and  $e^{r*}$  stand for the natural interest rate and real equilibrium exchange rate respectively, whereas  $\varepsilon_t^y$  is a demand shock

GPM-T<sup>26</sup>

$$y_t = 0.16 * E_t y_{t+1} + 0.66 * y_{t-1} - 0.04 * (i_t - E_{t-1} \Delta p_t - r^*) + 0.16 * (E_t e_{t+1}^r - e^{r*}) + 0.13 * g_t + 0.28 * y_{t-1}^{eu} + \varepsilon_t^y + \varepsilon_t^{dY^*} + \varepsilon_t^{r^*}$$

Where  $\varepsilon_t^y$  is demand shock and the sum  $\varepsilon_t^{dY^*} + \varepsilon_t^{r^*}$  can be interpreted as a supply shock;  $\varepsilon_t^{dY^*}$ , being a shock to the potential GDP, relates to the TFP, while  $\varepsilon_t^{r^*}$  - a shock to the natural interest rate - to the marginal productivity of capital. In such configuration  $\varepsilon_t^{dY^*}$  can be interpreted as a shock related to the labor productivity. It allows for a cost-pushed inflation under a negative supply shock.

<sup>26</sup> In the first version of GPM-T the foreign trade bloc consisted of 4 equations for exports, imports and prices. Since this did not improve results enough to add extra 18 parameters, the foreign trade block was replaced by the euro area output gap and exchange rate gap.

Almost null reaction on interest rate change (0.04) shows weakness of this instrument, comparing to e.g. exchange rate (0.16)

The Phillips curve:

SIMOT

$$\Delta p_t = 0.25 * E_t \Delta p_{t+1} + 0.66 * E_t \Delta p_{t-1} + 0.08 * \hat{y}_{t-1} - 4 * 0.05 * (e_{t-2}^r - e_{t-1}^r) + 0.03 * p_t^{world\ en.\ prices}$$

Core GPM

$$\Delta p_t = 0.62 * E_t \Delta p_{t+1} + 0.38 * E_t \Delta p_{t-1} + 0.1 * \hat{y}_{t-1} + 0.06 * (e_t + p_t^w) + \varepsilon_t^s$$

$\varepsilon_t^s$  - shock to inflation (supply side shock)

GPM-T

$$\Delta p_t = 0.29 * E_t \Delta p_{t+1} + 0.71 * E_t \Delta p_{t-1} + 0.06 * y_{t-1} + 0.23 * (e_t + p_t^w) + \varepsilon_t^s + \varepsilon_t^e$$

$\varepsilon_t^e$  - shock to the real exchange rate

$\varepsilon_t^s + \varepsilon_t^e$  - shock to inflation is amplified by the exchange rate (through the exchange rate pass-through)

Core GPM gives unexpectedly high coefficient at the expected inflation. The results of GPM-T and SIMOT seem to be more realistic.

Taylor rule:

SIMOT:

$$i_t = 0.9 * i_{t-1} + 0.1 * (r^* + 1.35 * (\Delta p_t - \Delta p_t^*) + 0.5 * (y_t - y_t^*))$$

Core GPM

$$i_t = 0.91 * i_{t-1} + 0.09 * (r^* + 1.23 * (\Delta p_t - \Delta p_t^*) + 0.44 * y_t) + 0.17 * (e_t^r - e_t^{r*}) + \varepsilon_t^i$$

GPM-T:

$$i_t = 0.79 * i_{t-1} + 0.21 * (r^* + 1.35 * (\Delta p_t - \Delta p_t^*) + 0.43 * y_t) + 0.19 * (e_t^r - e_t^{r*}) + \varepsilon_t^i + \varepsilon_t^y + \varepsilon_t^e$$

In GPM-T monetary shock  $\varepsilon_t^i$  is supplemented by demand shock  $\varepsilon_t^y$ . It may reflect unexpected government expenditures.

To link two instruments used by the Central Bank of Tunisia, we allow on the direct impact of the exchange rate on the interest rate in GPM and GPM-T. Addi-

tionally, in GPM-T we introduced the exchange rate shock ( $\varepsilon^e$ ) which may interact with the interest rate shock ( $\varepsilon^i$ ).

Real Exchange rate:

SIMOT:

$$e_t^r = 0.4 * e_{t-1}^r + 0.6 * e_{t+1}^r + 0.03 * (i_t^r - i_t^{r eu}) + 0.07 * y_{t-1}$$

The exchange rate equation has been augmented by a variable representing economic fundamentals. We use the lagged output gap, since owing to data limitations and lags in data dissemination, economic agents are expected to consider past economic situation when taking decisions on capital flows.

Core GPM

$$4 * (-0.27 * e_t^r + 0.73 * e_{t+1}^r) = ((i_t^r - i_t^{r eu}) - (i_t^{r*} - i_t^{r eu*})) + \varepsilon_t^e$$

This is the real UIP where the real interest rate disparity was replaced by the gap of the real interest rate disparity. It is assumed that coefficient at the interest rate gap is equal one, i.e. the same as at the interest rate disparity, what may not necessarily be true. Moreover, it implies that the risk in two countries is the same what rules out capital flows.

GPM-T

$$4 * (-0.43 * e_t^r + 0.57 * e_{t+1}^r) = 0.74 * (i_t^r - i_t^{r eu}) + 0.05 * g_t + 0.44 * \varepsilon_t^e + 0.6 * \varepsilon_t^g$$

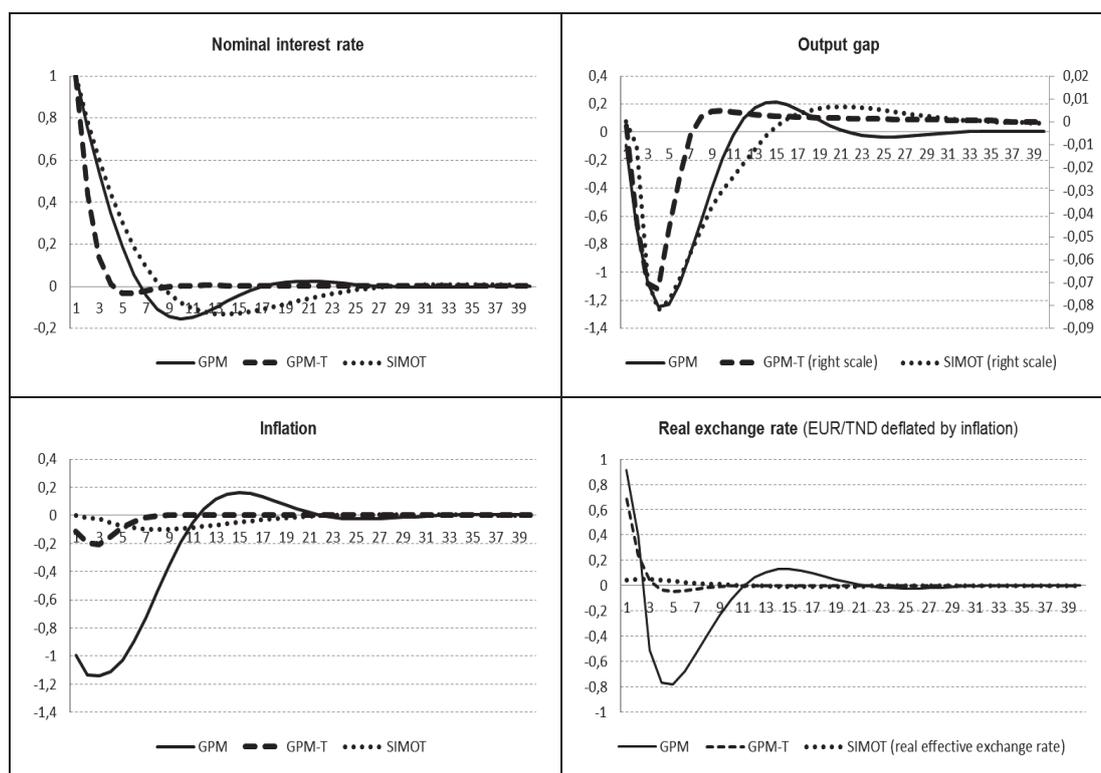
As in the core GPM, we use the real UIP, however directly in line with a concept of the interest rate disparity (not disparity gap) – as in works of J. M. Keynes – with the added risk factor determined by the change of  $g_t$ . Coefficient (0.44) at  $\varepsilon_t^e$  reflects the CBT policy aimed at smoothing the actual exchange rates (interventions).  $0.6 * \varepsilon_t^g$  shows the unexpected change in the government expenditures which may (to a certain extent) amplify the exchange rate shock.

Estimating coefficients at  $\varepsilon_t^e$  and  $\varepsilon_t^g$  we set up the prior mean equal 1, i.e. we assume no interventions of the CBT on the foreign exchange market nor any extra aid of the government in the case of a disaster. Estimated coefficients are much below one. It means that the CBT and the government willingly use available instruments to impact the economy.

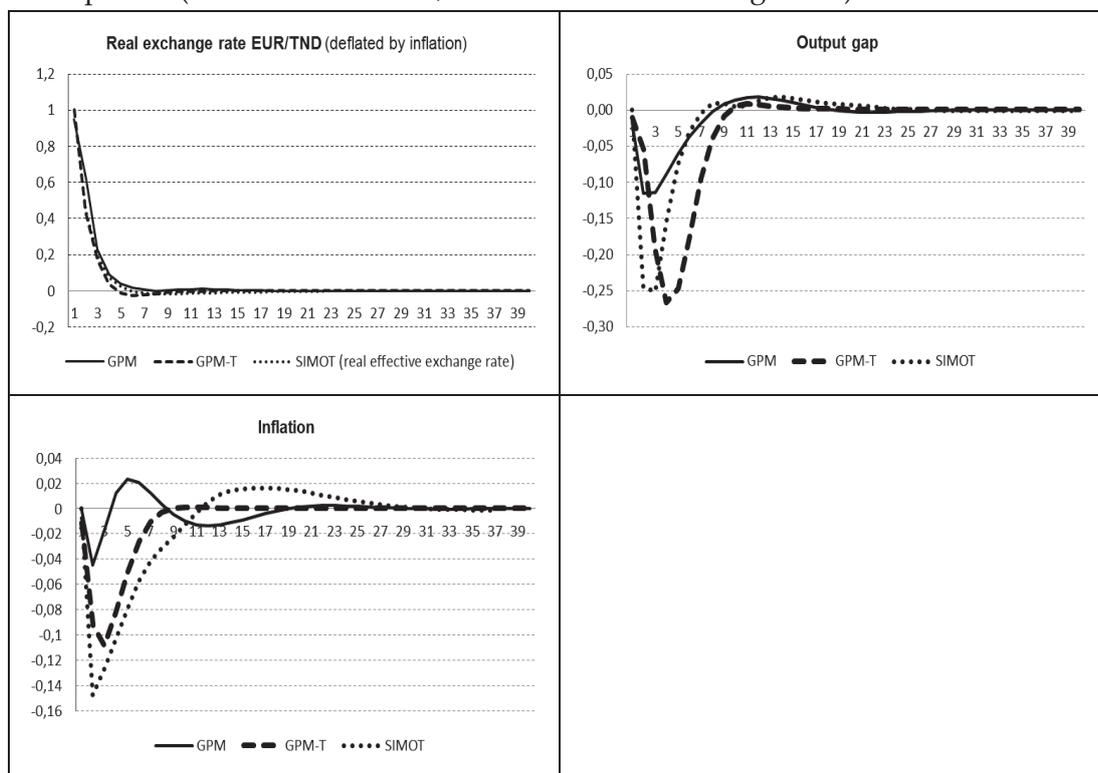
### 4.3. Reaction functions

The structural models serve us as the final stage of identification of the strength and delays of the monetary policy transmission. We assess them from a perspective of the maximum reaction of economic activity and inflation (year-on-year rate) to a change in the central bank interest rate and to interventions on the exchange rate market. The results are presented in the figures 16 -17 and tables 4-5.

**Figure 16.** Responses to the interest rate increase by 1 pp for 1 quarter, rule thereafter



**Figure 17:** Responses to the real TND/EUR (RER - SIMOT) appreciation by 1% for 1 quarter (caution – real TND/EUR and RER are endogenous)



Apart from the reaction of the exchange rate to interest rate shock, reactions of SIMOT and GPM-T are similar, while these of core GPM differ in most cases. Evidently, the former two are more in line with the stylized facts and our expectations about LDEMES than the core GPM. Because of the key role of the exchange rate in the Tunisian economy and exchange rate policy (real exchange rate rule and then de facto constant depreciation to the euro and capital controls) exchange rate equation must have been adjusted to reflect the actual policy. In the case of the GPM-T these adjustments led to the model with reduced responsiveness of inflation and output gap to the interest rate shocks as compared with the core model.

**Table 8.** Monetary transmission mechanism – synthesis of results from GPM-T and SIMOT models. Increase of the nominal interest rate 1 pp for 1 quarter, rule thereafter.

	Core GPM	GPM-T	SIMOT
<b>Output gap</b>			
strength of maximal reaction (in p.p.)	-1,23	-0,072	-0,081
lag of maximal reaction (quarter)	4	4	4
<b>Public expenditure</b>			
strength of maximal reaction (in p.p.)		-0,084	-0,051
lag of maximal reaction (quarter)		2	7
<b>Inflation</b>			
strength of maximal reaction (in p.p.)	-1,18	-0,21	-0,1
lag of maximal reaction (quarter)	3	3	6
<b>Real EUR/TND or RER (increase=appreciation)</b>			
strength of maximal reaction (in p.p.)	2,9	0,68	0,05
lag of maximal reaction (quarter)	0	0	1

Source: own calculations

**Table 9.** Monetary transmission mechanism – synthesis of results from GPM-T and SIMOT models. Appreciation of the Real EUR/TND or RER (increase=appreciation) 1 pp for 1 quarter.

	Core GPM	GPM-T	SIMOT
<b>Output gap</b>			
strength of maximal reaction (in p.p.)		-0,27	-0,25
lag of maximal reaction (quarter)		4	3
<b>Public expenditure</b>			
strength of maximal reaction (in p.p.)		-0,10	-0,16
lag of maximal reaction (quarter)		3	6
<b>Inflation</b>			
strength of maximal reaction (in p.p.)	-0,055	-0,11	-0,13
lag of maximal reaction (quarter)	1	3	3

Source: own calculations

Showing differences in reactions between GPM-T and SIMOT we stress uncertainty concerning both equilibria and model specification. We treat the obtained

responses of the main macroeconomic variables as a possible array of reactions. In the case of less developed economies, which are relatively susceptible to various negative shocks, variables reflecting risk factors may be highly unstable. We propose therefore one model which approximates risk with fundamentals and the other with the current macroeconomic policy. For example, if the expected reduction of the CBT reference rate results in some outflow of the short-term capital, the depreciation will be immediate and adequately strong, but secondary effects will be relatively small (GPM-T), while in a situation where short-term capital outflow is corrected by an inflow of investment capital, due to good fundamentals, the reaction will be much weaker and the period of return to equilibrium longer (SIMOT).

## 5. Conclusions

The paper describes features of a genuine small, trade-open non-resource dependent emerging market economy. Using the case of Tunisia we show specific features of LDEMEs, which make them different from mature market economies: underdeveloped financial market, with a small role of capital market, significant informal economy, administrative controls, including retail prices and retail interest rates, as well as administrative allocation of loans to preferred sectors. Furthermore, unlike more mature economies, which tend to exploit various forms of inflation targeting, monetary policy in less developed economies usually bases on monetary or exchange rate targeting. There are frequent changes in policy frameworks, multiple targets what leads to a lack of transparency and makes it more difficult to anchor inflation expectations. Financial illiteracy and smaller degree of financial inclusion are factors impeding effective monetary policy. Corruption and state capture exclude parts of economy from operation of market forces. In short, LDEMEs display a number of features which make them special and by the same token undermine many assumptions of New Keynesian and DSGE models which are usually based on the NK presumptions.

Analysing and modelling LDEMEs is problematic; responses of main macroeconomic categories to shocks can be distorted and counterintuitive. Last but not least problem is data shortage and poor reliability of existing series.

Using a complex approach we have identified the characteristics of the Tunisian economy. To overcome identification problems in econometric modelling, we have first exploited a narrative approach, which provided us with information about most pronounced distortions, and in the same time helped us to formulate hypotheses used in the SVAR models. In turn, SVARs have shown basic relationships in the economy, as well as their probable strength and lags. We have used

---

recursive and non-recursive decompositions as well as sign restrictions. The first two decompositions gave us very similar results owing to the fact that in Tunisia monetary policies were well separated one from another. Impulse responses to shocks identified with sign restrictions seemed to be better specified than those from classical SVARs. In general, results confirmed many of our working hypotheses, e.g. this of a considerable role of the exchange rate. It has a well proven impact on consumer prices and somewhat less evident impact on output represented by manufacturing. On the other hand, impulse responses to the interest rate shock have not brought a coherent picture, as shocks seemed to affect prices but not output. The latter tends to react to liquidity supply shocks. Our hypothesis that exchange rate policy might have led to surplus liquidity of the banking sector found too weak support to be accepted.

The role of the interest rate and the exchange rate have been re-examined using structural NK models. Bearing on mind that some NK assumptions do not hold for Tunisia, we have constructed two models which are tailored to the Tunisian conditions. In particular, we have adjusted the exchange rate equations to feature capital controls and interventions in the foreign exchange market. Then, we have compared responses of the two models enhanced with Tunisian features with a similar model, but without such characteristics. These which are tailored to the Tunisian conditions show that the interest rate impacts output and prices, but the effect is relatively small. This supports SVAR results on CPI reactions to the interest rate shocks. Furthermore, it suggests that other sectors than manufacturing, and most probably services, are more responsive to the interest rate, as they use more credits. On the other hand, a model with a standard UIP condition produces responses which seem to be much too big to be consistent with conclusions coming from the narrative approach and SVARs.

## 6. Literature

Adly Amr, 2014, "Reforming the Entrepreneurship Ecosystem in Post-Revolutionary Egypt and Tunisia", Center on Democracy Development, and the Rule of Law, Stanford University.

Agénor, Pierre-Richard and Karim El Aynaoui, 2007, « Le mécanisme de transmission de la politique monétaire au Maroc : Un cadre analytique », Bank Al-Maghrib, mimeo.

Agénor, Pierre-Richard and Karim El Aynaoui, 2010, "Excess liquidity, bank pricing rules and monetary policy", *Journal of Banking and Finance*, Elsevier, vol. 34, 923-933.

Agénor, Pierre-Richard and Peter J. Montiel, 2007, "Credit Market Imperfections and the Monetary Transmission Mechanism, Part I: Fixed Exchange Rates", Centre for Growth and Business Cycle Research, Economic Studies, *University of Manchester Discussion Paper 076*.

Argov, Eyal and Alon Binyamini, David Elkayam, and Irit Rozenshtrom, 2007, "A Small Macroeconomic Model to Support Inflation Targeting in Israel", Bank of Israel Monetary Department, August 2007.

Arias, Jonas E., Caldara Dario and Rubio-Ramirez Juan F., 2014, "The Systematic Component of Monetary Policy in SVARs: An Agnostic Identification Procedure", <http://documentos.fedea.net/mwg-internal/de5fs23hu73ds/progress?id=1k7eY-SoyQInEgyTFfUvo56mZmQ2j8Ca-lzOk32IT3o>.

Banque Centrale de Tunisie, 2007, *Rapport Annuel*.

Belke Ansgar and Christian Dreger, 2013, "The Transmission of Oil and Food Prices to Consumer Prices - Evidence for the MENA Countries", *Rhur Economic Papers, No 448*, Rhur Universität Bohum.

Ben Aïssa Mohamed Safouane and Nooman Rebei, 2012, "Price Subsidies and the Conduct of Monetary Policy", *IMF Working Paper, WP/12/15*, International Monetary Fund.

---

Benes Jaromir, Andrew Berg, Rafael A. Portillo, David Vavra, 2013, "Modelling Sterilized Interventions and Balance Sheet Effects of Monetary Policy in a New Keynesian Framework", *IMF Working Paper WP/13/11*, International Monetary Fund.

Bernanke Ben S., and Ilian Mihov, 1998, "Measuring Monetary Policy", *Quarterly Journal of Economics*, Oxford University Press, 113(3), 869-902..

Blaggrave Patrick, Peter Elliott, Roberto-Gacia-Saltos, Douglas Hostland, Douglas Laxton, and Fan Zhang, 2013, "Adding China to the Global Projection Model", *IMF Working Paper, WP/13/256*, International Monetary Fund.

Boughrara Adel (2009), "Monetary Transmission Mechanisms in Morocco and Tunisia", *Economic Research Forum Working Paper*, No 460, Giza.

Canova Fabio, Matteo Ciccarelli, 2011, "Cyclical Fluctuations in the Mediterranean Basin", *ECB Working Paper*, No 1367, European Central Bank

Carabenciov, Ioan and Charles Freedman, Roberto Garcia-Saltos, Douglas Laxton, Ondra Kamenik, Petar Manchev, 2013, "GPM6 - The Global Projection Model with 6 Regions", *IMF Working Paper, WP/13/87*, , International Monetary Fund.

Castillo Paul, Carlos Montoro, 2012, "Inflation Dynamics in the Presence of Informal Labour Markets", *BIS Working Paper*, 372, Bank for International Settlements

Chailloux Alexandre, Alain Durré and Bernard J. Laurens, 2009, "Requirements for Using Interest Rates as an Operating Target for Monetary Policy. The Case of Tunisia", *IMF Working Paper/09/149*, International Monetary Fund.

Chaari Inès, Jézabel Couppey-Soubeyran, 2008, « La place des banques dans le financement de l'économie tunisienne », *Revue d'Économie Financière*, Programme National Persée 93(3), 297-317.

Chen Minghua, Bang Nam Jeon, Ji Wu, 2014, "Corruption and bank risk-taking: Evidence from emerging markets", <http://cafd.cufe.edu.cn/docs/2014-04/20140421140205794858.pdf>.

Fanizza D., N. Laframboise, E. Martin, R. Sab, and I. Karpowicz, 2002, "Tunisia's Experience with Real Exchange Rate Targeting and the Transition to a Flexible

Exchange Rate Regime”, *IMF Working Paper, WP/02/190*, , International Monetary Fund.

Favero Carlo A., 2001, *Applied Macroeconometrics*, Oxford University Press, New York.

Glocker Christian and Pascal Towbin (2012a), Reserve Requirements for Price and Financial Stability – When are they effective?, *International Journal of Central Banking* 8(1), 65-114, Economic Research Department, Federal Reserve Bank of San Francisco.

Glocker Christian and Pascal Towbin (2012b), “The Macroeconomic Effects of Reserve Requirements”, *Document de travail no 374*, Banque de France.

Horj Alin Vasile, 2012, “The European Neighbourhood Policy towards Micro, Small, and Medium Enterprises in Tunisia”, *Universita da Ca’Foscari, Venezia*.

*IMF, Financial System Stability Assessment*, IMF, 2007 and 2012, International Monetary Fund.

*IMF, Staff Country Reports*, 1996, 2013, International Monetary Fund.

Institut Tunisien de la Compétitivité et des Etudes Quantitatives (ITCEQ), 2010, *Rapport Annuel*.

Jardak Tarak, ed. 2014, “Etude du mecanisme du transmission de la politique monétaire. Synthèse des résultats”, Banque Centrale de Tunisie, mimeo.

Kishan, Ruby P. and Timothy P. Opiela, 2000. "Bank Size, Bank Capital, and the Bank Lending Channel," *Journal of Money, Credit and Banking*, Blackwell Publishing, 32(1), 121-141.

Marques Carlos. R. (2004), “Inflation persistence: Facts or artefacts?”, *ECB Working Paper*, No 371, European Central Bank.

Ngalawa Harold P.E. and Nicola Viegi, 2013, “Interaction of Formal and Informal Financial Markets in Quasi Emerging market Economies”, *Economic Modelling*, Elsevier, 31(C), 614-624.

**OECD**, 2012, "The economic situation and the role of foreign direct investment in Tunisia", *OECD Investment Policy Reviews: Tunisia 2012*.

---

Peiris Shanaka J. and Magnus Saxegaard, 2007, "An Estimated DSGE Model for Monetary Policy Analysis in Low Income Countries", IMF Working Paper, WP/07/282, , International Monetary Fund.

Rijkers Bob, Caroline Freund, and Antonio Nucifora, 2014, "All in the Family. State Capture in Tunisia", *World Bank Policy Working Paper No 6810*, World Bank.

Strongin Steven, 1995, "The Identification of Monetary Policy Disturbances. Explaining the Liquidity Puzzle", *Journal of Monetary Economics*, Elsevier, 35(3), 463-497.

Tovar Camilo E., 2008, "DSGE Models and Central Banks", BIS Working Paper, 258, Bank for International Settlements.

Uhlig, Harald, 2005, "What are the effects of monetary policy on output? Results from an agnostic identification procedure", *Journal of Monetary Economics*, Elsevier, 52: 381-419.

---

[www.nbp.pl](http://www.nbp.pl)

