

**TRANSMISSION OF INTERNATIONAL SHOCKS
TO AN EMERGING SMALL OPEN-ECONOMY:
EVIDENCE FROM TUNISIA**

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***Abstract** - This paper examines how international monetary shocks are transmitted to emerging market countries like Tunisia. A long-standing empirical literature on the transmission of international shocks was mainly based on small-scale structural VAR approach. This paper proposes a Factor-Augmented VAR (FAVAR) model to select the main determinants of the Tunisia's economy and assess the response of Tunisia's macroeconomic variables to international fundamental variables. In particular, we aim to analyze the impact that world shocks may have on the Tunisian economy following the 2008 international financial crisis. This specification allows exploiting a wide range of variables that could influence the conduct of the monetary policy as well as spur the transmission mechanism of external monetary shocks to the national economy. We are mainly interested in specific sources of shocks, such as unanticipated fall in the global economic activity, in interest rates and in commodity prices. Our approach relies on a large panel of data covering Tunisia and 10 European and industrialized countries including Tunisia, and 211 price, activity and money indicators. Our results show that the Tunisian economy is highly exposed to the shocks of foreign economic activity and commodity prices and, to a lower extend, to shocks of foreign interest rates and world inflation. Our findings also suggest that international shocks are transmitted to Tunisia's national economy through real channels.*

Key-words - INTERNATIONAL TRANSMISSION, TUNISIA, ECONOMIC CRISIS, FAVAR MODEL

JEL Classification - F42, C38, F2

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1. INTRODUCTION

As global economy has become increasingly integrated, the pace of growth in the world economy and its impact on the domestic economy has become of first-order importance for economic agents and decision makers alike. In particular, the macroeconomic perspectives for the small open economies can be heavily influenced by the international developments. Thus, understanding the international transmission of the structural shocks is of crucial importance to identify the best-suited policy response to the international macroeconomic and financial fluctuations. In a world economy characterized by a steady increase in goods, capital and financial market integration the international dimension of the transmission mechanism has become an essential ingredient of the policy discussion. During the last decades and due to the agreements of partnership with the European Union (EU) in 1995, which boosted the commercial exchanges of its imported and exported goods, the Tunisian economy has turned into an open economy. This is clearly revealed by the degree of openness – as measured by the Openness Index - of the Tunisian economy which rose from 71.7% in 1994 to 91.2 % in 2012. Tunisia ranks now 10th in the European Union's market share¹. This evolution further adds to the vulnerability of the Tunisian economy to the different shocks such as the increase in commodity prices which weighs heavily on business costs (Maier and De Pratto, 2008)². With an open economy, Tunisia is now exposed to the global economic cycle and as such, understanding how these global economy fluctuations will impact home economy is of great importance in identifying the best policy response.

This paper provides a detailed assessment of the dynamic effects of external shocks on the Tunisian macroeconomic variables. Relatively, very little work has been done on the effects of the global developments on the Tunisian economy. Previous studies have estimated the transmission of the foreign shocks using small-scale econometric models employing basically the vector autoregressive models (VARs) or the structural vector autoregressive models (SVAR)³. Although these small-scale models supply plausible assessment of the dynamic responses of the key macroeconomic variables in response to shocks, they are essentially of low dimension leading to two potential problems with the results. First, the analysis is typically limited to some series that do not necessarily allow for a detailed evaluation of the transmission of foreign shocks to the domestic economy. Second, the sparse information set can contaminate the identification of the foreign shock because in a small dimension model these shocks are exogenously introduced and are not selected through data-driven statistical methods. These weaknesses can be addressed through an alternative approach which combines the standard VAR analysis with factor analysis

¹ Report from the BCT 2011 p 48.

² Tunisia has almost tripled its reserve budget for energy products to alleviate the charges for the companies and households between 2011 and 2012.

³ See for example Eichenbaum and Evans (1995) and Grilli and Roubini (1995) who use VAR models and Souki (2008) and Klyuev (2008) for the use of SVAR models. Another alternative is the use of structural models, like in Schmitt-Grohe (1998).

through the use of an open-economy “Factor-Augmented VAR model” (FAVAR), as developed by Bernanke et al. (2005), and subsequently applied by Boivin and Giannoni (2008) and Mumtaz and Surico (2009). In contrast to the small-scale traditional VAR evaluation techniques, the FAVAR model addresses all these limits of small-scale model since it permits treating a vast panel of data. We combine FAVAR modeling with principal components methodology in order to identify the main international drivers of the Tunisian economy and then introduce the selected drivers into the FAVAR model to assess the impact of their variations on the main Tunisian macroeconomic variables.

We are particularly interested in some specific sources of international shocks, in particular the prices of basic foreign⁴ products, foreign economic activity and foreign interest rates. Our analysis intends to estimate the impact of each shock on key Tunisian macroeconomic variables, mainly in the post-2008 international financial crisis, to assess the interaction between the Tunisian economy and the rest of the world, which we treat as “foreign” block. These movements clarify the transmission process of the foreign shocks to the Tunisian economy. Our methodology takes into account the co-movements of the international variables through the inclusion of several variables from the various sample countries. Contagion effect is also investigated using the principal components FAVAR approach.

Given the importance of the movements of commodity prices for the Tunisian economy⁵, we extend the open economy FAVAR model of Mumtaz and Surico (2009) to include prices of raw materials as additional explanatory variables. Afterwards, we attempt to extract the specific international components from 211 series relative to 10 countries which are the main trade partners of Tunisia and the most industrialized countries in view of analyzing the incidence of the world evolution on the Tunisian economy.

Our results suggest that Tunisia is mainly exposed to the shocks of foreign activity and commodity prices. The fall in foreign economic activity has significantly affected the economic indicators of Tunisia. For instance, the fall in the exports of Tunisian manufactured goods and mechanical and electrical products, due to the world economic downturn, has precipitated the degradation of national trade balance. The high sensitivity of the Tunisian economy to the shock inflicted on the global economy, and more specifically on the euro area, finds its explanation in the privileged trade relationships linking Tunisia to its European partners.

Contrary to the findings of Mumtaz and Surico (2009) that similarly applied the FAVAR model to the UK case, the fall in foreign interest rates impacts relatively less the Tunisia’s economy. This finding may reflect the delay of reaction of the Tunisian financial sector as compared to international standards of good governance and performance and, to a greater extend, disintegration of the Tu-

⁴ The terms ‘foreign’ and ‘international’ are used to denote external shocks.

⁵ Tunisia has an energy deficit and is a net importer of oil and its economy is heavily dependent on imports of petrol. The industry sector is the largest consumer of energy with a 36% share of overall consumption.

nisian financial system from the world financial system. In contrast, the decline in commodity prices has been beneficial for the Tunisian economy. It has improved the trade balance, in the sense that the fall in the price of the oil barrel reduced the import bill of energy products. For exporting firms, the fall in oil prices coupled with lower production costs helped to improve their competitiveness.

The paper is organized as follows: section 2 provides a literature review on the use of FAVAR model in studying the transmission of international shocks to national economies. Section 3 details our empirical methodology. In section 4 we summarize and discuss our findings. Section 5 concludes and presents some policy recommendations.

2. LITERATURE REVIEW

The recent empirical literature on the shock transmission gave more attention to the analysis of the impact of foreign shocks on macroeconomic fluctuations in emerging economies. Empirical methods include correlation analysis (Agrawalla and Tuteja, 2007; Ali and al., 2010), regression analysis (Nguyen and al., 2014; Makowiak, 2007) and quantile regression (Park et al., 2011; Eickmeier and Ng, 2011). The major limit of the previous papers is that they allow modeling the interaction between two time series only and hence fall in the omitted variables problem. Thus, other papers employ multivariate modeling to account for endogeneity and identification restrictions largely documented in the monetary policy literature. Indeed, by using the SVAR model, Sosa (2008) shows that the shocks to the US industrial production account for a large share of output fluctuations and Mexican exports and constitute the largest source of macroeconomic fluctuations in Mexico. In the same context, Berument and Ceylan (2010) investigate the effects of oil price shocks on output growth of countries in the MENA region. Gimet (2007) finds the high vulnerability of the Mercosur countries in the wake of international price shocks of agricultural products, the U.S. interest rate and the volatility of stock exchange indices in emerging countries. Mackowiak (2007) concludes that the US monetary policy shocks quickly and strongly affect short-term interest rates and exchange rates in emerging markets of Asia and Latin America.

In addition, Hoffmaister and Roldós (1997) find that Latin American economies are more sensitive than those in Asia following changes in the foreign interest rate. They also proved that emerging countries are affected unequally by external shocks.

Similarly, in the context of the global crisis, Moriyama (2010) shows that the increased financial stress and slowdown of economic activity in advanced economies may explain up to about half of the decline in growth of real GDP in the MENA countries following the collapse of Lehman Brothers.

Also, Utlaut and Roye (2010), analyze the effects of external shocks on countries in emerging Asia by estimating a Bayesian vector auto-regressive model (BVAR). The results show that the economic outlook in emerging Asia

highly depends on the growth path of the world economy and remarkably little on business cycle fluctuations in China.

In their paper, Cashin, Mohaddes and Raissi (2012) use the Global Vector Autoregression (GVAR) model to analyze spillovers from macroeconomic shocks in systemic economies (China, the Euro Area, and the United States) to the Middle East and North Africa (MENA) region. The results show that shocks are transmitted across economies via trade, financial, and commodity price linkages. The MENA countries are more sensitive to developments in China than to shocks in the Euro Area or the United States.

Some recent studies use the FAVAR model to trace out the transmission of a country's monetary, financial and real activity shocks to other countries. Stock and Watson (2002) developed an approximate dynamic model of factors to recapitulate the information content of large data sets for predicting the target variable. They prove that the predictions based on these factors are clearly more plausible than those derived from a standard VAR model. This finding is probably due to the constraint of reduced set of variables in the VAR representation.

Bernanke and Boivin (2003) prove that the use of estimated factors can improve the assessment of the Fed's policy reaction function. As for Bernanke et al. (2005), they propose a potential solution to the problem of limited information which combines the standard structural VAR analysis with the recent developments in the factor analysis for a large data panel. They notice that the information exploited by the factor-augmented VAR methodology is critical to a correct identification of the monetary transmission mechanism. Their results provide a complete and logical image of the effect of the monetary policy on the economy.

Similarly, in order to predict the interest rate curve, Diebold (2004) details the construction of a factor model. His model incorporates macroeconomic and financial factors and reveals that the effects of causality are more present with the interest rate curve. The above works suggest the existence of a solid relationship between the macroeconomic variables and the prediction of the interest rates. These conclusions corroborate the findings of Ang and Piazzesi (2003) or those of Stock and Watson (2002), and can be explained by the sign effects of the Fed's monetary policy.

Bernanke et al. (2005) adopt the Factor-augmented VAR approach in order to integrate large information set used by monetary policymakers. They used a large data panel consisting of 120 monthly variables on the American economy to study the impact of a restrictive monetary policy. Indeed, in line with this policy, they noticed the fall in the real activity which supplies a coherent measure of policy transmission.

Other papers employ a large number of international data to focus on the role of capital control and the increase in global liquidity puzzles such as Miniane and Rogers (2007), Lagana and Mountford (2005), Ruffer and Stracca (2006), and Sousa and Zaghini (2007).

Mumtaz and Surico (2009) extend the FAVAR model as developed by Bernanke and al. (2005) for an open economy in order to examine how the foreign economic turbulences can impact the economy in the U.K. They find that the shocks of the foreign economic activity have small effects on the U.K economy whereas the foreign short-term interest rate shocks can have substantial effects. This result is not surprising given the major role the country plays as a global financial hub.

In the same vein, de Bandt et al. (2010) employ the FAVAR model to analyze transmission mechanisms between the national and international house prices in the US. They find out that the house prices in the United States, along with other factors such as interest rates and real activity, constitute the main sources that impact the house prices in other countries of the world. Gupta et al. (2010) also investigate the impact of monetary policy on house price in South Africa using a FAVAR approach. Their results indicate that house price inflation responds negatively to monetary policy shock, but the responses are different according to the housing segment among middle, luxury and affordable. Their results are more reliable than those obtained using small-scale VAR models in the housing market in that they do not fall in the home price puzzle observed in previous studies.

More recently, Vasishtha and Maier (2011) use a FAVAR model to analyze the incidence of the world evolution on the Canadian economy. They investigate different sources of shocks, in particular, the prices of basic products, foreign economic activity and foreign interest rates.

Moreover, they estimate the repercussions of every shock on key Canadian macroeconomic variables so as to draw a complete scheme regarding the effects of the international shocks on the economy of the country. Their results indicate that while it is mainly exposed to the shocks affecting foreign activity and the prices of basic products, Canada is much less exposed to the shocks that hit the world interest rates and inflation.

By employing a FAVAR approach Zuniga (2011) investigates how the American monetary shocks are transmitted to emerging market countries such as Mexico and Brazil. The results reveal that foreign monetary shocks are transmitted differently to Mexico and Brazil.

The ability of the FAVAR model to handle a large data set and its attractive statistical properties make it up-to-date. For instance, Aastveit (2014) finds that oil demand shocks are more important than oil supply shocks in driving macroeconomic variables. Fernald et al. (2014) argue that increases in bank reserve requirements as well as change in policy rate reduce economic activity and inflation in China.

To the best of our knowledge, no previous works have investigated the impact of world economic indicators on the Tunisia's economy using a large data set. This may be due to at least two reasons. First, the lack of goodwill to conduct a serious study regarding this issue by the previous managers. Second, Scientifics were reluctant to undertake such studies due to fear of unreliable data provided by the local authorities. Our analysis of the reaction of the Tuni-

sian economy to international shocks is thus the first to shed light on the interaction between Tunisia and the world economy. To this end, we use the FAVAR model since, in addition to its ability to account for a large number of sources of international shocks; it is well-suited to time series with a short history and countries with rapid institutional and structural changes. Indeed, since 2011 Tunisia has undergone several structural changes either by effective reforms (more flexibility on the exchange rate policy, improved governance in the banking sector (Central bank Circular number 2011-06)) or by announcement effect (transparency in public procurement, support of the IMF and the World Bank for the structural reforms in financial sector).

3. EMPIRICAL STUDY

3.1. The open economy FAVAR model

The econometric framework used in this paper is based on the FAVAR model of Bernanke et al. (2005) and extended by the inclusion of international factors. According to Boivin and Giannoni (2008) and Mumtaz and Surico (2009), the model consists of two blocks: the first is for Tunisia (domestic) and the second is for the rest of the world (foreign /international). The situation of the economy cannot be directly observed but can be summarized by K unobserved factors, $F_t = [F_t^* \ F_t^T]$ where $*$ denotes the foreign economy and T indicates Tunisia. On the contrary, the policy rate of the Tunisian Central Bank (i_t) is supposed to be directly observed. The dynamic system of F_t and i_t evolves according to the following transition equation:

$$\begin{bmatrix} F_t \\ i_t \end{bmatrix} = B(L) \begin{bmatrix} F_{t-1} \\ i_{t-1} \end{bmatrix} + u_t \tag{1}$$

where $B(L)$ is a conformable lag polynomial of finite order p , and $u_t = \Omega^{\frac{1}{2}} e_t$ with $e_t \sim N(0, I)$ is a structural error term with zero mean and covariance structure given by $\Omega = A_0(A_0)'$.

The equation (1) is the standard VAR except that the vector of factors F_t is not observable. These unobserved factors are derived from a panel of N indicators containing information about the fundamentals of the economy. Let X_t be the $(N \times 1)$ vector of the informational variables where N is large with $N > K+1$, then X_t is linked to the two types of unobserved factors F_t and the observed i_t variables via the following equation:

$$X_t = \Lambda^F F_t + \Lambda^i i_t + v_t \tag{2}$$

where Λ^F and Λ^i are respectively $N \times K$ and $N \times 1$ matrices of factors loadings and v_t is a $N \times 1$ vector of zero mean disturbances. Equations (1) and (2) represent the FAVAR model proposed by Bernanke et al. (2005) but extended by adding the foreign block as in Boivin and Giannoni (2008) and Mumtaz and Surico (2009). The main advantage of the static representation of the factor-augmented model given by equations (1) and (2) is that factors can be estimated by the principal components approach (see also Stock and Watson, 2002).

3.2. Identification of factors

Before estimating the FAVAR model given by equations (1) and (2), we first need to introduce unobserved factors F_t . To this end, we rely on four factors of the foreign block F_t^* such that $F_t^* = \{Y_t^*, \Pi_t^*, M_t^*, i_t^*\}$ where Y_t^* denotes the factor of the international real activity, Π_t^* the international inflation factor, M_t^* the international money factor and i_t^* the co-movements in the international interest rates. These international factors are identified through the upper $N \times 4$ block of the matrix A^F , which is assumed to be a diagonal block.

This comes to extract the factor of the international real activity from our international series which captures the real activity. Similarly, the international inflation factor is identified as the only factor that is loaded by all international inflation series. The remaining international factors are identified similarly. The dynamics of the Tunisian variables are captured by k domestic factors extracted from a large panel of Tunisian macroeconomic time series.

Similar to the standard VAR approach, the FAVAR model needs also alternative schemes of identification of policy shocks. We use the Cholesky identification method which is based on the assumption that the unobserved factors do not react contemporaneously to monetary policy shocks. Like Bernanke et al. (2005), we treat i_t as the instrument of the monetary policy for the domestic economy.

The dynamic for every Tunisian time series is a linear combination of all the Tunisian factors which are linked to the foreign factors through the transition equation (1). This implies that the response of any underlying variable in X_t to a shock in the transition equation (1) can be computed using the estimated factor loadings and equation (2).

We focus on the study of the dynamic effects of four shocks during 2008 international financial crisis: an unanticipated decline of international activity, an unanticipated reduction of the interest rate in the rest of the world, an unexpected decrease of foreign inflation and an unexpected slowdown of global monetary growth. Indeed, from the summer of 2007 there was a crisis of confidence among banks that blocked interbank relations and thus the "credit crunch". This has induced a banking liquidity crisis. To avoid paralysis in the functioning of the markets, the major central banks adopte rescue programs (such as the Paulson plan) and quantitative easing policy which allow the increase in the money supply. In early 2008, most financial markets of developed countries have been strained following the development of the "securitization". Thus, the high level of interdependence of financial systems explains the unusually synchronized nature of this crisis. Finally, the crisis was transmitted worldwide by the capital movements channel and international trade. In 2008, the advanced economies and many emerging economies are in recession with a contraction in household demand leading to a global economic crisis.

In this paper we normalized the impulse response of each variable with respect to its standard deviation. Considering this normalization, responses can be

interpreted as percentage changes in the standard deviation (Lutkepohl, 1993). Impulse responses of each figure (section 4) show the response of the Tunisian variables following a one-standard-deviation shock.

The appropriate channel to the transmission of external shocks, often cited, is the foreign trade via exports and imports. These two variables, measured in volume, are used to gauge the intensity of the impact of the shocks caused by the turbulence in the world economy on the fundamentals of the national economies. Also, we introduce the oil price as the main external shock related to commodity prices.

The order of variables in our FAVAR specification is organized as follows: $[Y_t^*, \Pi_t^*, M_t^*, i_t^*, F_t^T, i_t]$. The foreign shocks in our model are identified by using the recursive ordering scheme. This way, the impact matrix A_0 is lower triangular implying that the rest of the world does not react to the variations of the contemporaneous Tunisian variables⁶.

3.3. Estimation of FAVAR

The problem in our specification is how to recover the unidentified factors. Indeed, Bernanke et al. (2005) and Mumtaz and Surico (2009) have propose a two-step analysis of principal components to estimate the model. In the first step, the space spanned by factors $\hat{C} = (F_t^T, i_t)$ is estimated through the use of principal components (Stock and Watson, 1998; 1999). This method is shown to be numerically robust and computationally efficient. As already described, \hat{F}_t is derived as part of $\hat{C} = (F_t^T, i_t)$ which is not covered by i_t . In the second stage, the FAVAR model in the equation (1) is estimated as the standard VAR by replacing the real factors (F_t) by their estimated counterparts (\hat{F}_t). The approach of the second stage is chosen for its computational convenience⁷. Moreover, Bernanke et al. (2005) show that two-step and one-step procedures produce very similar results.

Bai and Ng (2002) provide an information criterion statistic to determine the number of factors⁸ that should be selected to sum up effectively the existing information in the database. In our analysis of the Tunisia's economy we in-

⁶ The use of the Cholesky decomposition is a standard practice in the literature (see Christiano et al., 2000 for an excellent review of literature). In the literature there exist several other identification methods, but the goal of our study is to reflect the contributions of factor augmented models for the analysis of international transmission mechanisms and not to analyze the alternative identification methods. To this end, we will follow Bernanke et al. (2005) and other studies that use the Cholesky decomposition method.

⁷ The alternative estimator is a Bayesian one step likelihood based approach. Bernanke and al. (2005) show that the two approaches deliver qualitatively similar results.

⁸ For further details, see Bai and Ng (2002).

clude four factors capturing respectively the real activity, the inflation, the monetary growth and the interest rates.

We choose $k = 4$ so that the impulse responses do not change significantly if additional Tunisian factors are added to the model (as in Mumtaz and Surico (2009)). This choice shows that the second stage of our estimation procedure implies the estimation of the VAR with nine endogenous variables. We have included four lags in the model to properly capture the dynamics as in Vasishtha and Maier (2011).

3.4. Data

Based on the increasing importance of big data analysis in empirical macroeconomic modeling, we use the FAVAR model to investigate the response of the Tunisia's macroeconomy to movements of international macroeconomic indicators. Indeed we use 211 series related to 11 countries⁹ to analyze the incidence of the world economic innovations on the Tunisian economy. We are particularly interested in certain sources of shocks, in particular commodity prices, foreign economic activity, foreign interest rates and foreign inflation. We estimate the repercussions of every shock on key Tunisian macroeconomic variables so as to determine all the possible effects of the international shocks on the economy of the country.

Our database contains information on real activity, inflation, monetary growth and interest rates for Australia, Canada, Denmark, France, Germany, Italy, Japan, Spain, the United Kingdom and the United States. We use quarterly data covering the period from 1990:Q1 to 2011:Q4. When a data series is available on a monthly basis, we calculate the average of the monthly observations during the 3-month horizon to obtain the quarterly values¹⁰. As in Bernanke et al. (2005) all the series are transformed to ensure their stationarity through the use of Augmented Dickey-Fuller (ADF)¹¹ test.

4. EMPIRICAL RESULTS

4.1. International co-movements

The analysis of international factor comovements allows extracting four common components of the foreign block of the panel that summarizes large amount of information about the economies which are estimated by principal components prior $(X_t - \hat{B}X_{t-1})$ using Bayesian likelihood methods and Gibbs sampling (Stock and Watson, 2005).

⁹ The 11 considered countries include Tunisia (domestic), its main trading partners and some major industrialized countries (foreign).

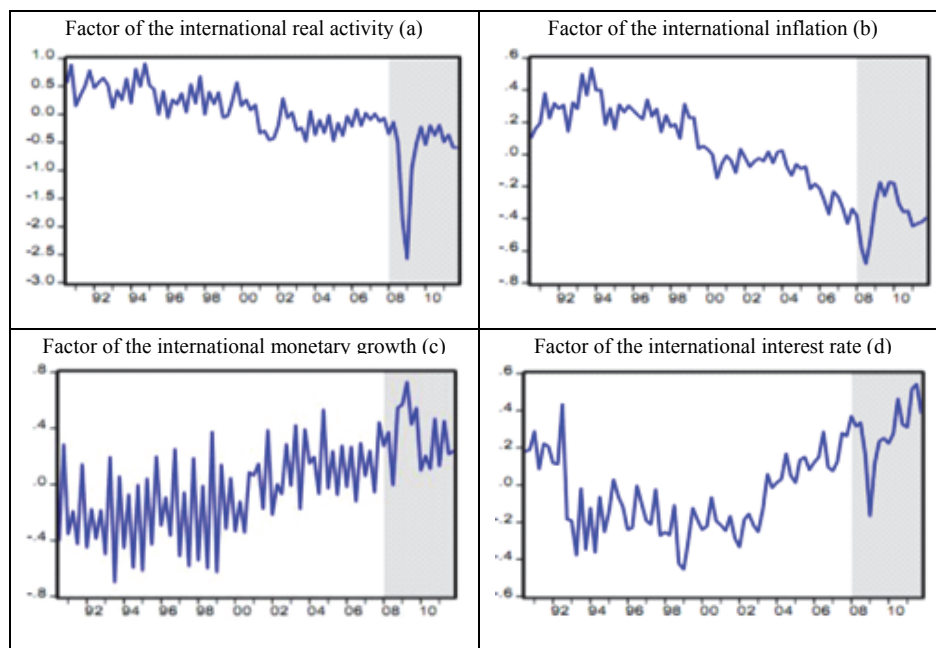
¹⁰ As in Bernanke et al. (2003), Mumtaz and Surico (2009) and Vasishtha and Maier (2011).

¹¹ Lag length in « Augmented Dickey-Fuller (ADF) » is determined by the Akaike Information Criterion (AIC).

Figure 1 plots the respective principal components of real activity, inflation, monetary growth and interest rates.

Between 1990 and 2011, the majority of countries witness several economic and financial crises (Asian crisis, Dot.com bubble). But these crises do not have the same magnitude or the same damage as the subprime mortgage crisis that has affected all sectors of these countries. Tunisia also has not suffered negative effects of these crises unlike the international financial crisis. However, in our study we are mainly interested in the 2008 international financial crisis which originated in the United States and widespread later to become a world economic crisis and hit the rest of the world countries. The components in Figure 1 illustrate the effects of this crisis. The recession of the global economy following the bankruptcy of Lehman Brothers and its domino effect on the U.S. banking system is clearly apparent in 2009 (Figure 1 (a)). This recession has caused a fall in demand at the international level, precipitating deflation (Figure 1 (b)).

Figure 1: Principal Components extracted from international data



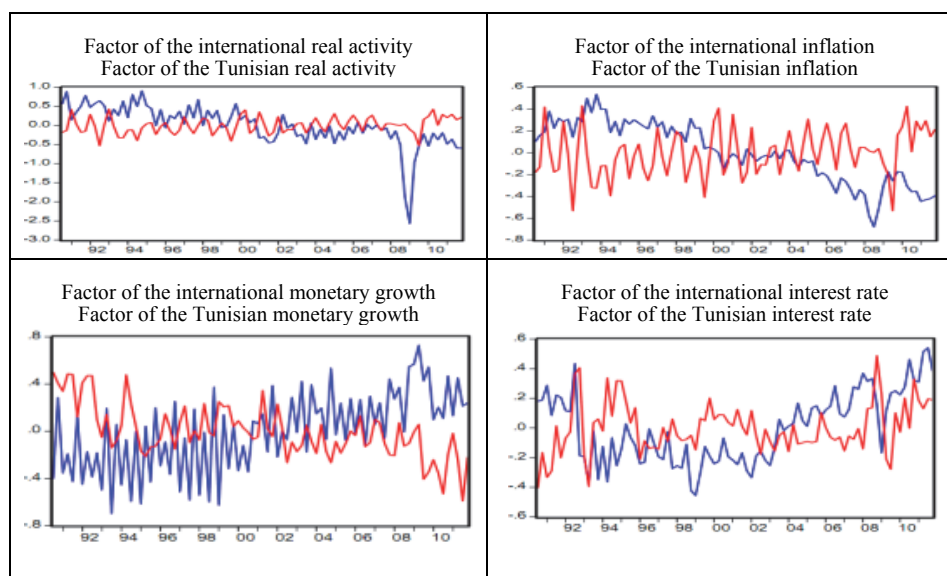
To salvage the banking system and avert massive failures of banks, many countries adopted plans to bail out their financial sectors, heavily damaged by the subprime crisis. The famous "Paulson" plan was the first to save the American banking system with a 700 million dollar injection to help banks to get rid of their toxic assets. Also, the central banks of the USA, European countries and many other countries of the world have adopted accommodating monetary policies which ended in reductions in interest rates which have achieved zero point (Figure 1 (d)) to allow banks to finance themselves at lower cost, limit the impact of the crisis on credit and revive the international economic activity. But

the decline in interest rates and refinancing facilities offered by the Paulson plan does not have a significant impact on the money supply. The monetary authorities resort to quantitative easing policy to observe the growth of the money supply. This explains the growth of the international money supply in 2009 (Figure 1(c)).

4.2. Co-movements between the Tunisian and international factors

Figure (2) shows the dynamics of Tunisian and international factors. We notice some synchronization of tendencies between the national and international factors of real activity and interest rate. This is understandably obvious because of the sensitivity of the Tunisian economy to international fluctuations, especially those that hit the Eurozone countries with which Tunisia's trades amount to 80 %. The Tunisian economy is highly dependent on countries of the European Union in particular, with regard to exports, tourism receipts and flow of Foreign Direct Investment.

Figure 2: co-movements between the Tunisian and international factors



Indeed, trade openness in Tunisia led to a recession that has strongly influenced the overall volume of trade. According to the report of the International Monetary Fund (IMF) (2010) “at the end of 2008 and early 2009, there was a considerable drop in the export of industrial goods. This is the result of the current recession in the European Union. The result was a decline of industrial production and a fall in real GDP growth from an average of 4.6% in 2008 to 1.3% in the first quarter of 2009”. Consequently, the Tunisian annual growth rate seems to be increasingly synchronized with that of the EU and its major trading partners. On the other hand, despite the weak financial market that is still emerging and undeveloped, Tunisia is required to take various immediate

actions such as lower interest rates in order to reorganize the functioning of the financial sector and revitalize the economy.

However, for the factors of international inflation and international monetary growth this synchronization is not verified. Regarding inflation, the financial crisis has generated deflationary effects leading to a sharp decline in international inflation, while growth in Tunisia has always remained above 2% during the crisis and therefore inflation remained maintained. For monetary growth, industrialized countries resort to unconventional monetary policies that result in a strong injection of money into the economy, which is not the case in Tunisia, where the central bank is limited to conventional instruments including the policy rate to stimulate the economy.

4.3 Impact of a decrease in foreign economic activity

Figure 3 depicts the responses of Tunisia's economic activity, following a one standard deviation decrease in the world economic activity. The decline in global economic activity affects Tunisia's exports (X) in a direct fashion since nearly 80% of those exports are directed to the Eurozone, the first victim of the crisis. Manufactured products (XAIM) and mechanical and electrical products (XIME) were the mostly hit. That has contributed greatly to the degradation of Tunisian trade balance.

As regards the evolution of the inflation level, the index of consumer prices (CPI) declined due to reduced demand. In response, the Tunisian monetary authorities have been forced to lower their key interest rate to stimulate economic activity, which is reflected by lower money market rate (TMM). This explains the significance of the impulse responses of interest rates for a short period (3 quarters).

The industrial production index (IPI), registered a sharp decline, as a result of the fall in demand from the main partners of Tunisia. This negative impact is felt especially in the sector of textiles, clothing and Leather (IPITH), the mechanical and electrical sector (IPIME) as well as various manufacturing sectors (IPIMD), whose reactions are immediate and remain negative until the end of the period. Similarly, Tunisian imports have witnessed a downward trend. Especially, food and agricultural commodities (MAA) reacted after four quarters, manufacturing products after two quarters (MAIM) and mechanical and electric products (MIME) after two quarters.

4.4. Impact of a decrease in foreign inflation

Figure 4 shows the responses of Tunisia's main economic indicators to a one standard deviation decrease of the foreign inflation. This decline has caused the decrease in the world interest rate which has a positive effect on the global economic activity. Thus, the impact of the transmission of foreign inflation on the Tunisian economy (GDP) is positive and lasted approximately nine quarters. The Tunisian exports (X) and imports (M) decreased during five quarters and then stabilized at a negative level.

Figure 3: Impulse responses due to a decrease in foreign economic activity

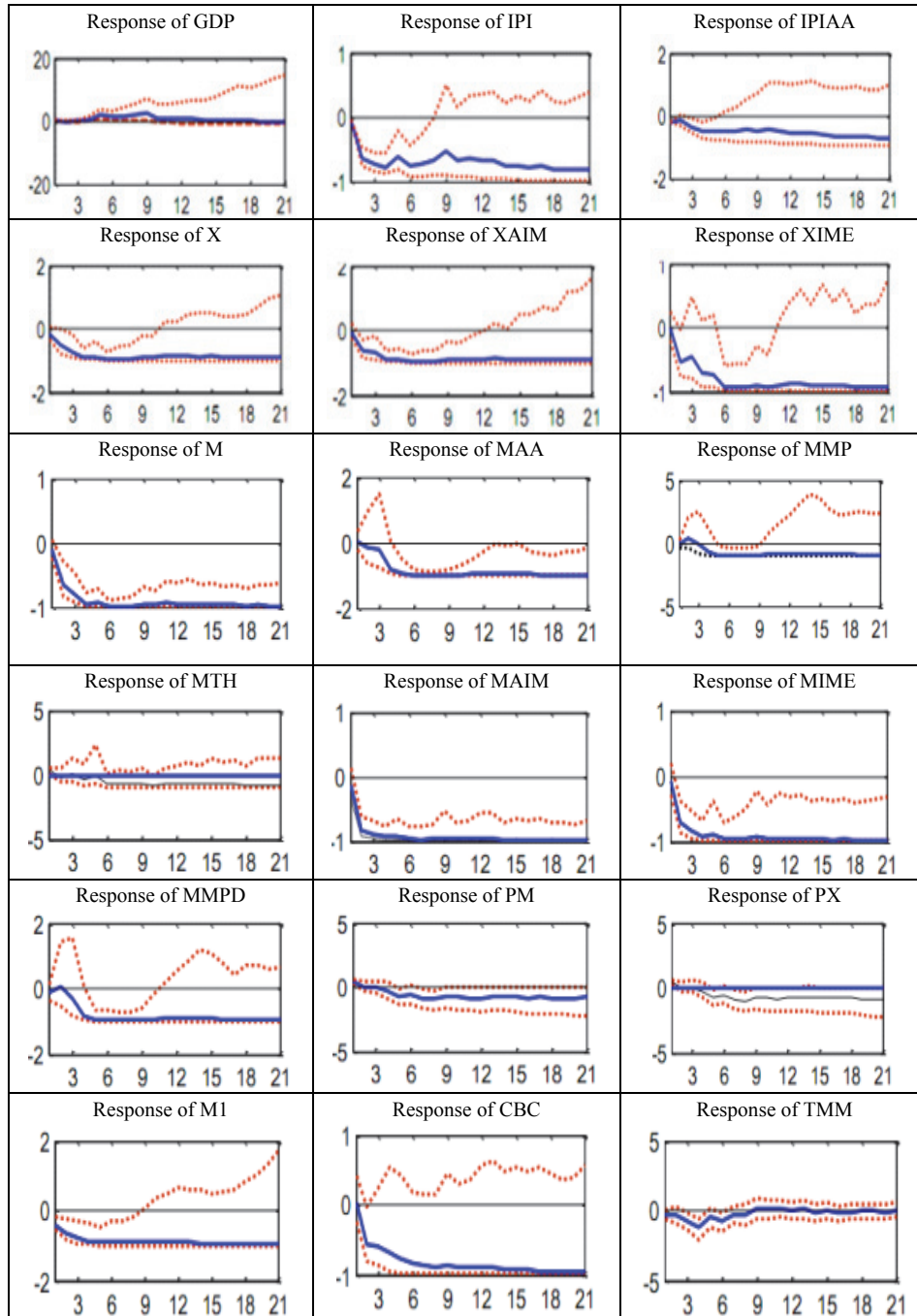
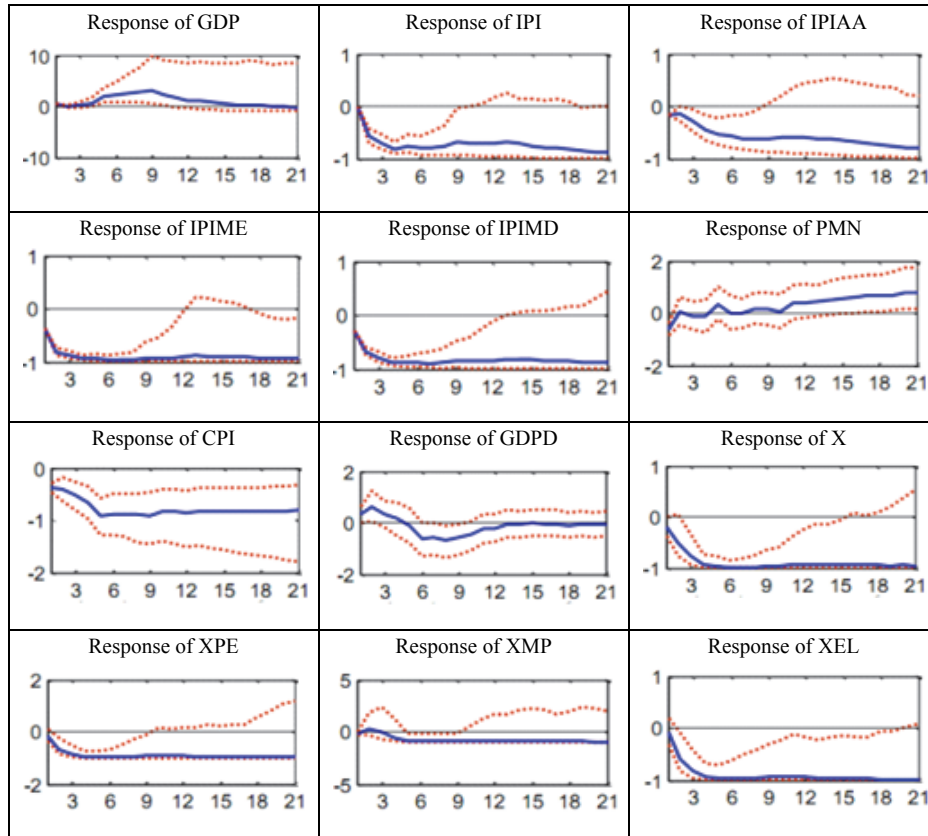


Figure 4: impulse responses due to a decrease in foreign inflation



The analysis of the structure of exports shows that the energy products (XPE), the mining and phosphate products (XMP) as well as the energy products and lubricants (XEL) were the most affected.

Regarding imports, the decrease incorporates the manufacturing industries (MAIM), the phosphate mining and derivatives (MMPD) as well as mechanical and electrical industries (MIME).

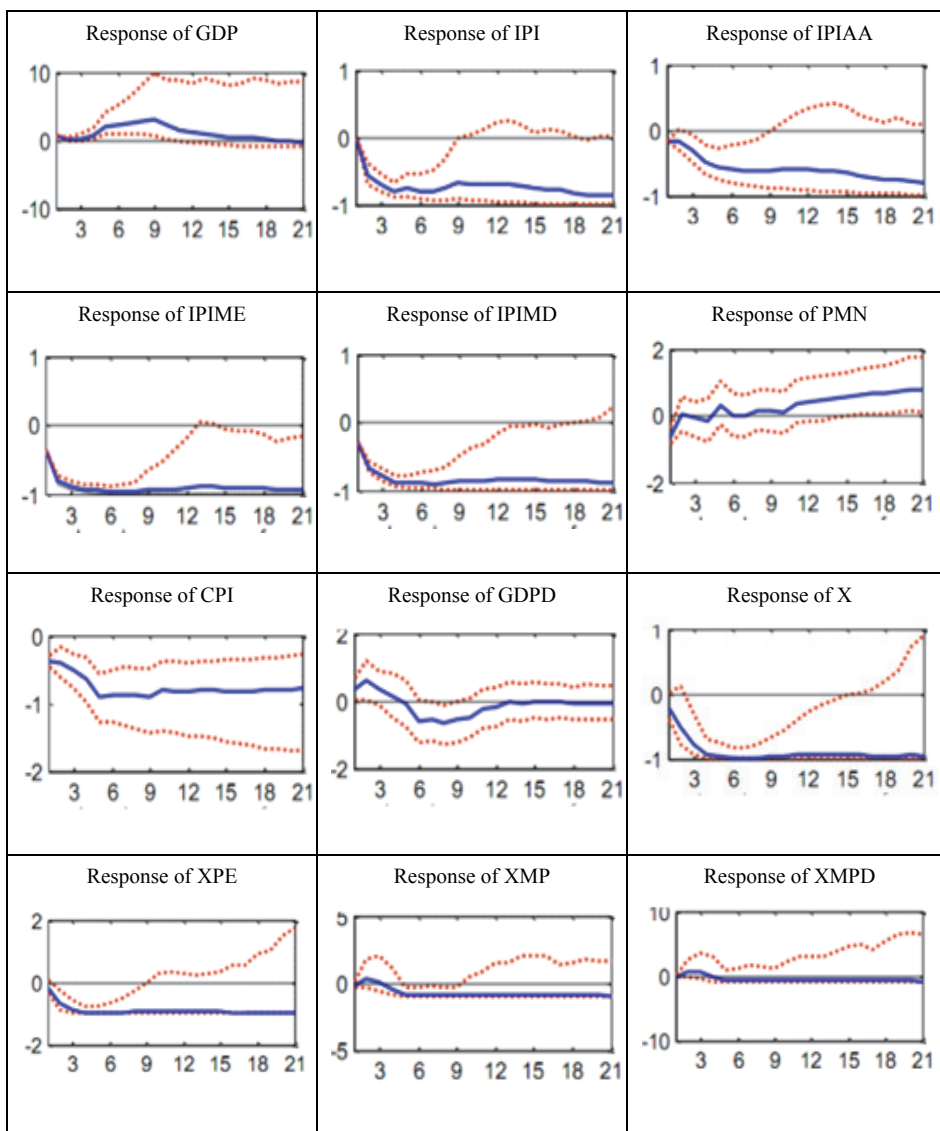
Furthermore, the reduction in the foreign inflation of key trade partners was imported to Tunisia. As a result, the implicit GDP deflator (GDPD) becomes negative from quarter 6 to quarter 9 causing the reduction of the volume of refinancing from the central bank.

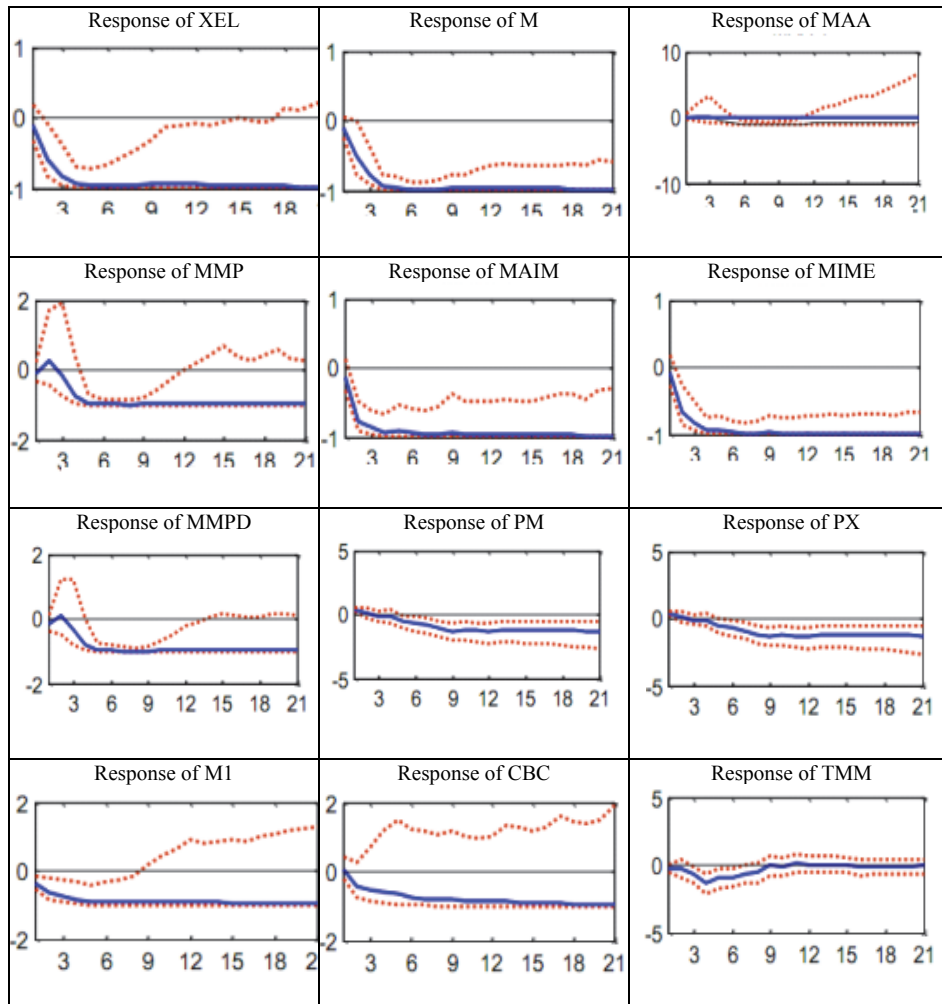
4.5. Impact of a decrease in foreign money supply

The impulse responses of Tunisian variables following a shock hitting the growth of the foreign money supply are represented in Figure 5. This shock is defined as one standard deviation decrease in the foreign money supply. Indeed, the decrease of the international money supply due to the world financial crisis

has led to a fall of Tunisian demand for goods. We also notice an immediate fall of the level of Tunisian exports (X) and a decline in the industrial production index (IPI) from the first quarter. These effects have affected the agricultural sector (IPIAA) and industrial goods (IPIME and IPIMD) as well as energy products (PMN, XPE, XMP, XMPD and XEL). As for the Tunisian imports, the decline was highly significant in the first period (MMP, MAIM, MIME and MMPD). As a whole, the Tunisian money growth (M1) registered a sharp decline.

Figure 5: impulse responses due to the reduction of the foreign currency





4.6. Impact of a decrease in foreign interest rate

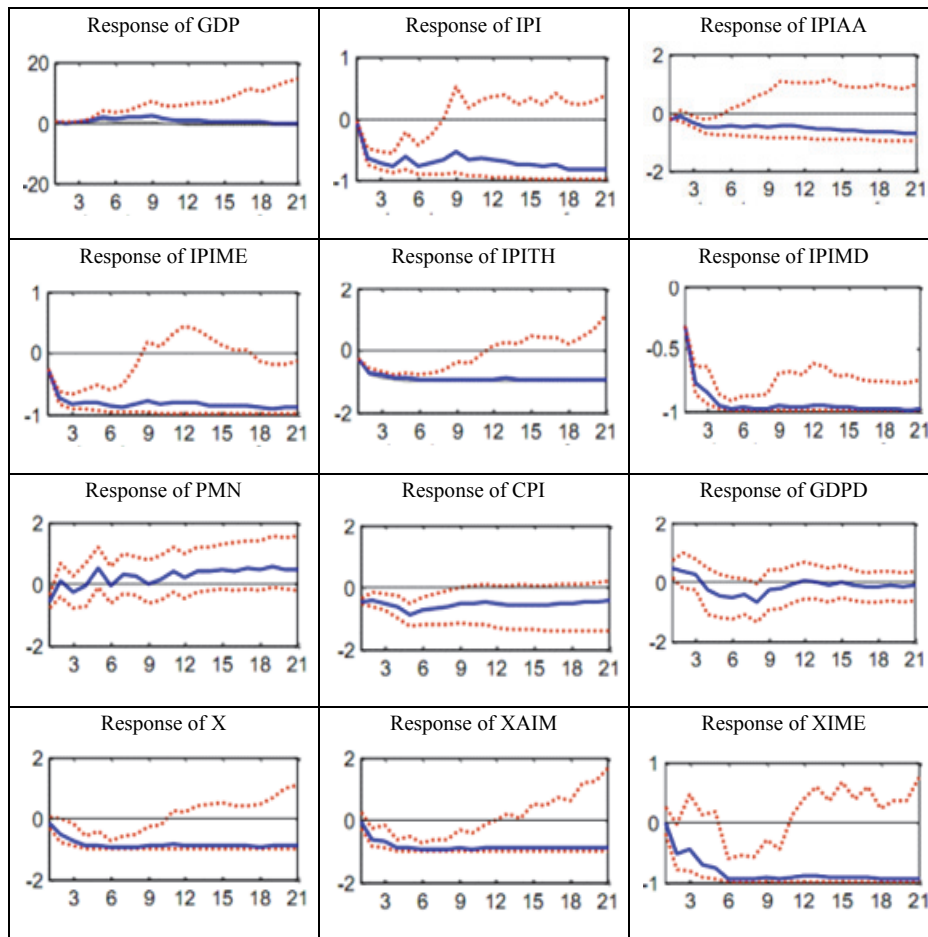
By testing the dynamic effects of an unanticipated one standard deviation fall in international interest rates, Figure 6 showcases the impact of a shock to the foreign interest rate in our FAVAR framework on the Tunisia's economic indicators. The international financial crisis has generated deflationary effects that forced monetary authorities to lower their key rates. This decision was transmitted to developing countries and particularly Tunisia through the imbalance in its trade balance.

The fall of the Tunisian economic activity is apparent through the fall of the industrial production indices (affecting food sector IPIAA, mechanical and electrical sector IPIME, textiles and clothing sector IPITH and mine production PMN), the fall in exports (including manufacturing industries XAIM and me-

chanical and electrical industries XIME) and the decrease in imports (food MAA, mining and phosphates products MMP, textiles and clothing MTH, other manufacturing industries MAIM, mechanical and electrical industries MIME and mines, phosphates and derivatives MMPD).

As regards the interest rate, the transmission of external shocks takes two months to trigger the fall of Tunisia's interest rates. Indeed, it is in order to counter the slowdown in economic activity that the central bank of Tunisia was constrained to lower its key rate.

Figure 6: Impulse responses due to a decline in foreign interest rate



4.7. Reduction in the price of raw materials

Several previous studies (Sims, 1992; Vasishtha and Maier, 2011) report the high sensitivity of the fundamentals of developing countries to fluctuations of world commodity prices. Tunisia is not immune from this phenomenon.

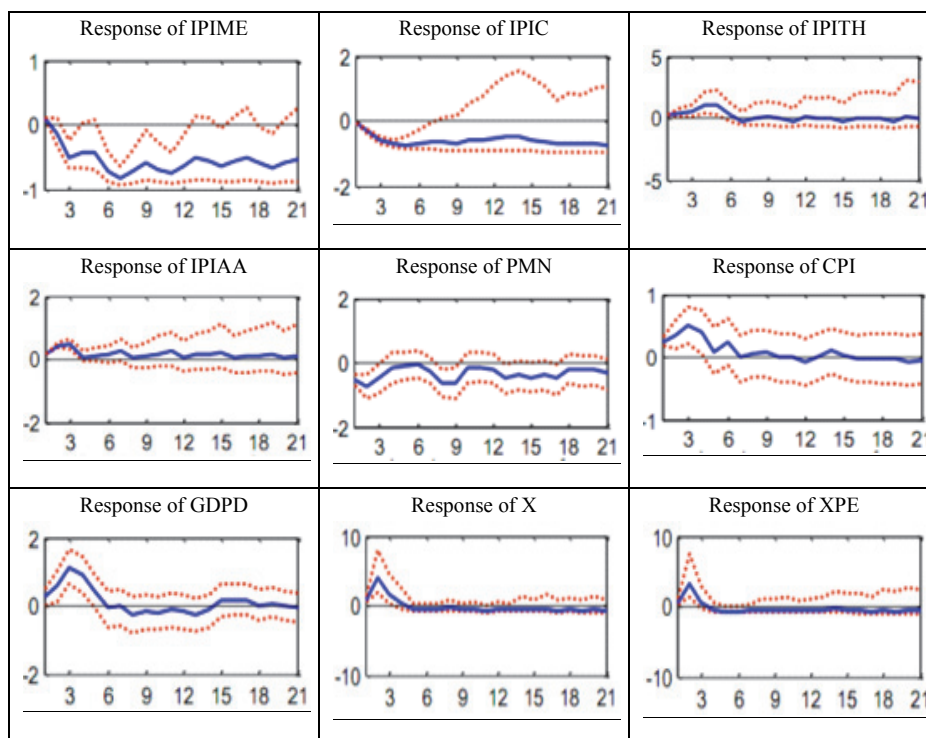
To examine the role of the oil price shock, we placed it in the foreign block of the FAVAR model. As Tunisia is a "price taker," the oil price is expected to affect the Tunisian macroeconomic variables and not the other way around. Figure 7 shows the effects of a one standard deviation shock hitting the oil price on the Tunisia's main macroeconomic variables. Indeed, an oil price shock causes a short-term increase of MMA, MMP and MEL that vanishes after 3 quarters. Additionally, an oil price shock has a similar effect on XPE and XEL.

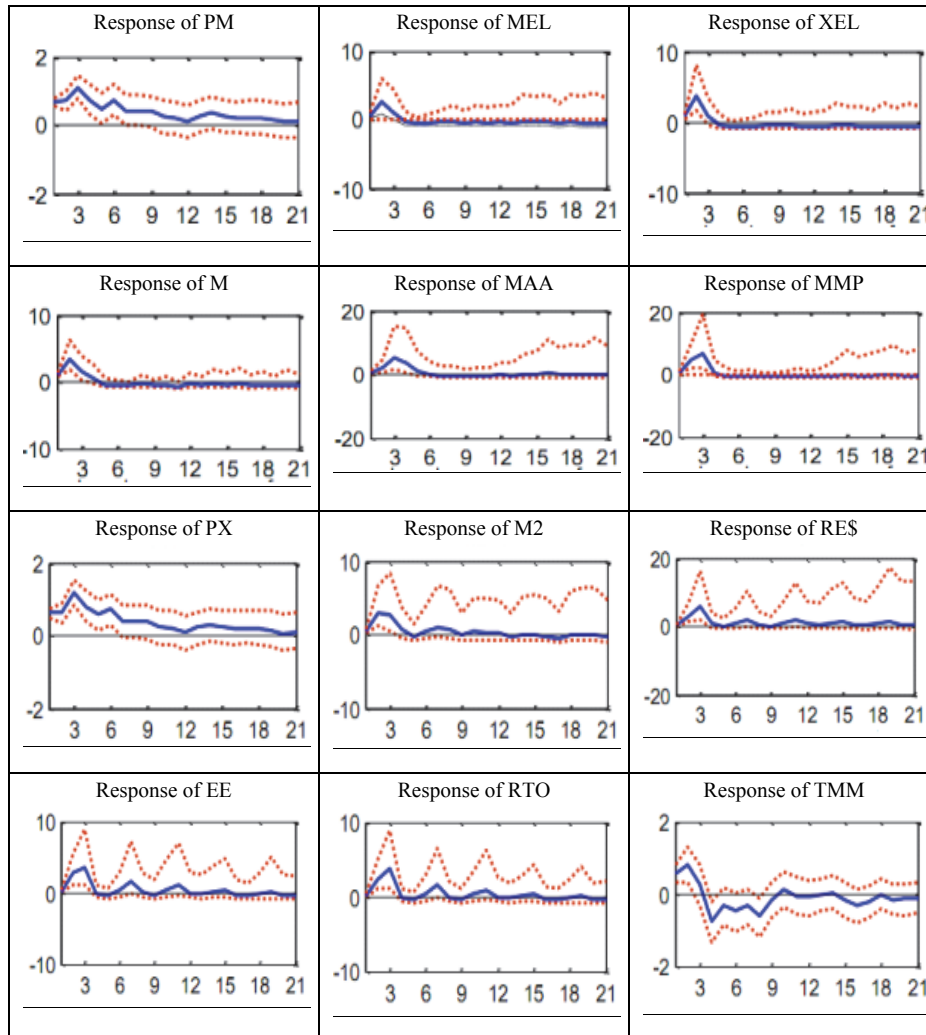
The decline in oil price has been beneficial for the Tunisian economy in two ways. At the macroeconomic level, it has improved the trade balance, since the fall of the price of a barrel reduced the import bill (food and agricultural products - MAA and mining Products and phosphate - MMP and Energy and lubricants - MEL).

Furthermore, for exporting companies (energy products - XPE and energy and lubricants - XEL), the fall in oil prices and the ensuing lower production costs helps to improve their competitiveness.

The decline in oil price has also driven the fall of inflation (GDPD) since three quarters after the occurrence of the shock and the interest rate (TMM) after two periods which helps increase the money supply (M2). Indeed, the fall in oil prices does not have the desired effect on the index of prices given that the prices of energy products are administered in Tunisia.

Figure 7: Impulsive response due to the reduction in the oil price





5. CONCLUSION

During the last decades, Tunisia has reinforced its integration into the global economy. This growing international economic integration increased its vulnerability to external shocks. The subprime mortgage crisis provides a vivid example of an economic event which was transmitted to the Tunisian economy via foreign demand and deterioration of the outside conditions.

To better understand how the world economic events were transmitted to Tunisia, we estimate an open-economy FAVAR model. This method allows to integrate a wide set of information, which will be then summarized by a small number of factors that will be introduced in standard VAR for analysis. We show how to identify and estimate a FAVAR model via a 2-step method. The

first step is based on the selection of the main factors impacting the Tunisian economy using a principal components approach while the second on the Bayesian method which is based on the Gibbs sampling algorithm. Another key advantage of the FAVAR approach is that it allows handling a large set of variables.

In contrast to the existing literature on the transmission of international shocks, we use a set of data incorporating 11 countries (Tunisia and 10 European and industrialized countries) and 211 variables covering their respective economic activities, prices and monetary indicators to model the interaction between the national and foreign blocks of the VAR. The FAVAR methodology allows to quantifying the effects of the world evolution on a wide range of Tunisian macroeconomic variables. We focus on four big types of foreign developments: foreign economic activity, foreign inflation, foreign interest rates and commodity prices. Our results indicate that Tunisia is mainly exposed to the shocks of the foreign activity and commodity prices.

The decline in foreign economic activity has mainly affected the economic indicators such as Tunisia's exports of manufactured products and mechanical and electrical goods, which contributed to the degradation of Tunisia's trade balance. The high sensitivity of the Tunisian economy to the global economy and more specifically to the euro area shocks, finds its explanation in the privileged relationships that link Tunisia to its European partners.

Contrary to the conclusions of Mumtaz and Surico (2009) related to the United Kingdom, the reduction of foreign interest rates is relatively less important for Tunisia which reflects the delay of the Tunisian financial sector compared with international standards of good governance and performance.

The decline in the commodity prices has been beneficial for the Tunisian economy. It has improved the trade balance, in the sense that the fall of the price of a barrel reduced the import bill. As for the exporting companies, the fall in oil prices and the ensuing lower production costs helped to improve their international competitiveness. Overall, our results offer insights for Tunisian decision makers so that they can better understand the global economic cycle.

There are several ways to further extend this analysis. Given the steady openness of Tunisia's trade dealings (imports and exports alike), the global economic cycle has become increasingly important for Tunisia, and as such extending the sample is likely to be worthwhile. The countries in an extended sample may include more economic partners of the Tunisian economy like China and many African countries with which Tunisia is expanding its trades and investments. Moreover, future work could cover a closer investigation of the properties of FAVARs, the estimation methods and possibly alternative identification schemes.

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Appendix. Description of the data

Data time series are from the IFS, the OECD (Main Economic indicators) and central banks of the considered countries. According to Bernanke et al. (2005), we divide the variables into subpanels: those with slow movement (S) and those with fast movement (F). All variables are then deseasonalized and stationarized. Below is a detailed description of data.

Industrial production (IPI)

All the countries: index of the total production of the industry, the seasonally adjusted data, 2005=100, Source: IFS

Exports(X)

All the countries: volume of the exports in Millions of US dollars, not seasonally adjusted data, Source: IFS.

Imports (M)

All the countries: volume of imports in Millions of US dollars, not seasonally adjusted data, Source: IFS.

Unemployment (CH)

All the countries: unemployment rate, in percentage, not seasonally adjusted data, Source: IFS.

Gross domestic product (PIB)

All the countries: index of the production, 2005=100, not seasonally adjusted data, Source: IFS

Gross National Income (GNI)

All the countries: Gross National Income, in national currency, seasonally adjusted data, Source: IFS.

Index of Consumer Price (CPI)

All the countries: index of the consumer price, 2005=100, not seasonally adjusted data, Source: IFS and OECD (Main Economic Indicators).

Import Prices (PI)

All the countries: index of the price of import, 2005=100, not seasonally adjusted data, Source: IFS.

Wages (S)

All the countries: unit cost of the work, Source: IFS.

International reserves (RI)

All the countries: international Reserves in millions, unit: SDR, Source: IFS.

Money growth (CM)

We use the series M1 for all the countries, except for the United Kingdom where we use M4, France M3 and Italy M2. The main source of data is IFS exception France M3 and Italy M2. The main source of data is IFS exception:

*France: central Bank of France.

*Italy: central Bank of Italy.

Treasury Bill Rate (TBR)

All the countries: rate of the short-term Treasury bonds, in percentage, Source: IFS.

Discount rate (DR)

All the countries: discount rate at the end of period, in percentage, Source: IFS.

Money market rate (TMM)

All the countries: rate of the money market, in percentage, Source: IFS.

Short-term interest rate (TICT)

source of data IFS and OECD (Main Economic Indicators).

* France: 3-month PIBOR

* Italy: 3-month interbank rate on deposits

* Germany: 3-month FIBOR

* Australia: Yield 90-day Bank accepted bills

* Spain: Interbank loans - 3month

* Denmark: 3-month uncollateralized interbank rate

* Canada: 3-month corporate to paper rate

* Japan: Rate New 90 to less than 120 CDS

* United Kingdom: 3-month means LIBOR / LIBID

* US: spleen 3-month CDS

Long-term interest rate (TILT)

* France, Germany, Italy, Denmark, Spain and United Kingdom: long term government bond yield (10 years), Source: Eurostat

* Australia: Commonwealth government bond Yield (10 years), Source: bank of Australia.

* Canada: Government bond yield: 10 years benchmark (the End of the month), Source: CANSIM - Statistics of Canada

* Japan: Interest bearing government bonds - 10 years, Source: OECD (main economic indicators).

* The United States: Government bond yield (10 years).

Tunisia variables

Variables	Acronym	S ou F	Stationarization
1-GDP	GDP	S	Log-first difference
2-Index of the Production manufacturer- total index	IPI	S	Log-first difference
3-Index of the industrial Production Food-processing industries	IPIAA	S	Log-first difference
4-Index of the industrial Production Materials of Ceramic construction and Glass	IPICV	S	Log-first difference
5-Mechanical and electric industrial Index of the Production	IPIME	S	Log-first difference
6-Index of the industrial Production Chemistry	IPIC	S	Log-first difference
7-Index of the industrial Production Textile, Clothing and Leather	IPITH	S	Log-first difference
8-Index of the industrial Production Diverse Manufacturers	IPIMD	S	Log-first difference
9-Index of the industrial Production- Mines	IPIM	S	Log-first difference
10- Industrial Production Energy Index	IPIE	S	Log-first difference
11-Mining Production	PMN	S	Stationary
12-Exportation-Total	X	F	Log-first difference
13-Exportation-Farm Products and Basic Food.	XAA	F	Log-first difference
14-Energy Exportation-Products	XPE	F	Log-first difference
15-mining Exportation-Products and phosphate	XMP	F	Log-first difference
16-Exportation-Textile, clothing and leather	XTH	F	Log-first difference
17-Exportation-Diverse manufacturing industries	XAIM	F	Log-first difference

18-Exportation-Mechanical and electric engineering industries	XIME	F	Log-first difference
19-Exportation-Mine phosphates and by-products	XMPD	F	Log-first difference
20-Exportation-Energy and lubricants	XEL	F	Log-first difference
21-Importation-Totale	M	F	Log-first difference
22-Import - Farm products and basic food	MAA	F	Log-first difference
23-Import - EnergyProducts	MPE	F	Log-first difference
24-Import - mining Products and phosphate	MMP	F	Log-first difference
25-Import - Textile, clothing and leather	MTH	F	Log-first difference
26-Import - Diverse manufacturing industries	MAIM	F	Log-first difference
27-Import – Mechanical and electric engineering industries	MIME	F	Log-first difference
28-Import - Mine phosphates and by-products	MMPD	F	Log-first difference
29- Importation - Energy and lubricants	MEL	F	Log-first difference
30-Tourism-Entry of the non residents	TENR	F	Log-first difference
31- CPI- General	CPI	S	Stationary
32- GDP deflator	GDPD	S	Stationary
33- Import Price	PM	F	Stationary
34- Export Price	PX	F	Stationary
35-Monetary aggregate M1	M1	F	Log-first difference
36--Monetaryaggregate M2	M2	F	Log-first difference
37- Foreignreserve in millions \$	RES	F	Log-first difference
38- Foreignassets	AE	F	Log-first difference
39- Foreign exchange	EE	F	Log-first difference
40-Total reserve of gold	RTO	F	Log-first difference
41-Bank deposit: active	DAB	F	Log-first difference
42-Bank deposit: passive	DPB	F	Log-first difference

43- MonetaryReserves, Money NLE	RM	F	Log-first difference
44-foreign Liabilities	PE	F	Log-first difference
45-Deposit of government	DG	F	Log-first difference
46-Major Account	CC	F	Log-first difference
47-Credit of the central bank	CBC	F	Log-first difference
48- Foreign reserves to the month of imports	REMI	F	Log-first difference
49-Real exchange rates	TCR	F	Log-first difference
50-Exchange rates of \$ in Dinars	TCS	F	Log-first difference
51-Rates of the money market	TMM	F	First difference
52-Rates of nominal effective exchange	TCEN	F	Log-first difference
53-Rates of real effective exchange	TCER	F	Log-first difference

TRANSMISSION DES CHOCS INTERNATIONAUX À UNE PETITE ÉCONOMIE ÉMERGENTE : CAS DE LA TUNISIE

Résumé - Cet article étudie comment les chocs internationaux sont transmis à des économies émergentes comme la Tunisie. La littérature empirique sur la transmission des chocs internationaux est basée principalement sur une modélisation VAR structurel à petite échelle. Dans cet article nous utilisons un modèle VAR enrichi de facteurs (modèle FAVAR) et un large panel de données comportant 211 séries relatives à 11 pays européens et industrialisés pour analyser l'impact des chocs mondiaux suite à la crise financière internationale de 2008 sur l'économie tunisienne. Cette spécification a l'avantage d'exploiter un grand nombre de variables pouvant influencer la conduite de la politique monétaire et qui peuvent accélérer le mécanisme de transmission des chocs monétaire externes à l'économie nationale. Nous nous intéressons principalement à certaines sources de chocs telles que la baisse non anticipée de l'activité économique mondiale, du taux d'intérêt et du prix des matières premières. Nos résultats montrent que la Tunisie est exposée essentiellement aux chocs de l'activité économique étrangère et des prix des matières premières. En revanche, elle est beaucoup moins exposée aux chocs concernant les taux d'intérêt étrangers ou l'inflation mondiale. Nos résultats montrent aussi que les canaux par lesquels se transmettent les chocs externes sont principalement des canaux réels.

Mots-clés : TRANSMISSION INTERNATIONALE, TUNISIE, MODÈLE FAVAR, CRISE ÉCONOMIQUE