Tunisia: Sources Of Real Exchange Rate Fluctuations

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Abstract

Using structural VARs identified with long-run restrictions, this paper evaluates the importance of nominal shocks and real disturbances on the Tunisian Dinar during the nineties. The estimated macroeconomic behaviour in response to the shocks identified with a Clarida and Gali–type structural VAR for Tunisia is generally in line with theoretical priors stemming from the Mundell-Fleming model. The structural decomposition shows that relative real demand and supply shocks account for most of the variations in real exchange rate changes during the estimation period and indicates that real disturbances explain about 80% of the variance of the forecast error of the real exchange rate.

Keywords: Tunisia, real exchange rate, structural VAR

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I. Introduction

During the last two decades, Tunisia has undertaken several reforms in the conduct of monetary and exchange rate policy. These reforms have generated a growing interest in assessing the performance of exchange rate policy and modelling the determinants of the dinar exchange rate. Most of the existing literature has focused on the estimation of the equilibrium exchange rate and on the valuation of its misalignment relative to this equilibrium. Coudert (1999) estimates the equilibrium exchange rate for a set of 16 countries including Tunisia using a purchasing power parity (PPP) approach and found that the misalignment have decreased since 1986. Domaç and Shabsigh (1999) also estimate a behavioural equilibrium exchange rate on the basis of certain fundamental determinants for Tunisia, Morocco, Jordan and Egypt between 1970 and 1995. Their results show evidence of significant currency overvaluation with reduced their economic growth. In a recent paper prepared for the International Monetary Fund (IMF), Fanizza and al (2002), find by estimating the equilibrium exchange rate based on fundamental variables and by analysing a number of standard competitiveness indicators, no evidence of misalignment. More recently the IEQ (2003)[1], have estimated the equilibrium exchange rate in Tunisia between 1961 and 2000 using a set of fundamental determinants of the actual real exchange rate. The results indicate that Tunisia's real effective exchange rate followed closely the equilibrium rate predicted by the model.

The purpose of this paper is to contribute to the discussion of the real exchange rate in Tunisia from a different angle. Instead of assessing the equilibrium exchange rate, we try to identify the dynamics and forces driving the real exchange rate variations over the last two decades. Understanding the underlying sources of the real exchange rate fluctuations in Tunisia is crucial since it play a key role in establishing the degree of competitiveness of the economy and in reflecting its performances. Furthermore, the movements of the real exchange rate in emerging economies like Tunisia may influence inflation and output and can have detrimental effects on the balance of payments.

We construct a structural vector autoregression (SVAR) model, on the line of Clarida and Gali (1994), to assess the relative importance of three types of shocks, which in the traditional IS-LM framework, could be referred to as the aggregate supply shocks, aggregate demand shocks, and nominal demand shocks. The structural VAR decomposition is based on the Blanchard-Quah (1989) approach implying that nominal (monetary) shocks have no long-run impact on the levels of output and the real exchange rate and that real demand shocks have no long-run impact on the level of output. It indicates that real demand and supply shocks accounted for most of the fluctuations in the real exchange rate movement during the estimation period, whereas nominal shocks were less important.

The remainder of this paper is structured as follows. In the next section, we provide an overview of exchange rate policy in Tunisia with a particular attention to real exchange rate evolution. Section III provides a brief discussion of the theoretical and empirical literature. Section IV describes our methodology. Section V presents preliminary data analysis, Section VI discusses the main empirical results from the estimation; and Section VII concludes.

[1] Institut d'Economie Quantitative.

II. Exchange Rate Regime and Developments: A Historical Overview

As many economies worldwide, Tunisia has experienced many of the menu options of exchange rate policies in the last 30 years. The quest for a reasonable exchange rate policy has been inspired in part by the different goals that, through these three decades, policy makers have attempted to achieve with this policy. In the early 70's, the authorities chose to peg their currency to the French Franc, given the importance of France as its principal trading partner. Following the demise of the Bretton-Woods system of fixed exchange rate system in 1973, Tunisia decided to move away from a fixed value relative to the French Franc to peg to a basket that was first composed of three currencies (French Franc, Deutschmark and the U.S Dollar) and that was widened in the early 80's by including the Italian Lira[2]. Since 1985, the objectives of promoting Tunisia's exports and enhancing the external competitiveness perused by the Tunisian government, in conjunction with some other international considerations forced the authorities to widen even more the basket and to incorporate currencies like the Belgian Franc, Dutch Florin and the Spanish Peseta[3].

During the 90's, Tunisia made significant progress in opening the external sector[4]. This strategy aimed at ensuring a competitive environment for domestic enterprises and products. In 1992, the authorities decided to introduce a more flexible exchange rate regime by targeting the Real Effective Exchange Rate (REER) through regular adjustments in the value of the nominal exchange rate and established the convertibility of the dinar for the non-residents. This exchange rate policy combined with very prudent and sound monetary and fiscal policies helped the country not only to ovoid currency and financial crises, but it also contributed to reduce inflation from 8% in 1991 to nearly 3% since 2000 and to establish a credible commitment to macroeconomic stability Fanizza and al (2002)[5]. Since 2000, in accordance with the IMF advice, the Central Bank of Tunisia (BCT) has reduced its intervention in the foreign exchange market and allowed for more flexibility in the exchange rate by adopting a managed float. This current regime is considered as an intermediate step toward a floating exchange rate regime.

The exchange rate policy undertaken by the Tunisian authorities has allowed the country to record remarkable economic performances (Table 1). It also permitted to the BCT to achieve its objectives of maintaining the real exchange rate in constant level to a composite basket of currencies of its main trading partners and to support competitiveness and export growth. With regard to REER dynamics it is clear that the exchange rate policy combined with appropriate structural reforms have resulted in a gradual depreciation of the REER that started in 1986 (Figure 1). It is also evident that the sharp devaluation of the dinar that took place in the same year[6] combined with a gradual process of trade liberalization and restrictions dismantlement has had a significant impact on exports growth and contributed to ensure a sustainable trend[7] (Figure 2).

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[2] This was partly justified because Italia was at that moment the third most important trade partner following France and Deutschland.
[3] The Basket consisted of 7 currencies for 19 countries that represented nearly 90% of Tunisia's total trade. The Weighting in the Basket have nevertheless never been disclosed but we can assume that the French Franc carried an important weight in this Basket, given its continued importance in trade with Tunisia.
[4] Tunisia Joined the World Trade Organization (WTO) in 1994 and signed an Association Agreement with the UE in 1996 witch will result in the elimination of tariffs imposed on European goods by 2009.
[5] See also IMF country Report N°02/120.
[6] The BCT let the dinar depreciate by nearly 40% over the period 1984 to 1986.
[7] Belgium, Egypt, France, Germany, Italy, Japan, the Netherlands, Spain, the United Kingdom and the United States account today for more than 90 percent of Tunisian exports. For more details on Tunisia's trade potential see IMF country Report N°04/360.

III. Theoretical Background and empiric literature

The theoretical framework that we consider hinges on Clarida and Gali (1994) which is based on the pioneering Mundell-Fleming-Dornbusch model. The stochastic rational expectations open macro model derived by Clarida and Gali (1994) is a version of the one developed by Obsfeld (1985). It also draws on previous papers of Dornbusch (1976) and Flood (1981)[8] and illustrates how the Mundell-Fleming-Dornbusch model can be used as a baseline framework to identify three different types of shocks in the economy. The representation of this model is sketched in the following four equations:

$$Y_t^d = d_t + \eta(s_t - p_t) - \sigma[i_t - E(p_{t+1} - p_t)] \qquad (1)$$

$$p_t = (1-\theta)E_{t-1}p_t^e + \theta p_t^e \qquad (2)$$

$$m_t^s - p_t = Y_t - \lambda_t i_t \qquad (3)$$

$$i_t = E_t(s_{t+1} - s_t) \qquad (4)$$

Equation (1) is an open economy IS equation in which the demand for home output relative to foreign output (Y_t^d) depends positively of the real exchange rate ($s_t - p_t$) and the relative demand shock d_t and negatively of the real interest differential in favour of the home country. Equation (2) is a price setting equation in witch the price level in period t is an average of the market clearing price expected in t-1 to prevail in t and the price that would clear the output market in period t[9]. Equation (3) is a standard LM equation and equation (4) is a statement of interest parity Clarida and Gali (1994)[10].

Shocks in the stochastic open macro model can be categorized into three types (to money, supply and demand). Under the assumption of a sluggish prices and output adjustment, these shocks influence the levels of prices, output and real exchange rate in the short run in accordance with the traditional Mundell-Fleming-Dornbusch model; nevertheless the system is expected to converge to equilibrium in the long run once price adjusted fully to all shocks. Therefore, only supply shocks (such higher productivity growth) are expected to have an impact on the level of relative output in the long run. Also, supply and demand shocks (such as changes in relative government spending) are expected to influence the long run level of real exchange rate. Finally, both real supply shocks and nominal monetary shocks (such as monetary policy shocks, money demand shocks and effects of financial liberalization) are expected to influence the long run level of prices.

Following the influential work of Blanchard and Quah (1989) based on a bivariate structural VAR model for output and unemployment; several studies have tried to investigate the sources of real exchange rates fluctuations. Bayoumi and Eichengreen (1992) was among the first to analyse exchange rate variations using the Blanchard and Quah (1989) approach. They

[8] See also Mussa (1982).
[9] When θ=1, prices are fully flexible and output is supply determined. When θ=0, prices are fixed and determined 1 period in advance.
[10] For details on model solution see Clarida and Gali (1994).

distinguish demand and supply shocks by assuming that demand shocks have no long run effects on output whereas supply shocks have permanent effects. Their empirical results, for the G-7 countries, indicate that the shift from the Bretton Woods system of pegged exchange rates to the post Bretton Woods float can be explained by a modest increase in the cross-country dispersion of supply shocks but not their magnitude. Lastrapes (1992) carry out the same analysis for six industrialized countries over the period 1973 to 1989. He identifies two types of structural disturbances, nominal and real shocks. He also restricts nominal shocks to have no long-run impact on the real exchange rate level. His results indicate that for all countries real shocks account for the major part of both real and nominal exchange rate fluctuations. Another important paper is due to Clarida and Gali (1994) whose framework is employed in our work. It specifies a trivariate VAR model and identifies three types of structural disturbance; real aggregate supply shocks (those which can influence the level of all three variables in the long run), real aggregate demand shocks (those which have no long-run impact on the real output level) and nominal shocks (those which only affect the price level in the long run). The empirical analysis, undertaken for four industrialized countries (Germany, Japan, the UK and Canada) over the floating period 1973 to 1992, suggest that in the former two countries nominal disturbances explain a substantial amount of the variance in the real exchange rate against the dollar (41% of the unconditional variance of the change in the dollar-deutschmark real exchange rate and 35% of the variance of the change in the dollar-Yen real exchange rate) whereas in the latter two the real exchange rate fluctuations are mainly driven by real demand shocks. Since a detailed review of existing studies including an explanation of their methodological differences is beyond the scope of this paper, suffice it to say that these studies set a benchmark for researchers seeking to explain real exchange rate movements[11].

IV. Implementation of the Methodology

The log of the real exchange rate, the log of the relative output and the log of relative consumer price indexes (CPI) are the three variables in the first system. To justify the appropriateness of the structural VAR, we need to show that each individual series are integrated of order one and that they follow different stochastic trends in the long run (they are not co-integrated)[12]. Using first differences we assume that the vector $\Delta X_t = [\Delta Y_t, \Delta q_t, \Delta p_t]'$,where Δ denotes the difference operator, $Y_t = (Y_t^{Home} - Y_t^{Foreign})$ is the difference between the real income in home country and the real income abroad, $q_t = (e_t - p_t)$ is the real exchange rate of the domestic currency against the foreign currency, e_t is the nominal exchange rate and $p_t = (p_t^{Home} - p_t^{Foreign})$ is the difference between the domestic price level and the price level abroad, has a structural interpretation given by:

$$\Delta X_t = C(L)\,\varepsilon_t \qquad (1)$$

Where L is the lag operator and $\varepsilon_t = [\varepsilon_s\ \varepsilon_d\ \varepsilon_f]'$ is a $(n \times 1)$ vector of structural shocks with covariance matrix $\Sigma\varepsilon$ that could be respectively interpreted as: relative supply shocks, relative real demand shocks and relative nominal shocks. We assume that the structural shocks have no contemporaneous correlation and they are not autocorrelated. This implies that $\Sigma\varepsilon$ is a diagonal matrix.

[11] Table 2 summarizes the approaches and findings of these studies with regard to the sources of real exchange rate fluctuations.
[12] If the three series are non stationary but co-integrated with each other then the VAR model should be replaced by an error correction representation.

Suppose that true form of the model can be represented by the following infinite moving average (VMA) process:

$$\Delta X_t = A(L)\, u_t \qquad (2)$$

Equations 1 and 2 imply a linear relationship between ε_t and u_t.

$$u_t = C_o\, \varepsilon_t \qquad (3)$$

Where C_o is a 3X3 matrix that defines the contemporaneous structural relationship among the three variables and that need to be identified for the vector of structural shocks ε_t to be recovered from the estimated disturbance vector u_t. We than need nine parameters to convert the residuals from the estimated unrestricted VAR into original shocks that drive the behaviour of the endogenous variables. Of these nine, six are given by the elements of $\Sigma u = C_o C_o'$ and therefore we only need three more identifying restrictions[13]. Blanchard and Quah (1989) suggest that we can use economic theory to impose these restrictions. Following Clarida and Gali (1994), three additional restrictions on the long run multipliers are imposed while the short run dynamics are freely determined. The three restrictions are; only supply shocks (ε_s) are expected to influence relative output levels in the long run, while both supply and demand shocks (ε_s and ε_d) are expected to influence the real exchange rate in the long run. Finally monetary shocks are expected to have no long run impact on either relative output levels or the real exchange rate. The long run representation of equation (1) can be written as:

$$\begin{bmatrix} \Delta Y_t \\ \Delta q_t \\ \Delta p_t \end{bmatrix} = \begin{bmatrix} C_{11}(1) & C_{12}(1) & C_{13}(1) \\ C_{21}(1) & C_{22}(1) & C_{23}(1) \\ C_{31}(1) & C_{32}(1) & C_{33}(1) \end{bmatrix} \begin{bmatrix} \varepsilon_S \\ \varepsilon_d \\ \varepsilon_f \end{bmatrix}$$

Where $C(1) = C_o + C_1 + C_2 + \dots\dots\dots$ are the long run multipliers of the structural VAR (long run effect of ε_t on ΔX_t).

Using the Clarida and Gali's (1994) identifying restrictions, amounts technically to impose that the long run multipliers C_{12}, C_{13} and C_{23} are equal to zero which make the matrix C (1) upper triangular[14].

V. Preliminary Data Analysis

This section examines the time-series properties of the variables included in the analysis. The data used in this study range from January 1993 to December 2002 and are obtained from the BCT statistics, Eurostat and the IMF's international financial statistics[15]. We use the relative income and prices differentials against the Euro Area aggregates as our system variables since

[13] The six restrictions imposed by the symmetric matrix Σu are the three estimated variances and the three covariances of the VAR residuals.

[14] The three additional long run restrictions that are imposed in the model are sufficient to identify the structural matrix C_o and to recover the structural system dynamics defined by C1, C2 … as well as the time series of structural shocks. See Clarida and Gali (1994) for details.

[15] The sample range was constrained by data availability for Tunisia.

we are only interested in relative or asymmetric shocks with regard to the EU. Since monthly data for Tunisa's GDP is not available we use the industrial production index as a proxy. The real bilateral exchange rate of the Tunisian dinar against the Euro is considered in the analysis. Finally, the relative price level is defined as the Tunisian CPI minus and the EU CPI. All variables are in logarithms so that their differences can be interpreted as the rate of change in the underlying variable.

In order to properly specify the VAR, we first determine the time series properties by testing for unit roots and stationarity. Figure 3 plots the three variables used in the VAR, it is clear that with the possible exception of the relative output, the other variables have trended over the period and it is therefore necessary to determine whether the variables are stationary around stochastic or deterministic trends. Table 3 presents a number of univariate stationarity tests for the data. The table indicates that null hypothesis of a unit root for the relative output, the real exchange rate and the relative price can not be rejected against the hypothesis of stationarity around a deterministic trend. Both the Augmented Dickey Fuller (ADF) and the Phillips-Perron test (PP) statistics are smaller than the 5% critical value for the variables[16]. To confirm that the variables are first difference stationary, tests statistics for the first differences of the variables were computed. We find that the tests statistics are greater than their respective 5% critical values, the variables are consequently first difference stationary.

Having established that the individual time series are integrated of order 1, the next step is to check whether the variables are cointegrated. As explained before, even if there is no economic reason to expect them to be cointegrated, we have to show that the relative output, the real exchange rate and the relative price level are not cointegrated to justify the appropriateness of the structural VAR. Otherwise, the VAR model should be replaced by an error correction representation. There are a number of techniques for testing for and estimating cointegrating relationships in the literature. Of these techniques, the Johansen (1988) and Johansen and Juselius (1990) maximum-likelihood test procedure is the most efficient as it tests for the existence of a third cointegrating vector[17]. This procedure gives two likelihood ratio tests for the number of cointegrating vectors: (a) the *maximal eigen value test*, which tests the null hypothesis that there are at least r cointergration vectors, as against the alternative that there are r+1, and (b) the *trace-test*, where the alternative hypothesis is that the number of cointegrating vectors is equal to or less than r+1. In order to implement Johansen's procedure we need to determine the optimal lag length in the VAR system. The lag length of the chosen VAR was 3. Our procedure for choosing the optimal lag length was based on the Akaike, Schwarz and Hannan-Quinn information criteria as well as the liquidity ratio test (AIC, SC, HQ, and LR, respectively). The residuals from the chosen VAR were then checked for whiteness. Table 4 presents cointegration test results based on Johansen's maximum-likelihood procedure. Test results indicate that there is no evidence of cointegration among the three variables in consideration.

VI. Estimations results

This section presents results from the empirical implementation of the structural VAR analysis developed previously. We present the impulse responses of each of the variables to one standard deviation in each of the fundamental shocks and compute variance decompositions of the forecast errors based on the VAR analysis.

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[16] The PP test has an advantage over the ADF test as it gives robust estimates when the series has serial correlation and time-dependent heteroscedasticity, and there is a structural break.

[17] The optimality of Johansen's estimation technique has been shown by Phillips (1991) in terms of symmetry, unbiasedness and efficiency properties. Gonzalo (1994) also showed the superior proprieties of the Johansen estimation technique relative to several other techniques.

Figure 4 illustrates the impulse response functions of the explanatory variables to one standard deviation structural shocks. The results are broadly in line with most conventional models of the open economy. The top panel shows that supply shocks accounts for most of the variations in relative output and leads to a permanent increase in it. Positive real or nominal demand shocks have smaller effects and leave the long run relative output level unaffected. The centre panel demonstrates that a positive supply shock leads a persistent appreciation of the real exchange rate. This result is inconsistent with the predictions of the traditional Mundell-Fleming model since we expect the real exchange rate to depreciate in the long run. However Thomas (1997) find a similar impulse response profile for the Swedish krona real exchange rate[18]. A positive real demand shock is associated with a permanent appreciation of the real exchange rate while a nominal shock has a temporary depreciating impact on the real exchange rate and asymptote to zero as imposed by long run restrictions. Finally, the last panel shows that the response impulse of the relative price level is totally consistent with economic theory as it drops immediately and permanently after a supply shock. We also can see that demand and nominal shocks have positive permanent effects on relative prices as predicted by the Mundell Fleming model.

To shed light on the question of the sources of real exchange rate fluctuations in Tunisia, in a second step of our analysis we calculate the forecast error variance decompositions[19]. While impulse responses are useful in assessing the signs and magnitudes of responses to specific shocks by revealing the dynamic effects of one time shock, variance decomposition is a convenient measure of the relative importance of such shocks to the system. Table 5 shows for each variable the fraction of the forecast error variance at different horizons which can be attributed to each shock in the model. Supply shocks account for roughly half of the variance in output growth throughout the estimation horizons and represent the most important factor for variation in the forecast errors of relative output, while the rest of the variance is attributable to demand and nominal shocks in similar fractions (around 25%). The estimates imply that real shocks (supply and demand) explain a substantial amount of the variance of output growth. This result is consistent with the previous findings of Clarida and Gali (1994) for the G-7 countries, Thomas (1997) for Sweden, Hoffmaister and Roldós (2001) for Korea and Wang (2004) for China.

Forecast error variance decompositions for the variations in the real exchange rate suggest that relative real demand and supply shocks explain most of the movements in the real exchange rate. Real demand shocks are the most important factors, especially in the short run, and account for about two-third of the variance in exchange rate movement. During the first three years after the shock, between 51% and 71% of the forecast error variance of the rate of change in the real exchange rate is due to relative demand shocks. At the same time, supply shocks appear to play a very weak role in explaining fluctuations in the real in exchange rate in the short run, accounting only for roughly 7% of the forecast error variance during the first year after the shock. Nevertheless, the importance of supply shocks increases over the long run, accounting for more than 40% four years after the shock. The contribution of nominal shocks to the fluctuations of the real of the real exchange rate amounts to between 12% and 20%. To summarize, a substantial amount of the forecast error variance of the change in the real exchange rate in Tunisia is due to real shocks (demand shocks in the short run, supply shocks in the long run) a result that is similar to Lastrapes (1992), Evans and Lothian (1993), Thomas (1997) for industrialized countries and Chen and Wu (1997), Dibooglu and Kutan (2001) (for Hungary), Chowdhury (2004) or Kontolemis and Ross (2005) for developing ones. Finally, forecast error variance

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[18] Clarida and Gali (1994) also find a similar impulse response profile for the US-Japan real exchange rate and for the US-Canadian real exchange rate. Buiter (1995) stress that the effect of a positive supply shock on the real exchange rate in the long run is ambiguous.

[19] Variance decompositions measure the relative contribution of forecast error variance of each shock as a function of forecast horizon.

decompositions for relative inflation rates show that most of the variation in changes of relative prices comes from nominal shocks in the short run, which explain more than 60% in the first month following the shock and from demand shocks in the long run which account for nearly 65% of the total forecast error in relative prices two years after the shock.

VII. Conclusion

This paper studied the sources of real exchange rate fluctuations in Tunisia employing a long run structural VAR approach. Following Clarida and Gali (1994) we identify three types of macroeconomic shocks (supply, demand and nominal) and use the technique developed by Blanchard and quah (1989) to uncover the sources of movements in real exchange rates. The evidence presented indicates that real shocks play a large a role in explaining the fluctuations of real exchange rate in Tunisia. Real disturbances account for more than 80 percent of the forecast error variance of the real exchange rate in Tunisia.

The fact that real exchange rate fluctuations in Tunisia are dominated by real shocks presents several implications for the decision making and the exchange rate modelling. First, with regard to the implementation of exchange rate policy, our results imply that, to improve competitiveness, the Tunisian authorities' need to focus on the real side of the economy, such as improving efficiency, technologies and productivity. This also calls into question a monetary policy which seeks to promote competitiveness through currency devaluation. Second and concerning modelling exchange rate in Tunisia, it seems that equilibrium exchange rate models in lines of Stockman (1987) will be more suitable to explain the real exchange dynamics than disequilibrium models a la Dornbusch (1976).

Table 1: Exchange rate regimes and macroeconomic performance in Tunisia

periods	Exchange regime	Growth+	Inflation+
1970-1978	Fixed	4,84	5,16
1979-2001	Intermediary	2,30	6,37
2002-2006	Managed Float	5,14	2,8

(+) Mean across periods

Table 2: Studies on the sources of real exchange rate fluctuations (RERF)

Author	Time frame, Data Frequency and Sample	Variables and SVAR Specification	Sources of RERF
Bayoumi and Eichengreen (1992)	1953-1988 Annual G-7 countries	Real GDP and GDP deflator Bivariate	Dispersion of supply shocks but not their magnitude
Lastrapes (1992)	1973-1989 Monthly USA, GER, UK, JAP, ITA, CAN	Real Exchange rate (RER) and Nominal Exchange Rate (NER) Bivariate	Real Shocks
Evans and Lothian (1993)	1975-1989 Monthly ITA,JAP, UK, GER	RER and price level Bivariate	Real Shocks
Clarida and Gali (1994)	1974-1992 Monthly JAP, GER, UK, CAN	Real output, RER, price level Trivariate	Nominal Shocks for JAP and GER Real Shocks in the UK and CAN
Chadha and Prasad (1997)	1975-1996 Quarterly Japan (JAP)	Real output, RER, price level Trivariate	Real Shocks
Weber (1997)	1971-1994 Monthly USA, GER, JAP	Labor input, Real output, RER, Real money supply and price level Five-dimensional VAR	Demand shocks
Chen and Wu (1997)	1981-1994 Quarterly JAP, Korea, Taiwan, Philippines	RER and Price level (CPI) Bivariate	Real Shocks

Thomas (1997)	1979-1995 Monthly Sweden	Relative output, RER and relative price level Trivariate	Supply and demand shocks (higher fraction for demand shocks)
Enders and Lee (1997)	1973-1992 Monthly CAN, GER, JAP	RER and NER Bivariate	Real Shocks
Lee and Chin (1998)	1979-1994 Monthly USA, CAN, UK, JAP, GER, FRA, ITA	RER, Current account Bivariate	Real Shocks
Rogers (1999)	1889-1992 Annual UK, USA	Real government spending, real income, RER, money multiplier, real monetary base Five-dimensional VAR	Nominal shocks (shocks to money supply or the money multiplier account for nearly 50% of the variation in the real exchange rate)
Funke (2000)	1980-1997 Quarterly UK	Real output, RER, price level Trivariate	Real Shocks (demand innovations)
Dibooglu and Kutan (2001)	1990-1999 Monthly Hungary, Poland	RER and price level Bivariate	Real Shocks in Hungary Nominal shocks in Poland
Soto (2003)	1990-1999 Monthly Chile	RER and interest rate differential Bivariate	Real Shocks in the long run Nominal shocks in the short run

Borghijs and Kuijs (2004)	1993-2003 Monthly Czech Republic, Hungary, Poland, the Slovak Republic, and Slovenia	NER, real output Bivariate and trivariate	Nominal shocks
Chowdhury (2004)	1980-1996 Monthly Chile, Colombia, Malaysia, Singapore, South Korea, and Uruguay	RER and NER Bivariate	Real Shocks
Wang (2004)	1980-2002 Annual China	Relative output, RER and relative price level Trivariate	Real Shocks
Kontolemis and Ross (2005)	1986-2003 Monthly Poland, Latvia, Slovakia and the Czech Republic, Cyprus, Poland,Estonia and Lithuania. and Estonia	RER, NER, relative interest rates and relative credit Bivariate, trivariate and a four-dimensional VAR	Real Shocks (demand shocks)
Stazka (2006)	1995-2005 Monthly Czech Republic Estonia Hungary Latvia Lithuania Poland Slovakia Slovenia	RER, Industrial production index and price level (CPI) Trivariate	Nominal shocks in non ERM II countries and Latvia Real demand shocks in ERM II countries

Table 3: Tunisia Unit Root tests

	Augmented Dickey Fuller (ADF test)		Phillips-Perron (PP Test)	
Variables	**Level**	**1st difference**	**Level**	**1st difference**
Relative output	-1.408	-8.519**	-2.572	-23.76**
RER	-1.665	-5.688**	-1.595	-10.78**
Relative CPI	-2.229	-5.920**	-1.728	-7.334**
5% critical value	-2.886	-2.886	-2.885	-2.885
10% critical value	-2.579	-2.580	-2.579	-2.579

Note: The regressions were run with a constant and a time trend for the levels and only a constant for the first differences. The maximum lag in the ADF and PP tests is specified using the general to specific procedure.
** Test statistic significant at 5 percent level.

Table 4: Tests for Cointegration

Number of cointegrating vectors	Eigenvalue	Trace statistic	5% critical Value	1% critical Value
None	0.115	19.15	29.68	35.65
At most 1	0.038	5.73	15.41	20.04
At most 2	0.012	1.425	3.76	6.65

Number of cointegrating vectors	Eigenvalue	Max-Eigen statistic	5% critical Value	1% critical Value
None	0.115	13.41	20.97	35.65
At most 1	0.038	4.309	14.07	18.63
At most 2	0.012	1.425	3.76	6.65

Both trace and Max-Eigen tests indicate no cointegration at both 5% and 1% levels

Table 5: Tunisia: Forecast Errors Variance Decompositions

Variable	Relative Output		
Horizon	Supply	Demand	Nominal
1	42.5	29.1	28.2
3	37.4	26.9	35.5
6	37.1	26.3	36.4
9	37.7	26.6	35.5
12	38.5	26.8	34.6
24	42.3	26.01	31.6
36	45.6	24.6	29.7
48	47.8	23.6	28.5
60	49.2	22.8	27.9
72	50.03	22.4	27.5
84	50.48	22.1	27.3
96	50.7	22.02	27.2

Note: The numbers are the percentage contribution of each shock for each horizon.

Variable	Real Exchange Rate		
Horizon	Supply	Demand	Nominal
1	8.1	71.6	20.2
3	7.2	63.8	28.9
6	7.03	64.2	28.7
9	8.4	64.7	26.7
12	10.7	64.3	24.9
24	22.1	58.5	19.3
36	32.6	51.4	15.9
48	40.1	45.7	14.08
60	44.8	41.9	13.2
72	47.6	39.5	12.8
84	49.1	38.07	12.7
96	50.02	37.2	12.7

Note: The numbers are the percentage contribution of each shock for each horizon.

Variable	Relative CPI		
Horizon	Supply	Demand	Nominal
1	0.06	32.7	67.1
3	0.19	50.8	48.9
6	2.20	61.5	36.1
9	3.92	65.2	30.8
12	4.91	66.7	28.3
24	6.61	68.3	25.06
36	7.34	68.3	24.3
48	7.749	68.1	24.1
60	7.98	67.9	24.08
72	8.12	67.7	24.07
84	8.20	67.7	24.08
96	8.24	67.6	24.09

Note: The numbers are the percentage contribution of each shock for each horizon.

Figure 1: Tunisian CPI-based Real Effective Exchange Rate (1970-2005)

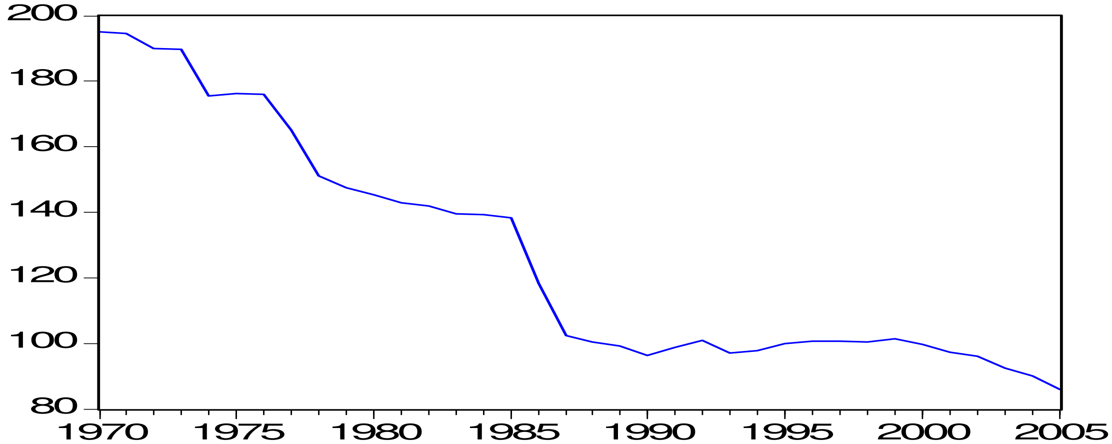


Figure 2: Tunisian Exports of Goods and Services (%GDP) (1970-2005)

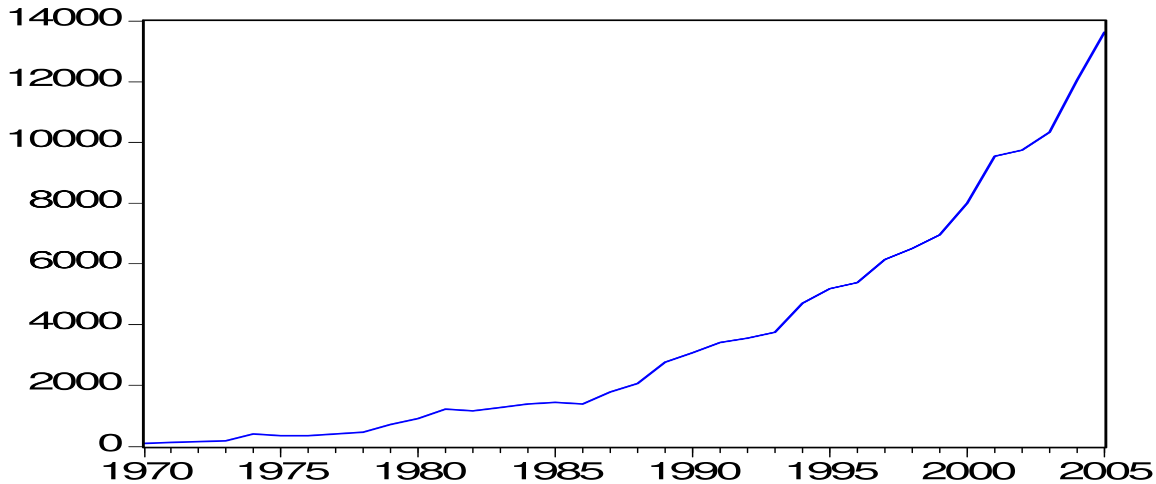


Figure 3: Variables in VAR model

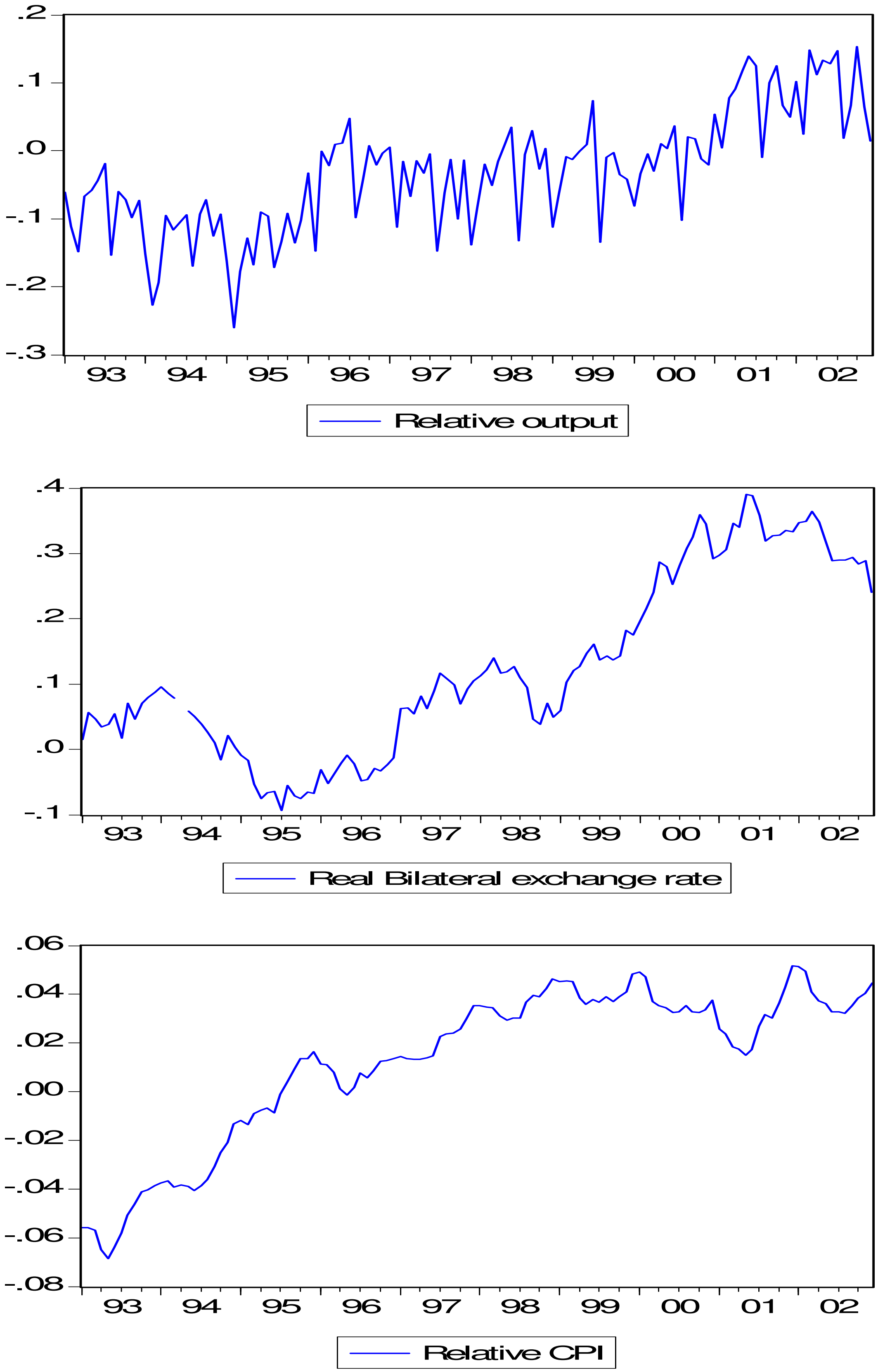
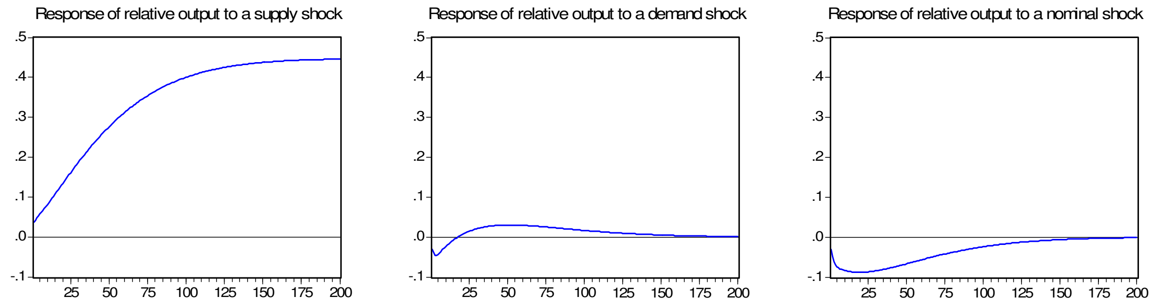
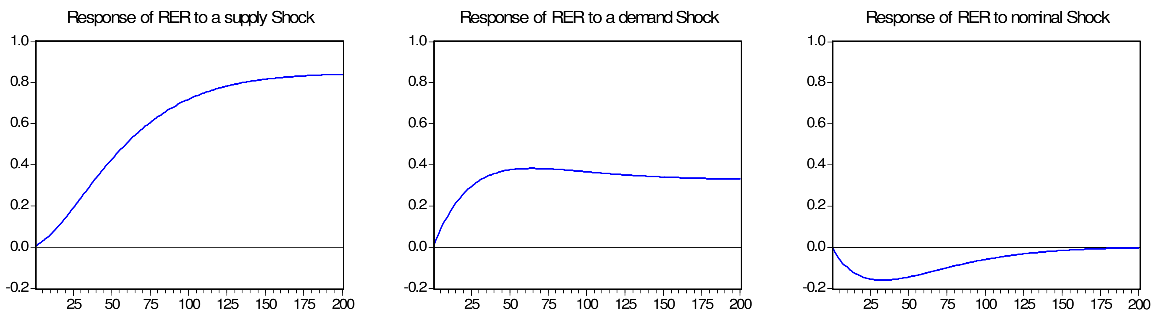


Figure 4: Accumulated Impulse Response Function of Relative Output, Real Exchange Rate and Relative Price Level

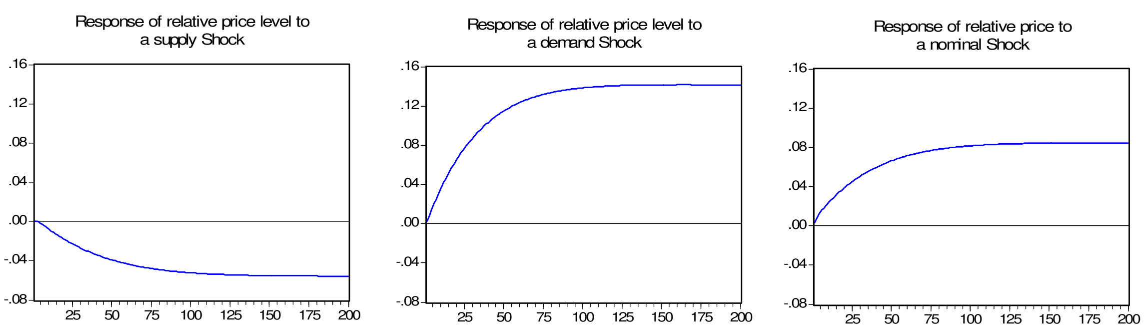
Responses of relative output



Responses of Real Exchange Rate (RER)



Responses of Relative Price Level



Time (in Months)

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