

The role of commodity terms of trade in the determination of the real exchange rates of the Mediterranean countries

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Abstract

The aim of this paper is to investigate whether there exists a long run relationship between the real exchange rate and the commodity terms of trade in the so-called “Mediterranean” or MENA countries. These economies are good candidates for this type of formulation, as they can be considered commodity exporting countries. Using cointegration techniques, we find long run relationships linking the real exchange rate and a commodity-based measure of the terms of trade. Thus, commodity terms of trade are a potential explanation for the apparent non-stationarity of MENA countries real exchange rate previously found in the empirical literature.

Classification J.E.L.: C22, F31

Key words: real exchange rate, terms of trade, commodity prices.

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1 Introduction

Explaining the behaviour of the real exchange rates (RER hereafter) may be one of the most controversial macroeconomic issues. Many relevant empirical studies such as those by Meese (1990), Mussa (1990) and MacDonald and Taylor (1992) have found that the forecasts based on a random walk are a better approximation to its behaviour than those based on monetary models (Meese and Rogoff, 1983). As Backus (1984) points out, monetary models for real exchange rate determination performed relatively well until the seventies, but not afterwards probably due to the importance of the real shocks that affected the RER¹.

Rogoff (1996) explains the RER deviations from its equilibrium value using real factors. Therefore, Purchasing Power Parity (PPP hereafter) would not hold due to the occurrence of permanent shocks that affect the real exchange rate. Within this literature, Evans and Lothian (1993) find that an important part of RER fluctuations have their origin in real shocks and, therefore, a random walk is not a good approximation for RER behaviour².

Based on previous empirical results on RER, it is possible to highlight some conclusions. First, that PPP is not always a good approximation for RER behaviour. Second, that, during the floating exchange rate period, simple monetary models have hardly been able to beat the random walk. Finally, those models which account for real shocks might be a better approximation for real exchange rate behaviour than the random walk. Therefore, an adequate model for the RER should explain deviations from its long-run equilibrium based on real shocks with enough frequency and volatility (Chen and Rogoff, 2003).

Among the real variables, shocks on commodity prices may be an essential explanatory factor in commodity exporting countries. Edwards (1985), explains the slow mean reversion of RER from the supply side. Additional results favourable to this hypothesis are those by Chen and Rogoff (2003), and Cashin, Céspedes and Sahay (2004), who find that for a large group of commodity exporting countries the most important factor in RER determination is a commodity-price-based terms of trade.

In this paper we aim to analyze whether there exists a long run relationship between the RER and a terms of trade variable based on commodity prices in the so-called “MENA Countries” (Algeria, Cyprus, Egypt, Israel, Jordan, Malta, Morocco, Syria, Tunisia and Turkey). In addition, unlike other papers, we concentrate on the real exchange rate against the European

¹There are important exceptions to this conclusion, as in MacDonald and Taylor (1994).

²In an eclectic model that also includes real variables Camarero, Ordóñez and Tamarit (2005), estimate a model for the euro-dollar exchange rate that beats the random walk.

Union (EU). There are several reasons for the adoption of this approach and for choosing this group of countries for the analysis. First, the MENA group trades intensively with the EU countries: over two thirds of their trade either goes to or comes from the European Union. However, this is an asymmetric relationship, as their share in EU trade is below 3%. Second, from the seventies, they have been preferential trade partners. In fact, they signed an association agreement with the EU several decades ago and they have already reached the commitment with the EU for the creation of a Free Trade Area by 2010, on the basis of the Euroministerial Conference held in Barcelona in 1995. Third, former studies such as Sarno (2000), and Camarero, Cuestas and Ordóñez (2003) have highlighted that PPP does not hold for these countries. One of the reasons that may explain the non-fulfilment of PPP may be the composition of trade between the two areas: whereas the EU exports manufactured products to the MENA countries, the majority of these countries sell mainly primary products to the EU. Thus, it is very likely that the behaviour of the RER may depend on primary products prices, commonly fixed in international markets.

The reminder of this paper is organized as follows. In the next section we summarize some theoretical approaches for RER determination as a function of the terms of trade and, in particular, commodity prices. In the third section we review the empirical evidence on this topic and in the fourth, we present the results of our analysis. Finally, in the last section we report some concluding remarks.

2 Real Exchange Rate determination and commodity terms of trade

The real exchange rate and the terms of trade are two relative prices of great importance for any economy, as they play central roles in an open economy's adjustment to economic shocks. Many authors have studied the theoretical linkages between the two variables. The conventional wisdom is that there is a positive relationship linking them (an improvement in the terms of trade implies an appreciation of the currency).

One of the first theoretical contributions was made by Neary (1988). This author considers a small country that produces either tradable or non tradable goods in a competitive market and analyzes how RER equilibrates the balance of payments. According to this author, an improvement in the terms of trade requires a real appreciation of the currency in order to eliminate the non tradable demand excess generated by such improvement.

The model proposed by Blundell-Wignall and Gregory (1990) can be a starting point to understand the role of the terms of trade in real exchange rate determination for a small commodity-exporting country. Their initial hypotheses are, first, as the country is small, that the terms of trade are exogenous³ and, second, that the only produced good is sold internationally at international prices and internally at monopoly prices. Under these assumptions the RER⁴ is a function of the terms of trade, given the demand and supply elasticities⁵.

Edwards (1985) in turn considers two channels through which the commodity price movements may affect the RER. First, an increase in commodity prices will increase national income, as these products are demand-inelastic, rising demand in general. This growth in demand will increase just non tradable goods prices, as tradables prices are fixed internationally. This will provoke a rise in CPI and, therefore, a real appreciation of the domestic currency. Second, an increase in commodity prices will generate a surplus in the trade balance, an increase in foreign reserves and, possibly, in the monetary base, yielding inflation and, thus, a real appreciation of the national currency.

In the above mentioned studies, the RER depends on the terms of trade (Neary, 1988, and Blundell-Wignall and Gregory, 1990) or on commodity prices (Edwards, 1985). Cashin, Céspedes and Sahay (2004) go beyond by establishing a theoretical framework that justifies the analysis of the relationship between RER and commodity terms of trade for commodity exporting countries. In a model with two countries, two sectors (tradable and non-tradable goods) and one factor (labour), mobile among sectors, an increase in the commodity world prices will rise wages in this sector. If wages between sectors equalize, the rise in wages in the non tradable sector will provoke an increase in the prices of these products, appreciating the RER. Thus, Cashin, Céspedes and Sahay (2004) arrive to a model where the mechanisms at work are similar to the traditional Balassa-Samuelson effect.

As a conclusion, all the above described theoretical approaches find that an improvement in the terms of trade will appreciate the currency⁶. In this

³Although reasonable in many instances, there are potential sources of endogeneity in this relationship.

⁴An increase in the RER means a real appreciation of the national currency.

⁵Note that although Blundell-Wignall and Gregory (1990) are considering the case of Australia as a commodity exporting country, the prices of the primary products do not appear explicitly in the RER determination.

⁶However, Connolly and Devereux (1996) have challenged the conventional wisdom and showed that the direction of the relationship is ambiguous: the effects on an external import prices shock is uncertain, as income and substitution effects work in different directions. The only exception are the countries whose exports are dependent on commodities.

case, as we concentrate on commodity-exporting countries, we assume that the main terms of trade shocks are exogeneous and related to international variations in the primary product prices.

3 Revision of previous empirical evidence

To the best of our knowledge the empirical evidence on the determinants of RER for developing countries and, in particular, the role of the terms of trade, is scarce. In contrast, there is an important bulk of literature on this topic for developed countries. In what follows we review the empirical literature for the two groups of countries. In table 1 we report a brief summary of this literature.

Blundell-Wignall and Gregory (1990) analyze the relationship between the RER and the terms of trade for Australia and New Zealand, concluding that the terms of trade play an important role in determining the RER. Also for the case of Australia, Gruen and Wilkinson (1994) estimate the relationship among the RER and the terms of trade (goods and services in this case), finding that there is no evidence of a relationship linking them. Nevertheless, once the interest rate differential is introduced in the model, the RER movements appear to depend upon the terms of trade and interest rate differential.

Amano and Van Norden (1995, 1998a, 1998b) have devoted an important line of research to the role of the terms of trade. In the first paper, they analyze the long run relationship between the RER and the commodity terms of trade for Canada. They conclude that there is a relationship between the two variables, where causality goes from the terms of trade to the RER. In the second one, the authors study the relationship between the RER and the real oil price for the US, concluding that there exists a cointegration relationship between them. Finally, in the last paper, the authors introduce not only the real oil price, but also the real interest rate differential for Germany, Japan and the US. They analyze the cointegration relationships among those variables and find that the RER depends on the real oil price and the real interest rate differential. In a recent publication by the Bank of Canada, Issa et al.(2006) have found that the Canadian degree of dependence on oil export has increased during the nineties. Using cointegration tests with structural breaks the authors estimate a long-run relationship, where the long-run parameter has changed around 1992.

Chen and Rogoff (2003) analyze the RER behaviour for a group of three OECD members (Australia, Canada and New Zealand). They find that

In this case, the sign is unambiguously positive.

commodity prices have an important influence in the RER of Australia and New Zealand. However, the estimation residuals present slow mean reversion even before introducing productivity differentials in the non-tradable products sector.

In general, as Dungey (2004) remarks, the link observed between the real exchange rate and the commodity terms of trade for developed countries is strong, whereas in the case of developing countries the link seems to be weaker.

Cashin, Céspedes and Sahay (2004) study whether the RER depends in the long run on real commodity prices for commodity exporting countries. The authors consider, among the group of countries in their study, the cases of some Mediterranean countries such as Morocco, Syria, Turkey and Tunisia. They find that the RER depends on real commodity prices in the Mediterranean countries analyzed with the only exception of Turkey.

4 Empirical results for the Mediterranean Countries

4.1 Data

The variables used in the empirical analysis are the real exchange rate (q_t) and the commodity terms of trade (pc_t). The first one is computed as $e_t - p_t^* + p_t$ where e_t is the nominal effective exchange rate defined as the price of the domestic currency in terms of the foreign currency, p_t^* is the foreign price and p_t is the national Consumer Price Index. The nominal effective exchange rate and foreign prices have been computed for each country as a weighted average, using as weights the proportion of trade with their respective EU trade partners.

Concerning the commodity terms of trade, this variable has been computed as:

$$pc_{it} = \log \left[\frac{\exp \left\{ \sum_{i=1}^i [w_i (\ln P_i)] \right\}}{IVUX_t} \right] \quad (1)$$

where w_i are the weights (% of commodity i in total exports), P_i is the price of the commodity i and $IVUX$ is the index of unitary value of manufactured exports for the industrialized countries. The data have been obtained from the

International Financial Statistics and *Direction of Trade Statistics Yearbook*, IMF. The observations are quarterly and cover the period 1979:1-2002:4.

Previous to the econometric analysis, in figure 1 we report the RER and the commodity terms of trade. Looking at the graphs, it is possible to observe a co-movement between the two variables that can be a sign of a long-run relationship between them. It seems that the most important changes in the commodity terms of trade in the cases of Algeria, Egypt and Syria are linked with the fall in oil prices in 1986 and with the rises in 1999 and 2000.

4.2 Cointegration analysis

In this section we analyze the role of commodity terms of trade in the real exchange rate over the long run. The expected cointegration relationship is the following:

$$q_{it} = f(p_{cit}) \quad (2)$$

(+)

where the positive relation means that in the long run, an increase in the commodity terms of trade will provoke an appreciation of the national currency in real terms.

The empirical analysis of cointegration is based on the VAR(p) model with a constant restricted to lie in the cointegration space:

$$\Delta x_t = \sum_{i=1}^{p-1} \Gamma_i \Delta x_{t-i} + \alpha \beta' x_{t-1} + \alpha \delta_0 Ds_t + \Phi_1 Dp_t + \mu_0 + \varepsilon_t \quad (3)$$

where $x_t = \{q_t, pc_t\}'$, $\mu_0 = \alpha \beta_0 + \alpha_{\perp} \gamma_0$, so that β_0 is an intercept in the cointegration relations and γ_0 is equal to zero. The coefficient δ_0 stands for mean shifts in $\beta' x_t$ as a result of mean shifts in the variables that do not cancel in the cointegrating relationships. These mean shifts are captured by a set of dummy variables Ds_t . Dp_t stands for permanent impulse dummies⁷.

Concerning the lags of the VAR models, they have been selected using information criteria in the first stages of the analysis. We have included 1 lag for Morocco, 2 lags for Algeria, Egypt and Turkey, and, finally, 4 in the case of Syria⁸.

⁷See the appendix for a detailed description of both Ds_t and Dp_t for each country

⁸In this section we present the results for Algeria, Egypt, Morocco, Syria and Turkey. For the rest of countries it has not been possible to find a cointegration relationship between the RER and the terms of trade and, therefore, the results are omitted although available from the authors upon request.

The baseline model was carefully checked for signs of misspecification using a variety of diagnostic tests, reported in tables 2 and 3. At this stage, even after the inclusion of the dummy variables, there are still some normality and ARCH problems in the RER equation for Morocco. However, since the normality problem arises from an excess of kurtosis, the estimators by maximum likelihood are robust (Gonzalo, 1994). Moreover, the multivariate tests point to the absence of specification problems.

Table 4 presents the Johansen stationarity test⁹. In all cases the null hypothesis of stationarity is rejected, except for the case of Syria. Therefore, we exclude Syria from the rest of the cointegration analysis.

The choice of the cointegration rank is based on the Bartlett corrected trace test. The 5% critical values for this test have been simulated to account for the shift dummies restricted to the cointegration space. According to the results reported in table 5, we might accept $r = 1$ in all the cases.

Once the cointegration rank has been determined, the next step in our analysis is testing the hypothesis of long run exclusion of the variables. In the cases of Algeria, Egypt and Turkey the restricted constant is not significant, i.e. the intercept in the data cancels in the cointegration space¹⁰.

The identified cointegration vectors are presented in table 6. In all the cases the commodity terms of trade estimated parameter is close to unity (with the exceptions of Morocco and Egypt) and positively signed but Morocco. A possible explanation for this result may be that the main products that Morocco exports (phosphate, fish and lead) are relatively demand-elastic and, therefore, the RER appreciates as the commodity terms of trade fall, i.e. as the commodities become cheaper, the revenues from exporting these products increase, appreciating the exchange rate in real terms.

The restricted dummy variables are related to shocks that have permanent effects on the variables and that do not cancel out in the cointegration space. In particular, for Algeria, the first one is related to a large and sudden fall in oil prices, and the second one to a RER depreciation due to a stabilization and structural adjustment process started in 1994 supported by the World Bank and the International Monetary Fund. In the case of Egypt, the dummy variable reflects the effects on the RER of a set of economic reforms initiated

⁹In addition to this stationarity test, we have used a variety of complementary unit root and stationarity tests, such as the KPSS tests, the standard ADF tests and GLS unit root tests. The results did not change and, for the sake of simplicity, we have restricted our tables to those obtained from the Johansen methodology. Further results are available upon request.

¹⁰In particular, the long run exclusion test results for the restricted constant are the following: Algeria $\chi^2(1) = 0.32$, p-val. = 0.57; Egypt $\chi^2(1) = 2.07$, p-val. = 0.15; Turkey $\chi^2(1) = 0.25$, p-val. = 0.62.

by president Mubarak. The restricted dummy variable picks up, for the case of Morocco, after a sudden fall in phosphate during 1987, which is the most important commodity in the exports of this country. Finally, the dummy variable for Turkey is related to a shift in the monetary policy of the Central Bank of this country, with the aim of limiting the volatility of the currency as well as keeping the value of the Turkish Lira in real terms.

The estimated error correction models are presented in table 7. After testing for exogeneity in the commodity terms of trade, the null hypothesis could not be rejected, so that we have been able to reduce the system and to estimate just the RER equation (the so-called partial system) for each country. From table 7 it is possible to point out that the adjustment parameters¹¹ are pretty small with the only exception of Turkey. It means that the shocks that affect RER last for a long time. Thus, the estimated life of shocks is quite long for Egypt and Morocco (17.2 and 8.5 years, respectively) whereas for Algeria and Turkey the half life of shocks is 5.6 and 0.7 years, respectively, very close to those estimated in the literature. The relatively large speed of mean reversion found for Turkey might be explained by the fact that Turkey has been a high inflation country (McNown and Wallace, 1989; Zhou, 1997).

Parameter constancy is checked using the recursive test procedures proposed by Hansen and Johansen (1999). Figure 2, shows the test of constancy of β (panel a) and of the loadings α (panel b) for Algeria¹². According to these tests the cointegration space is stable¹³.

Finally, in order to test the stability of the error correction model, we report the CUSUM test. As we can see from figure 2 panel (c) there are no stability problems, as the representation of the test remains within the confidence intervals¹⁴.

Thus, from the empirical analysis we can conclude that the behaviour of the real effective exchange rate against the EU is significantly affected, **although only temporally**, by the evolution of commodity prices in Algeria, Egypt, Morocco and Turkey. The group represents the four largest economies among the MENA countries. In the eve of a future free trade area between them and the EU, a factor to be accounted for previous to deeper integration

¹¹The t-Student statistics of the α parameters are below the critical value computed by Ericsson and Mackinnon (2002) of -3.25 (5%) to test for cointegration in error correction models.

¹²The first graph in panel b corresponds to the recursive estimation of the real exchange rate loading, DQARG; in the second graph, DPCARG, the recursive estimation of the commodity terms of trade loading is zero, as this variable is weakly exogenous.

¹³Similar results are obtained for the rest of the countries. Although we do not present them in the article, they are available upon request.

¹⁴Again, as the results for the other countries are very similar to those for Algeria, we do not report the graphs, that are available upon request.

is the price of international commodities. This is an exogenous factor (this variable is weakly exogeneous in our empirical analysis) and further shocks can be expected in future years. Both the EU authorities and those of the MENA countries should take into account the potential disturbing effects in their economic transactions.

5 Concluding remarks

The relatively weak empirical evidence about PPP fulfillment found in the so-called MENA Countries has recommended to look for additional factors that may explain the shocks affecting the RER in the area. Based on the economic links that exist between these countries and the EU, as well as the important weight that primary products have in the bilateral trade, we have applied cointegration techniques to look for a long-run relationship between the RER against the EU and a commodity-based terms of trade variable.

Some conclusions can be drawn from the obtained empirical results. First, that the assumption, commonly maintained in the theoretical models, of weak exogeneity of the commodity terms of trade is confirmed by the data. Second, that the link between the two variables, RER and commodity terms of trade is positive (with the exception of Morocco), so that an improvement in the latter appreciates the currency, as predicted by the theory. Third, a stable cointegration relation and error correction model has been estimated for four countries in the area: Algeria, Egypt, Morocco, and Turkey. Finally, concerning the half life of the shocks affecting the real exchange rate (and derived from the error correction model) although Algeria and Turkey do not present signs of persistence, it is still relatively large for Egypt and Morocco.

Therefore, although further shocks in commodity prices can be expected in future years, their half life is either short or not very large. **Therefore, even if the potential disturbing effects on trade and investment between the two economic areas exist, probably due to the differences in the composition of their trade structure and in the level of economic development, they may not be long-lasting.**

A Sources and definitions of the data

The data have been obtained from the *International Financial Statistics* of the International Monetary Fund (exchange rates and commodity prices) and from Cashin, Céspedes and Sahay (2004). We have used quarterly observations for the period 1979:1-2002:4. More specifically, the

Real exchange rate: q_t is defined as $e_t - p_t^* + p_t$, where e_t is the nominal effective exchange rate defined as the price of the domestic currency in terms of the foreign currency, p_t^* is the foreign price and p_t is the national Consumer Price Index. The nominal effective exchange rate and foreign prices have been computed for each country as a weighted average, using as weights the proportion of trade with their respective EU trade partners. Source: IMF International Financial Statistics.

Commodity terms of trade: this variable is country-specific and has been defined as follows:

$$pc_{it} = \log \left[\frac{\exp \left\{ \sum_{i=1}^i [w_i (\ln P_i)] \right\}}{IVUX_t} \right] \quad (4)$$

where w_i are the weights (% of commodity i in total exports). The variables have been obtained from Cashin, Céspedes and Sahay (2004) in the cases of Morocco, Syria and Turkey. The weights have been computed using the proportion in exports of the three most important commodities. For example, in the case of Morocco, the commodities are phosphate rock, fish and gold. For Algeria and Egypt the only commodity price considered is crude petroleum. $IVUX_t$ is a price index for manufactured exports from 20 industrial countries. It has been obtained from the IMF's International Financial Statistics and has been computed with country weights based on total 1995 exports of manufactures (base 1995=100). According to the IMF, the 20 industrial countries considered are: US, UK, Austria, Belgium, Denmark, France, Germany, Luxemburg, Netherlands, Norway, Sweden, Switzerland, Canada, Japan, Finland, Australia, New Zealand, Portugal, Greece and Spain.

Dummy variables: The following dummy variables have been included in the regressions¹⁵:

Algeria: d823, d824, d861, d891, d903, ds911, d914, ds942, d992;

Egypt: d861, d891, d893, ds903, d911, d924, d992;

Morocco: d801, d811, d852, ds871, d902, d931;

Syria: d861, d881, d903, d911, d992;

Turkey: d801, ds924, d942;

where $d_{xxy} = 1$ in 19xx:y and 0 otherwise ('blip' dummy), and $ds_{xxy} = 1$ from 19xx:y to the end of the sample and 0 otherwise ('step' dummy)¹⁶.

¹⁵Due to the presence of socio-political events it is necessary to intervene the models with a number of dummies.

¹⁶'Step' dummy variables are restricted to the cointegration space and appear in first differences in the dynamics. 'Blip' dummies are not restricted.

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Table 1: Revision of the empirical literature

| Paper | Countries | $q = f()$ | Results |
|-----------------------------------|---|---|---|
| Blundell-Wignall & Gregory (1990) | Australia, New Zealand | Terms of Trade (TOT) | TOT explains RER. |
| Gruen & Wilkinson (1994) | Australia | Goods and services TOT, Real interests rates differential | RER explanatory variables: TOT, Real interest rate differential. |
| Amano & Van Norden (1995) | Canada | Primary products TOT (fuel and non-fuel) | There is a long run relationship between both variables. TOT cause RER. |
| Amano & Van Norden (1998b) | USA | Oil Real Price | Oil Real Prices explain RER. |
| Amano & Van Norden (1998a) | Germany, Japan and USA | Oil Real Price and Real Interest Rate Differential | RER has as explanatory variables Oil Real Prices and Real interest rate differential. |
| Chen & Rogoff (2003) | Australia, Canada and New Zealand | Commodity prices and productivity differential | RER explanatory variables: commodity prices and prod. differential. Residuals are persistent. |
| Cashin, Cespedes & Sahay (2004) | Commodity Exporters, among them: Morocco, Syria, Tunisia and Turkey | Real Commodity Prices | For most countries, a long run relationship RER / Real Commodity prices (explanatory variable). |

Table 2: Univariate misspecification tests

| | Algeria | | Egypt | | Morocco | | Syria | | Turkey | |
|------------|--------------|---------------|--------------|---------------|--------------|---------------|--------------|---------------|--------------|---------------|
| Univariate | Δq_t | Δpc_t | Δq_t | Δpc_t | Δq_t | Δpc_t | Δq_t | Δpc_t | Δq_t | Δpc_t |
| ARCH | 0.67 | 0.30 | 1.83 | 0.19 | 4.89 | 0.10 | 7.67 | 3.02 | 0.17 | 0.59 |
| J-B(2) | 3.46 | 3.24 | 1.69 | 2.53 | 6.91 | 1.40 | 3.95 | 3.21 | 2.57 | 1.05 |
| Skewness | -0.36 | -0.29 | -0.28 | -0.27 | 0.25 | -0.17 | 0.16 | -0.01 | -0.16 | 0.20 |
| Kurtosis | 3.58 | 3.57 | 2.73 | 3.44 | 3.24 | 4.09 | 3.70 | 3.59 | 3.48 | 3.11 |

Note: A significant test statistic (5%) is given in bold face.

Table 3: Multivariate misspecification tests

| | | | | | |
|---------|-----------------------------|----------------|------|--------|------|
| Algeria | Autocorrelation : Ljung-Box | $\chi^2(84) =$ | 97.6 | p-val. | 0.14 |
| | LM ₁ | $\chi^2(4) =$ | 3.68 | p-val. | 0.45 |
| | LM ₄ | $\chi^2(4) =$ | 3.72 | p-val. | 0.44 |
| | Normality | $\chi^2(4) =$ | 5.78 | p-val. | 0.21 |
| Egypt | Autocorrelation: Ljung-Box | $\chi^2(84) =$ | 95.8 | p-val. | 0.17 |
| | LM ₁ | $\chi^2(4) =$ | 3.17 | p-val. | 0.52 |
| | LM ₄ | $\chi^2(4) =$ | 3.54 | p-val. | 0.47 |
| | Normality | $\chi^2(4) =$ | 4.31 | p-val. | 0.36 |
| Morocco | Autocorrelation: Ljung-Box | $\chi^2(88) =$ | 101 | p-val. | 0.16 |
| | LM ₁ | $\chi^2(4) =$ | 7.06 | p-val. | 0.13 |
| | LM ₄ | $\chi^2(4) =$ | 1.97 | p-val. | 0.74 |
| | Normality | $\chi^2(4) =$ | 3.23 | p-val. | 0.52 |
| Syria | Autocorrelation: Ljung-Box | $\chi^2(76) =$ | 95.6 | p-val. | 0.06 |
| | LM ₁ | $\chi^2(4) =$ | 1.31 | p-val. | 0.85 |
| | LM ₄ | $\chi^2(4) =$ | 2.26 | p-val. | 0.68 |
| | Normality | $\chi^2(4) =$ | 8.34 | p-val. | 0.08 |
| Turkey | Autocorrelation: Ljung-Box | $\chi^2(84) =$ | 0.57 | p-val. | 0.57 |
| | LM ₁ | $\chi^2(4) =$ | 2.24 | p-val. | 0.69 |
| | LM ₄ | $\chi^2(4) =$ | 5.18 | p-val. | 0.26 |
| | Normality | $\chi^2(4) =$ | 9.54 | p-val. | 0.05 |

Table 4: Johansen's stationarity tests

| Countries | q_t | pc_t |
|-----------|----------------|----------------|
| Algeria | 31.7 [0.00] | 32.9 [0.00] |
| Egypt | 7.30 [0.03] | 6.22 [0.04] |
| Morocco | 23.6 [0.00] | 5.35 [0.07] |
| Syria | 0.02 [0.88] | 8.67 [0.00] |
| Turkey | 17.1 [0.00] | 13.6 [0.00] |

Note: p-values are in brackets

Table 5: Trace test for the cointegration space

| Countries | p-r | r | Eigenvalue | Trace | Trace* | P-val. | P-val* | CV 95 | CV 90 |
|-----------|-----|---|------------|-------|--------|--------|--------|-------|-------|
| Algeria | 2 | 0 | 0.32 | 38.23 | 36.68 | 0.00 | 0.00 | 26.57 | 24.80 |
| | 1 | 1 | 0.02 | 1.57 | 0.78 | 0.85 | 0.96 | 12.77 | 11.57 |
| Egypt | 2 | 0 | 0.21 | 24.02 | 23.02 | 0.01 | 0.02 | 24.97 | 22.51 |
| | 1 | 1 | 0.02 | 1.53 | 1.19 | 0.86 | 0.91 | 12.22 | 10.47 |
| Morocco | 2 | 0 | 0.29 | 37.04 | 36.72 | 0.00 | 0.00 | 24.46 | 22.17 |
| | 1 | 1 | 0.05 | 4.57 | 4.55 | 0.35 | 0.35 | 12.14 | 10.28 |
| Syria | 2 | 0 | 0.32 | 38.97 | 36.01 | 0.00 | 0.00 | 19.99 | 17.79 |
| | 1 | 1 | 0.04 | 3.75 | 3.04 | 0.46 | 0.58 | 9.13 | 7.50 |
| Turkey | 2 | 0 | 0.20 | 29.24 | 28.14 | 0.00 | 0.00 | 24.76 | 22.33 |
| | 1 | 1 | 0.08 | 7.80 | 7.55 | 0.09 | 0.10 | 12.22 | 10.44 |

Note: The symbol * means Bartlett corrections. The last two columns are the simulated critical values when dummy variables are restricted in the cointegration space (except in the case of Syria that are standard critical values), using a simulation procedure developed by instructors at the 2003 Econometric Summer School in Copenhagen S. Johansen, K. Juselius, A. Rahbek and B. Nielsen.

Table 6: Identified cointegration vectors

| | |
|---------|--|
| Algeria | $q_t = 0.99pc_t + 1.35ds911_t + 1.69ds942_t$ (33.6) (4.55) (5.42) |
| Egypt | $q_t = 1.82pc_t + 1.65ds903_t$ (11.6) (1.73) |
| Morocco | $q_t = -0.56pc_t + 0.54ds871_t + 6.94$ (-1.12) (3.13) (3.02) |
| Turkey | $q_t = 0.99pc_t + 0.36ds924_t$ (146) (7.73) |

Note: t-Student are given in parenthesis. ds_{xy} is a dummy variable that takes 1 from 19xx:y to the end of the sample and 0 in the rest.

Table 7: Estimated error correction models

Algeria:

$$\begin{aligned} \Delta q_t = & 0.14 \Delta q_{t-1} - 0.03 (ect)_{t-1} + 0.11 d823_t - 0.11 d824_t - 0.11 d903_t - 0.35 \Delta ds911_t \\ & \quad (3.07) \quad (-6.03) \quad (3.83) \quad (-3.77) \quad (-3.74) \quad (-11.7) \\ & - 0.21 d914_t - 0.36 \Delta ds942_t + 0.014 sea_t - 0.03 sea1_t - 0.034 sea2_t + \hat{u}_t \\ & \quad (-7.07) \quad (-11.9) \quad (1.58) \quad (-3.26) \quad (-3.82) \end{aligned}$$

Autocorrelation: F(5,77) = 0.54, p-value = 0.74 ; Normality: $\chi^2(2) = 5.19$, p-value = 0.07
ARCH: F(4,74) = 0.73, p-value = 0.57 ; Heteroskedasticity (x_i^2): F(10,71) = 0.49, p-value = 0.88
Heteroskedasticity ($x_i x_j$): F(11,70) = 0.45, p-value = 0.92

Egypt:

$$\begin{aligned} \Delta q_t = & 0.15 \Delta q_{t-1} + 0.07 \Delta pc_t - 0.01 (ect)_{t-1} - 0.34 d893_t - 0.66 \Delta ds903_t - 0.25 d911_t \\ & \quad (2.84) \quad (1.67) \quad (-4.66) \quad (-7.20) \quad (-12.9) \quad (-5.05) \\ & + 0.23 d924_t + 0.03 sea_t + 0.03 sea1_t + 0.012 sea2_t + \hat{u}_t \\ & \quad (4.81) \quad (2.17) \quad (2.52) \quad (0.85) \end{aligned}$$

Autocorrelation: F(5,78) = 0.19, p-value = 0.96; Normality: $\chi^2(2) = 2.77$, p-value = 0.25
ARCH: F(4,75) = 0.75, p-value = 0.56 ; Heteroskedasticity (x_i^2): F(10,72) = 0.93, p-value = 0.50
Heteroskedasticity ($x_i x_j$): F(13,69) = 0.87, p-value = 0.58

Morocco:

$$\begin{aligned} \Delta q_t = & 0.06 \Delta pc_t + 0.22 \Delta q_{t-1} - 0.02 (ect)_{t-1} - 0.05 d811_t - 0.05 d852_t - 0.06 d902_t \\ & \quad (1.64) \quad (2.68) \quad (-4.40) \quad (-3.63) \quad (-3.59) \quad (-4.35) \\ & - 0.004 sea_t - 0.01 sea1_t - 0.008 sea2_t + \hat{u}_t \\ & \quad (-0.97) \quad (-2.66) \quad (-2.00) \end{aligned}$$

Autocorrelation: F(5,80) = 0.64, p-value = 0.66 ; Normality: $\chi^2(2) = 1.40$, p-value = 0.49
ARCH: F(4,74) = 0.70, p-value = 0.59 ; Heteroskedasticity (x_i^2): F(9,75) = 0.64, p-value = 0.75
Heteroskedasticity ($x_i x_j$): F(12,72) = 0.52, p-value = 0.89

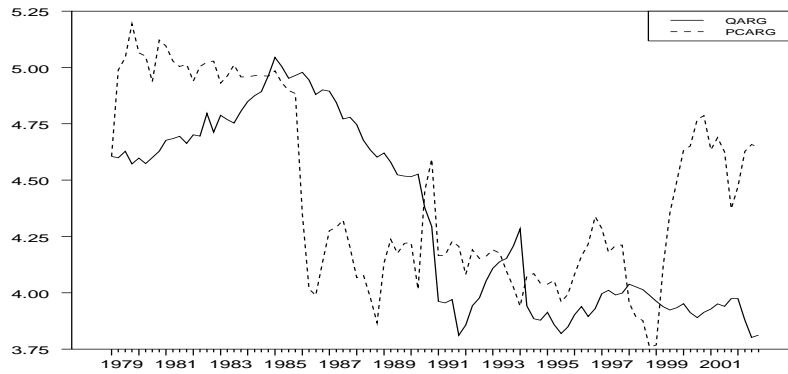
Turkey:

$$\begin{aligned} \Delta q_t = & 0.12 \Delta q_{t-1} - 0.21 (ect)_{t-1} - 0.28 d801_t + 0.21 \Delta ds924_t - 0.31 d942_t - 0.02 sea_t \\ & \quad (1.57) \quad (-3.96) \quad (-4.74) \quad (3.66) \quad (-5.26) \quad (-1.26) \\ & - 0.03 sea1_t - 0.048 sea2_t + \hat{u}_t \\ & \quad (-2.06) \quad (-2.85) \end{aligned}$$

Autocorrelation: F(5,80) = 1.01, p-value = 0.41 ; Normality: $\chi^2(2) = 5.83$, p-value = 0.05
ARCH: F(4,77) = 3.02, p-value = 0.02 ; Heteroskedasticity (x_i^2): F(7,77) = 0.87, p-value = 0.53
Heteroskedasticity ($x_i x_j$): F(8,76) = 1.01, p-value = 0.39

Note: *ect* is the error correction term, *sea*, *sea1* and *sea2* are three centered seasonal dummies and \hat{u}_t are the estimation residuals. *dsxxxy* is a dummy variable that takes 1 from 19xx.y to the end of the sample and 0 otherwise, while *dxxxy* is a dummy variable that takes 1 in 19xx.y and 0 otherwise. t-Student statistics are reported in parenthesis.

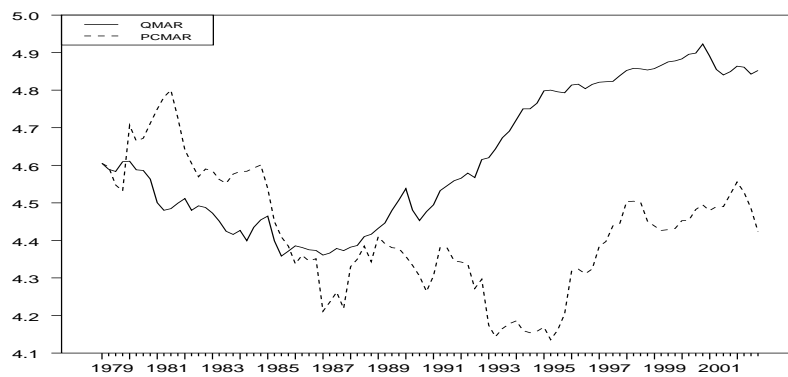
Figure 1: Real Exchange Rates and commodity terms of trade



(a) Algeria



(b) Egypt

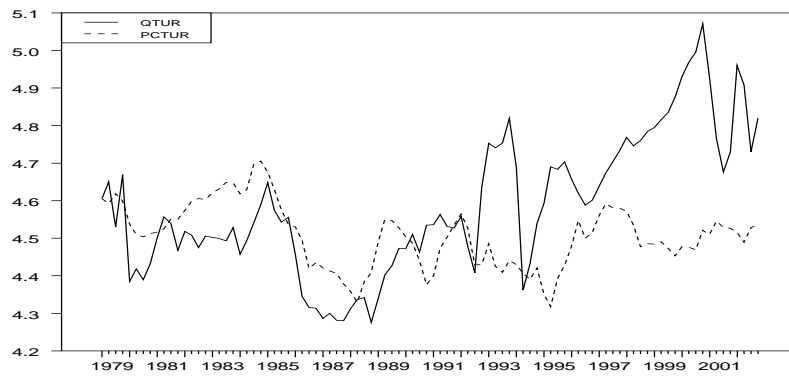


(c) Morocco

Figure 1 (continued)

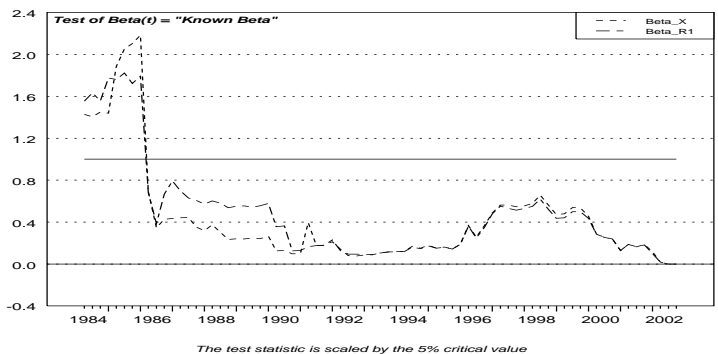


(d) Syria

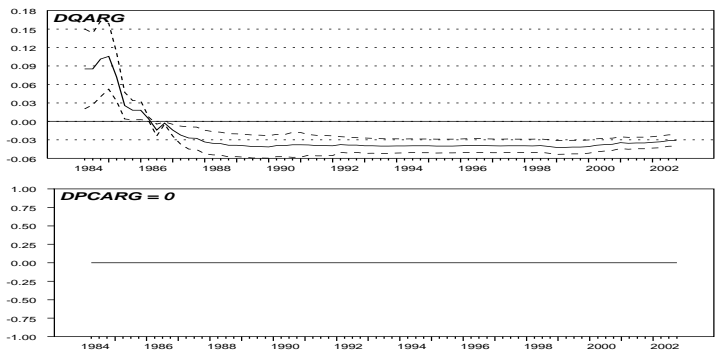


(e) Turkey

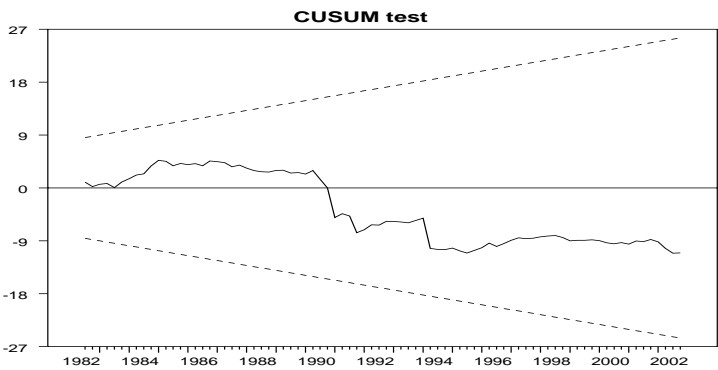
Figure 2: Structural stability tests for Algeria



(a) β stability test



(b) α stability test



(c) CUSUM test