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Exchange Rate Undervaluation to Foster Manufactured Exports: A Deliberate Strategy?*

by**

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Abstract:

Recent literature suggests that a proactive strategy consisting of deliberate real exchange rate depreciation can promote exports diversification and growth. This paper is built on these recent developments and investigates whether four developing countries have adopted such a strategy. Data from Egypt, Jordan, Morocco and Tunisia are used to construct and compare the macroeconomic Real Effective exchange rate (*REER*), similar exchange rates at the sector level (*SREER*) and the macroeconomic Equilibrium Real Effective exchange rate (*EREER*). It shows that there are instances where the objective of diversifying exports through depreciation of exchange rate comes at the expense of further misalignment (*REER* departs from the *EREER*) and, then, monetary authorities are doomed to choose. The results show that Morocco and Tunisia are choosing the proactive exchange rate strategy while Egypt and Jordan are not. This fits with the observation that the former are doing much better than the latter in terms of exports diversification.

Key words: Exchange rate, Misalignment, Undervaluation, Exports diversification
JEL classification: O14, O24, O53

1. Introduction

In most developing countries, import substitution strategies have failed to promote the industrialization process. Diversification did not occur, as was expected, while the productive systems suffered greatly from high trade barriers and distorted relative prices. However, building new comparative advantages in new non-traditional exports, including labor-intensive manufactured products, remains a crucial objective for small economies. Manufactured exports are able to support sustained overall economic growth for several reasons (Hirschman, 1958; Seers, 1964; Matsuyama, 1992). The demand for manufactured goods increases more with income increases than the demand for primary products. Hence, growth prospects for a country's exports are higher through specializing in manufacturing. The development of the manufacturing sector induces substantial dynamic productivity gains, and consequently growth, arising from economies of scale, learning effects, and externalities among firms and industries. Third, with relatively higher price elasticities of both demand and supply, the economies are less susceptible to price swings (Elbadawi, 2001). To ease the attainment of these structural objectives, reforms have generally been launched relying on trade liberalization and exchange rate management. Both dimensions led to an influential strand of economic literature of the late seventies and beginning eighties.

In past research, the relation between diversification and exchange rate changes was analyzed from diverse angles. In Krueger (1978), exchange rate modification is determined according to the need to, partially or fully, compensate producers for the financial impact of the tariff removal, adjusted or not for the domestic inflation arising with the nominal exchange rate depreciation. Balassa (1982) recalls that devaluation of the domestic currency can be interpreted as the parallel imposition of import tariffs and export subsidies at equal rates. Then, a move to free trade and devaluation can be seen as replacing the existing protective measures with a uniform rate of tariff and subsidy that will maintain the balance of trade unchanged. This gives rise, therefore, to the issue of determining the extent of devaluation or alternatively the "free trade exchange rate". In estimating such a hypothetical rate there is, however, considerable scope for error coming from the limited information on demand and supply responses to changes in tariffs, in export subsidies, and in exchange rates. In spite of the limitations underlying partial equilibrium analysis, this body of literature stresses the need to eliminate relative price distortions affecting manufactured goods and to put exports at the heart of development strategies; diversification being in a context of trade openness.

In the eighties, a broader concept of equilibrium emerged regarding exchange rate. Beyond the specific role in relation with external trade, exchange rate has to be perceived as an instrument to adjust the economy for some variables affecting a country's long term internal and external situations, the so-called "fundamentals" (see Edwards, 1988**).** Focused on the global macroeconomic equilibrium, this concept remains narrowly influenced by the medium term balance of payments equilibrium although some light is shed on the negative relation between a misalignment of exchange rate and economic growth. The new concept contrasted with the former intuitive arguments considering that an overvaluation could operate as an incentive for diversification: the export-oriented agricultural sector being indirectly taxed while the industrial sector benefits from cheap imported inputs. However, empirical evidence by Cottani et al (1990) and Ghura and Grennes (1993) showed a negative relation between overvaluation and economic growth. By raising uncertainty, overvaluation can be harmful to investment and outward looking economic growth (e.g. Fischer 1993). This implies that countries should keep their exchange rate as close as possible to the equilibrium level.

While such analyses illustrate the implications of departing from the exchange rate equilibrium, they do not tell us a lot about the complex relationship between the exchange rate and the dynamic of the development process. Alternative strategies fostering long run employment and growth, which go hand in hand with diversification and development of manufactured goods, may call for stronger pro-active exchange rate policies. In 1986, Rodrik provided some theoretical arguments calling for an active disequilibrium exchange rate strategy taking the form of a deliberate undervaluation of the national currency. This policy is considered as welfare increasing by promoting structural change, fostering industrial growth through the shift of the internal terms of trade in favor of industry. Sachs and Warner (1995) and Freund and Pierola (2008) also point to a positive relationship between undervaluation and growth. The latter find a surge in manufacturing export following episodes of real exchange rate undervaluation. Since manufactured exports and economic growth are positively related (Sachs and Warner, 1995), real exchange rate undervaluation would boost GDP growth. Rodrik (2009) has recently come back to this point by refereeing to seven high growth rate countries over the period 1950-2004. The author argues that, just as overvaluation hurts growth, undervaluation facilitates it. More than the non-tradable sector, which may incorporate excess costs in domestic prices; tradable goods particularly suffer from domestic institutional weaknesses as well as market failures that remain sometimes prominent in low to middle per capita income countries. Collier (1997) made a similar point asserting that manufacturing being one of the most transaction-intensive activities, high transaction costs due to a poor policy environment might have caused Africa's comparative disadvantage more than *Dutch-disease* phenomena. The conclusion then arises in Rodrik (2009)'s paper: a systematic increase of the relative price of tradables acts as a "second-best" solution to partially alleviate relevant distortion and spur economic growth[1].

Although some of the Middle East and North African Countries (MENA) have recently shown fair growth performance with a diversification toward manufacturing products, this part of the world has shown disappointing economic performance over the long term. One reason that Rodrik (2009) puts forward is the State's heavy hand that limited and sometimes blocked economic take-off. Another reason is the so-called "governance gap". Although measuring the quality of institutions and public governance is a challenge, none of the four countries analyzed in this paper has a satisfactory record. In relation with what Collier (1997) suggested for Sub-Saharan Africa, poor institutional environment could have been one of these structural weaknesses justifying the active exchange rate policy that Rodrik (2009) calls for[2].

The objective of this paper is not to investigate the relationship between exchange rate and growth but to identify whether the monetary authorities of MENA countries adopt a proactive exchange rate policy in accordance with price incentives for diversifying through manufactured exports. We focus on four countries over the period 1990-2005 that are the earliest (since the mid-eighties) and the most advanced (abstracting from Turkey) reformers in the whole MENA region: Egypt, Jordan, Morocco and Tunisia. Since the start of reforms, the countries have achieved unequally in terms of export diversification. While Tunisia exhibited spectacular increases of the share of manufactures in total exports (45% in 1987 and 69% in 2007) followed by Morocco (37% in 1987 and 53% in 2007), Jordan (38% in 1987 and 39% in 2007) and Egypt (29% in 1987 and 24% in 2007) showed disappointing records. Such achievements are likely to be related to the link between exchange rate policy and manufactured exports.[3] We will come back to this issue latter on.

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[1] Another way to promote the diversification is to improve productivity more than competitors do. However, improvement of productivity is not an easy target in LDCs. Because increased uncertainty about future profitability pushes domestic producers to limit their investment, which further affects their technological upgrading. Rigidity on the labor markets limits greatly the possibility of rationalizing the use of labor by firms and, hence, improvement in labor productivity.

[2] The World Bank (2009)'s *Doing Business*, ranks Egypt 114th out of 181 economies, Jordan 101st, Morocco 128th and Tunisia 73rd. The Global Competitiveness Index of the World Economic Forum[2] ranks Egypt 81st among 134 economies, Jordan 48th; Morocco 73rd , and Tunisia 36th.

[3] On the link between exchange rate and manufactured exports in developing countries, see for instance Sekkat and Varoudakis (2000) and Achy and Sekkat (2003)

Using recent developments in panel-data-co-integration analysis, the paper first examines possible incompatibility between the requirements of macroeconomic equilibrium and those of manufacturing competitiveness. In order to assess the potential incompatibility, the paper compares the evolution of the Real Effective Exchange Rate computed at the macroeconomic level (*REER*), the evolution of similar rates computed at the industry level (*SREERs*) and the one of the Equilibrium Real Effective Exchange Rate (*EREER*). The incompatibility emerges when, for instance, the *EREER* appreciates. In order to comply with the macroeconomic equilibrium requirement the *REER* might need to appreciate too in order to keep on track with the *EREER*. However, in order to foster export and diversification the *SREERs* need to depreciate. One way of achieving this target is to depreciate the *REER*. This implies that the *REER* cannot always keep simultaneously on track with the movement of the *EREER* and the desired movements of the *SREERs*. Hence, the monetary authorities are doomed to choose. If the priority is given to maintaining macroeconomic equilibrium, the *REER* should keep on track with the *EREER* while diverging with the desired *SREERs*. In contrast, the priority given to export diversification should appear in a *REER* that keeps on track with the desired *SREERs* while diverging with the *EREER*. Note, however, that the *REER* can keep on track with both the *EREER* and the *SREERs* if the former depreciates. Alternatively, one can imagine situations where the *REER* keeps on track neither with the *EREER* nor with the *SREERs*.

The rest of the paper is organized as follows. Section 2 provides a descriptive analysis of the *REER* and the *SREERs*. Section 3 presents the estimation of the Equilibrium Real Effective Exchange Rate (*EREER*) using an Edward (1994)’s type model. In section 4, we first compare the three exchange rates to see whether exchange rate management is confronted with a priority problem. It shows that the problem actually exists. The section, then, tackles the question of which objective is given priority in each of the four countries under consideration. It presents Granger causality tests to examine the leads and lags between the *REER* and the *SREERs*. The idea is that if the exchange rate is set by the monetary authorities in order to foster future export competitiveness, changes in the *REER* should be a good predictor (i.e. Granger cause) of the *SREERs*. The results show that Morocco and Tunisia are giving priority to export competitiveness while Egypt and Jordan are not. The last part of Section 4 assesses the gains from the monetary authorities’ choice. Estimations of a simple model of “incentive policies and export performance” using different proxies for exports competitiveness, lend support to the hypothesis that undervaluation is paying off. Section 5 concludes.

2. Macroeconomic and sectors' exchange rates

At the macroeconomic level, the four under-reviewed countries pursued different exchange rate policies. After a long period of peg to the dollar, the Egyptian exchange rate policy witnessed numerous changes. In 1991, monetary authorities replaced the *de facto* peg to the US dollar by an adjustable currency band. In January 2003, they abandoned the adjustable peg regime to adopt a floating exchange rate. Under this regime, the Egyptian pound moved to a free float system where the central bank only intervenes in the foreign exchange market to counter major imbalances and sharp swings in the exchange rate. In Jordan, monetary authorities tied the exchange rate to the Special Drawing Rights (SDR) until 1995 when they decided to peg the Jordan Dinar to the US dollar. In Tunisia, because of historical links and the weight of trade partners, the dinar was first anchored to the French franc and later on to the other currencies of the European Monetary System (EMS). The situation has changed over the last ten years with a growing role attached to a larger basket of currencies giving a more significant role to the US dollar. To some extent, and according to the IMF exchange rate regime classification, the dinar has progressively moved from a crawling peg to a managed floating with no pre-announced path for the exchange rate. As in Tunisia, until the early 1970s, the Moroccan dirham was pegged to the French franc and then, to a basket of currencies. In the late 1990s the dirham moved to a managed or dirty floating (Bubula and Otker-Robe, 2002).

To examine how such exchange rate policies reflect in country's price competitiveness, we compute the Real Effective Exchange Rate (*REER*), which is the most commonly used in this respect. It assumes the existence of competition between the country under study and its trading partners. One major issue with the construction of the *REER* is the debated subject about the appropriate price index. On a long-term basis, we hypothesize that exporters cannot deviate from the "law of one price". Then our concern is to find an index allowing comparisons of domestic costs of production across countries that may reflect relative long run ability to produce while remaining profitable. The IMF regards the unit labor cost (ULC) in manufacturing as a simple and useful index for the measure of competitiveness. However, if its evolution offers a reliable gauge of the profitability of traded goods, most developing countries lack the data to calculate it.

The Wholesale Price Index (WPI) does not prove to be an appropriate alternative to the ULC. Not only it is also available for few countries, generally industrialized economies, but it under-weighs non-traded goods. Therefore, it does not reflect the long run profitability as reallocations may exist in the short run between wages and profits for the constraint of competitiveness to be maintained. Accordingly, the Consumption Price Index will be preferred for the construction of the *REER*. This index is available over a long period and incorporates a significant non-traded component. In addition, the CPI tends to be correlated with production costs as salary arrangements generally rely on its evolution. However, one limitation underlying the use of this index is that nominal wages and unit labor costs are supposed to be related in the same way across countries. In other words, the effect of the change in labor productivity on wages is assumed not to differ much across the trading partners incorporated in the calculation of the REER. However, following Chaffai, Plane and Tikki (2009), Tunisia is probably the only potentially problematic case among the four understudied countries. Indeed, some of its manufacturing sectors prove to be in a long run total factor productivity catching up process with those of OECD members. These most industrialized countries are also the main trading partners considered for the construction of real exchange rates. For a given country, this real exchange rate index comes as follows:

$$Log(REER) = \sum_{j=1}^{j=10}\left[w_j * Log\left(e_j * \left({}^{CPI}/_{CPI_j}\right)\right)\right] \quad (1)$$

where:

CPI is the Consumer Price Index of the country;

CPI_j is the Consumer Price Index of the country’s partner j;

e_j is the nominal bilateral exchange rate of the country as regard partner j;

w_j is the weight of the j-th partner in the bilateral trade of the country.

The weighting pattern refers to the 10 largest trade partners over the period 1999-2003 excluding oil exporting countries (i.e. those for which petroleum related products represent at least 50% of their exports). Weights are calculated at the end of the period of observations in order to focus on the competitiveness diagnosis for the most recent years. This choice allows taking into account the increasing contribution of some large emerging countries such as China, India or Brazil. Because of its better statistical properties, a geometric rather than an arithmetic mean of the relative prices has been used to compute the *REER*. An increase of the *REER* means an appreciation and, hence, a potential loss of competitiveness.

One of the most cited criticisms to the *REER* as a competitiveness indicator is that the geographical distribution of aggregated bilateral trade does not reflect the effective international competition across sectors. Tradables are not a homogeneous basket of goods having the same price evolution as it was assumed for a long time in macroeconomic models.

Prices potentially vary between imported and exported goods as witnessed by the evolution of the international terms of trade. Prices are also subject to change within a national productive system between manufactured products, for example according to the trade liberalization process, as well as between primary commodities in connection with world prices. The elaboration of product-specific real effective exchange rates indexes (*SREERs*) is a way to better assess the ability of a country to export while taking into account the specific characteristics of products.

To our best knowledge, Goldberg (2004) was the first to highlights the issue. She constructed sector-specific real exchange rates and presented their paths for the USA. She found that the period-to-period percentage changes in sector-specific and aggregate exchange rates could differ substantially. Using the impact of exchange rate changes on producers' profits as an illustration, Goldberg (2004) showed that using aggregate exchange rate indexes instead of sector-specific ones could underestimate the empirical importance of exchange rates for producers. One can, therefore, expect that the use of aggregate instead of industry-specific rates also affects the estimated incentive for producers to export.

To compute sector-specific real exchange rates (*SREERs*), we focus on the export structure. The first step to build these rates consists in disaggregating the international trade of each the four countries according to the 4-digit of the Standard International Trade Classification (SITC). For each of good we compute a separate series of *SREER*. In the construction of a specific *SREER*, we take into account the ten largest world-exporters of the corresponding good. The weight which is attributed to each of these exporters depends on its importance in the country's exports toward the ten partners. For a given country and a given sector s the $SREER_s$ is given by:

$$Log(SREERs) = \sum_{j=1}^{j=10} \left[w_{js} * Log\left(e_j * \left({}^{CPI}/_{CPI_j} \right) \right) \right] \qquad (2)$$

where

CPI is the Consumer Price Index of the country;

CPI_j is the Consumer Price Index of the country's partner j;

e_j is the nominal bilateral exchange rate of the country as regard partner j;

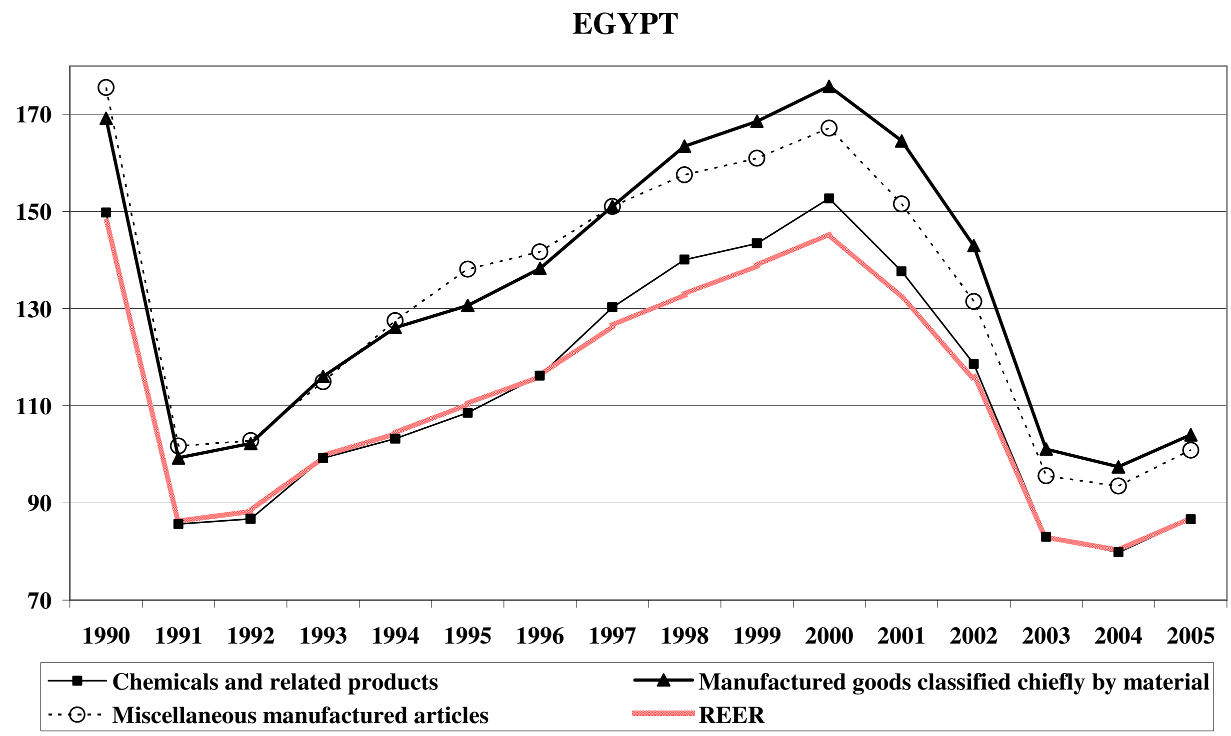
w_{js} is the weight of the j-th partner in total international trade pertaining to sector s.

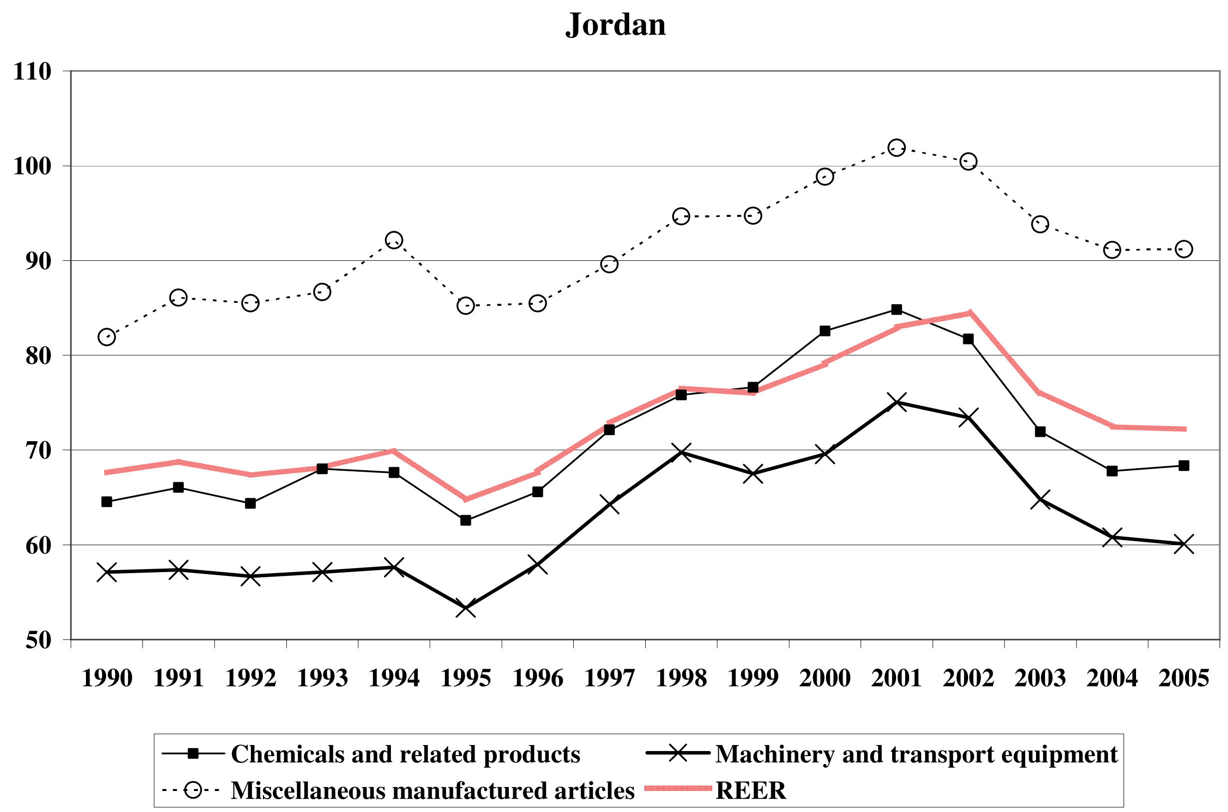
The same calculation is replicated as many times as the number of goods exported by the country requires, provided that the good represents at least 1% of average national exports over the period 1999-2003. To get a single *SREER* for all the 4-digit products for a given country, we compute:

$$Log(SREER) = \sum_{s=1}^{s=S} [q_s * Log(SREERs)] \qquad (3)$$

where q_s is the weight of the s-th good in the country's total exports. The weights are given in Appendix A.

Figure 1: Evolution of the *REER* and *SREERs* (1980 = 100)




Jordan
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60
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1990
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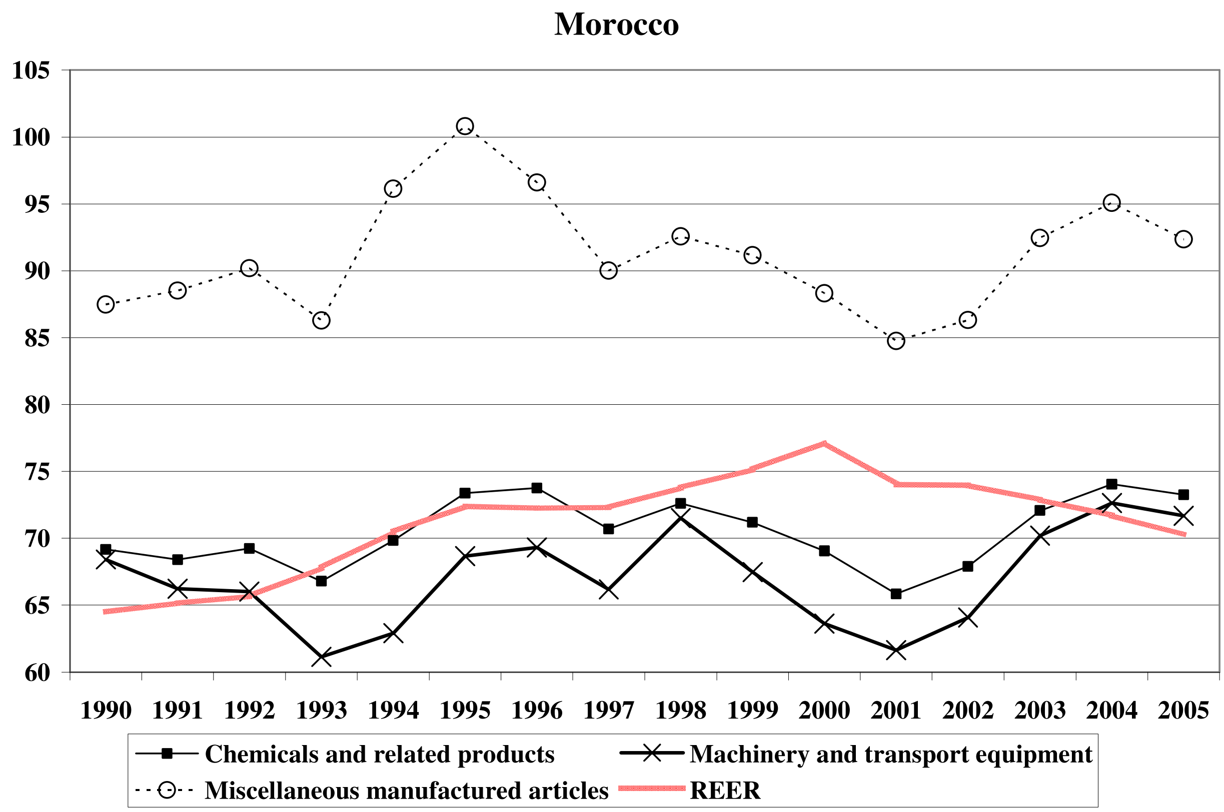
2004
2005
Chemicals and related products
Machinery and transport equipment
Miscellaneous manufactured articles
REER


Morocco
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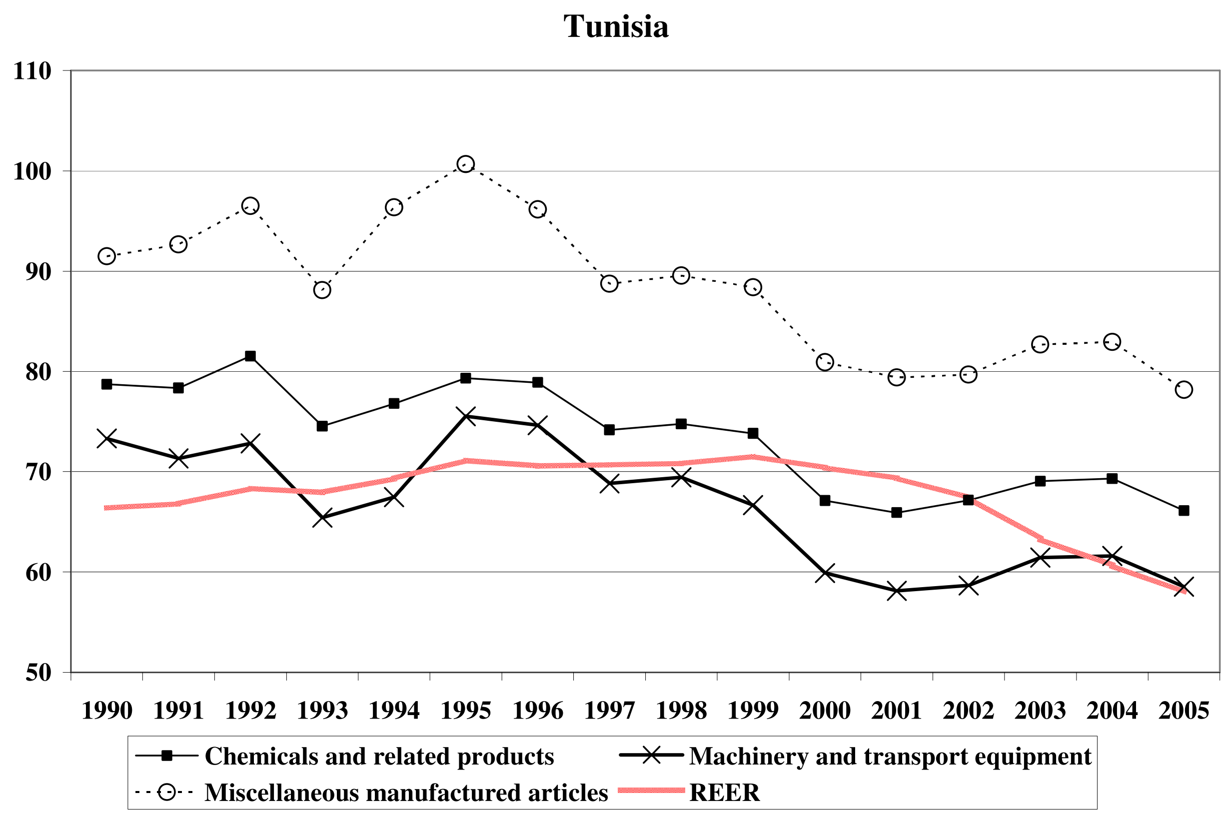
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
Chemicals and related products
Machinery and transport equipment
Miscellaneous manufactured articles
REER


Tunisia
110
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1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
Chemicals and related products
Machinery and transport equipment
Miscellaneous manufactured articles
REER

Figure 1 presents the *REER* over the 1990s for each country. The evolutions reflect the pursued exchange rate policies. The Egyptian pound exhibits large fluctuations. The currency depreciated markedly in 1990-91, then steadily appreciated between 1992-2000, to depreciate again significantly after 2000. This long run evolution displays the difficulty of monetary authorities to deliver clear relative price signals. The Jordanian dinar shows a slow and steady appreciation over the period. In contrast, in Morocco and Tunisia the exchange rates show a slow and steady depreciation over the period.

Figure 1 also reports the *SREERs*. Actually, the *SREERs* are computed separately for 23 to 31 products (at the 4-digit level) depending on the country (See Appendix A). For readability, and although any aggregation of the 4-digit products underestimates the variability of relative prices, the figure presents the results for products aggregated at 1-digit using the weights in Appendix A. In Egypt, the figure reveals a similar evolution of the *REER* and the *SREERs* and Jordan exhibits almost a similar picture. In Morocco and Tunisia, the evolutions of the *REER* and the *SREERs* are different; especially in Morocco. The divergence is mainly due to the *SREER* of the sector "Miscellaneous manufactured articles" which has an important weight in both countries. This sector has a much lower weight in Jordan and Egypt.

To shed further light on the relative evolutions of the *REER* and *SREERs*, Table 1 displays the results of a correlation analysis. Here, we take advantage of all the information we have by computing a separate correlation coefficient between the *REER* and the *SREERs* of each product at the 4-digit level. The table gives, for each country, the percentage of correlation coefficients belonging to each class.

Table 1: Pattern of the correlation between the *REER* and *SREERs* Four-Digit products (1980-2005)

	EGYPT	JORDAN	MOROCCO	TUNISIA
Number of 4 digit-products	27	23	31	28
Percentage of correlation:				
Less than -60	0.00	0.00	3.23	0.00
Between -60 and -30	0.00	0.00	16.13	7.14
Between -30 and 30	0.00	0.00	29.03	10.71
Between 30 and 60	0.00	0.00	6.45	17.86
Between 60 and 80	0.00	17.39	16.13	14.29
Between 80 and 90	0.00	0.00	0.00	14.29
Higher than 90	100	82.61	29.03	35.71
Total	**100**	**100**	**100**	**100**

Sources. Calculations from the CD-ROM; Personal Computer Trade Analysis System (PC-TAS) of the International Trade Centre (ITC). World Development Indicators, World Bank and International Financial Statistics, IMF, various years.

Here, the contrast between Egypt and Jordan on one hand and Morocco and Tunisia on the other hand is much more visible. In Egypt, all correlation coefficients are higher than 90% and in Jordan, more than 80% of the coefficients are higher than 90%. In Morocco and Tunisia, no more than 36% of correlation coefficients are higher than 90%. Both countries exhibit, even, a non-negligible share of negative or zero coefficients.

The fact that Morocco and Tunisia exhibit different evolutions of the *REER* and *SREERs* could be interpreted as exchange rate management favoring macroeconomic equilibrium at the expense of export diversification. This is not necessarily true, however. On the one hand, to assert that the priority is given to one objective over another, one should first investigate whether the objectives are incompatible. Hence, the Equilibrium Real Effective Exchange Rate (*EREER*) should be computed and compared to the *REER* and the *SREERs*. On the other hand, the correlations in Table 1 are contemporaneous. Supporting export diversification may imply that the *REER* movements precede the *SREERs*'. To address these issues, the next section computes the *EREER* while the subsequent one compares the leads and lags between the three exchange rates.

3. Exchange rate and macroeconomic equilibrium

3.1 The economic model

The *REER* discussed above is widely used as an indicator of the "price competitiveness" of an economy. However, because of misconceived policies or imperfect functioning of the exchange market, it may be a poor indicator of the competitiveness of an economy. Misconceived economic policies can maintain exchange rate away from its equilibrium level but a country can also be willing to keep an over evaluated exchange rate in order to reduce the cost of importing machinery and other inputs for domestic firms. The resulting misalignment has been found to be damaging to economic performance (Edwards, 1988 and Cottani et al. 1990) implying that the *REER* should be maintained as close as possible to its equilibrium level (i.e. *EREER*).

Over the last thirty years, the economic literature on the exchange rate has developed in a way that allowed determining the influence of a limited range of variables affecting the long run real value of a currency (e.g. Williamson, 1994; Edwards, 1998). These variables, called the "fundamentals", include external (e.g. the international terms of trade) as well as internal factors (e.g. government expenditure). The impact of these determinants can be estimated through an econometric regression and are used to calculate the *EREER* as well as the potential accompanying misalignment of the actual rate. Practically, the *REER* is decomposed into the *EREER* and misalignment. Edwards (1988) was the first to propose an approach that makes it possible to distinguish between the two sources of *REER* variations. The latter is regressed on external and domestic ''fundamentals'', which bring about changes in the *EREER* if sustained over a long time period and do not create misalignment, unless price adjustment is extremely sluggish. In estimating the impact of these factors, we use the following empirical model (Edwards, 1994):

$$\text{Log}(REER) = \alpha_0 + \alpha_1 \text{Log}(Open) + \alpha_2 \text{Log}(Cap) + \alpha_3 \text{Log}(ToT) + \alpha_4 \text{Log}(rDebt) + \alpha_5 \text{Log}(Gov) + \alpha_6 \text{Log}(GDPgap) + \alpha_7 \text{Log}(BalSam) + \varepsilon \quad (4)$$

For clarity, we drop the year and country indices. The *REER* is defined in Equation 1, *ToT* is the terms of trade (the ratio of export to import prices), *Open* is the ratio of export plus imports to GDP, *Cap* is the net capital inflow scaled by GDP, *Gov* is government consumption in percentage of the GDP, *rDebt* is the country debt services including interest payments and reimbursements as a share of GDP, *GDPgap* is the difference between the country's growth rate and the average growth rate over the whole sample and *BalSam* is the ratio between the country's real per capita GDP and the geometric mean (weighted in a similar way as the exchange rate) of the same variable in the 10 major trading partners.

We expect a rise in the terms of trade to appreciate the equilibrium *REER* to the extent that it improves the trade balance; the income effect dominating the substitution effect; α_3 is expected to be positive. It is expected that restricted trade openness will exert downward pressure on the relative price of tradable to non-tradable goods, thereby leading to an appreciation in the equilibrium *REER*; α_1 is expected to be negative. Higher capital inflows involve stronger demand for both tradables and non-tradables and lead to a higher relative price of non-tradables and *REER* appreciation. This is needed for domestic resources to be diverted toward production in the non-tradable sector in order to meet increased demand; α_2 is expected to be positive. Government consumption has a similar effect: stronger demand for non-tradables increases their relative prices leading to an appreciation in the equilibrium *REER*; α_5 is expected to be positive. The higher the country debt services the higher will be the demand for foreign currencies inducing depreciation of exchange rate; α_4 is expected to be negative. The variable BalSam reflects a productivity gap and aims at capturing the potential Balassa-Samuelson effect. Assume the prices for tradable sectors homogeneous across countries and their productivity higher than in non-tradable sectors. The increase in wages in the tradable sectors due to higher productivity spills over the wages in non-tradable sectors. The latter induce an increase in inflation and an appreciation of the *REER*; α_7 is expected to be positive.

3.2 The econometric analysis

Equation (4) will be used to estimate the *EREER* and potential misalignment on a sample of 52 developing countries from Africa, Asia and Latin America over the period 1980-2005 (See Appendix B)**.** However, as explained above, the *EREER* concerns the long-term relationship between the *REER* and the fundamentals. In order to determine such a relationship, one should use the co-integration methodology (Engle and Granger, 1987). The latter allows separating the long and short-term relationships between the *REER* and the fundamentals.

While co-integration analysis has been for a long time applied to "pure" time series (e.g. a given country over time), in this paper we take advantage of the time series and the cross-section dimensions of the sample to study the relationship in Equation (4) using recent developments of panel-data-co-integration analysis. The latter allows for more efficient estimation and testing, especially when the number of time periods is limited (e.g. Levin and Lin, 2002; Im, Pesaran and Chin, 2003; Moon and Perron, 2004; Chang, 2002; Pesaran, 2005; Pedroni 2004 and Kao and Chiang, 1998).

The model is estimated by considering a panel dataset of 52 developing countries from Africa, Asia and Latin America over the period 1980-2005. The sample is determined according to the availability of data with the major source of information we used (e.g., the World Development indicators of the World Bank). Pooling the data potentially improves the robustness of estimations with misalignments being determined according to a "normal" behavior given by the average estimated coefficients over the sample. Moreover, panel data being vulnerable to countries heterogeneity, country fixed effects have been introduced in the empirical model. Time fixed effects did not prove statistically significant over the period. In order to avoid too much technicality in the main text, the panel-data-co-integration analysis is presented in Appendix C. The resulting long-term relationship between the *REER* and the explanatory variables is given in Table 2. It has a good overall quality of fit and all the coefficients are significant with the expected sign.

Table 2. Panel data estimation results of the REER (1980-2005)

Equation (4)

Variables	Coefficients
Cap	0.00
	4.02
Open	-0.52
	-14.01
BalSam	0.38
	7.90
rDebt	-0.11
	-6.11
Gov	0.25
	6.25
ToT	0.12
	3.31
GDPgap	-0.01
	-1.75
Adjusted-R^2	0.60

Sources. *World Development Indicators*, World Bank and *International Financial Statistics*, IMF, various years. Note that t-statistics are in bold

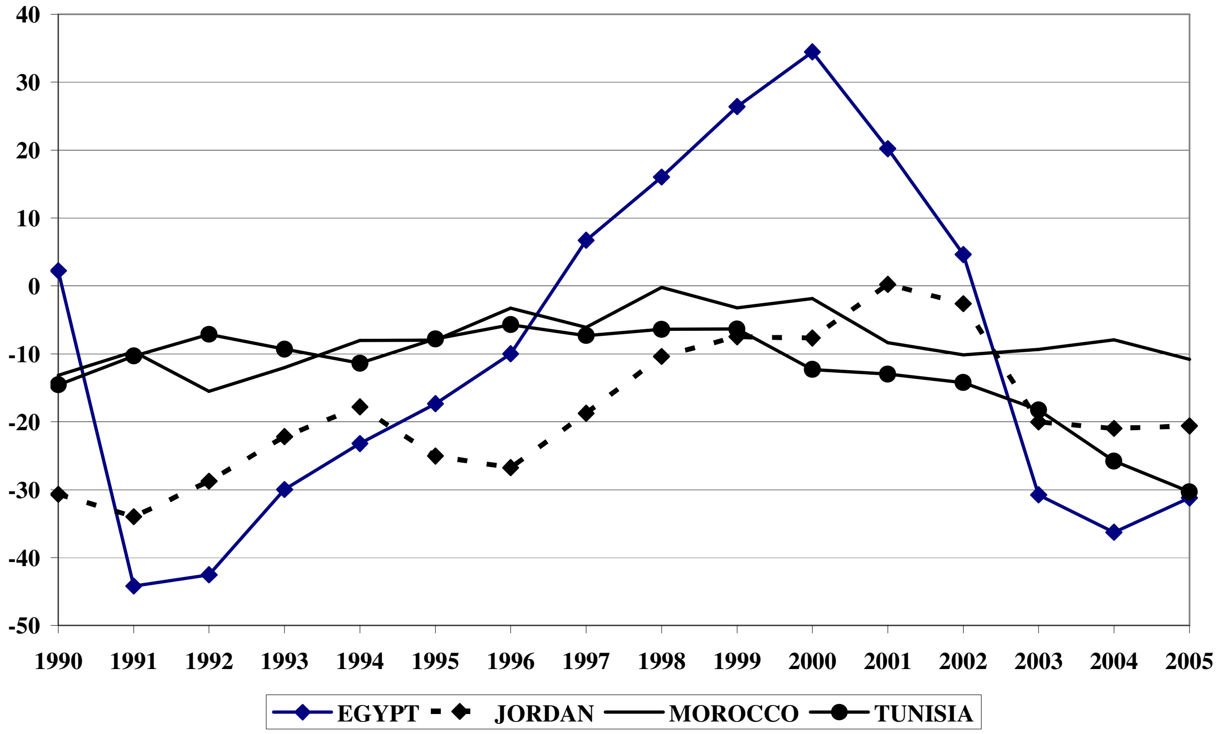
Using the coefficients in Table 2, one can compute the extent of the *REER* misalignment. Recall, however, that misalignment refers to the difference between the *REER* and its equilibrium level; the *EREER*. The latter is given by the fitted values using together the estimates in Table 2 and the long run values of the explanatory variables. To get such long run values, we use the Hodrik-Precsott filter to separate the permanent and temporary components of each variable.

We define misalignment as:

$$Mis = (REER \,/\, EREER - 1) * 100 \qquad (5)$$

the positive values of which correspond to overvaluations. Figure 2 shows the extent of misalignment in the four countries since 1990. Egypt exhibits wide variations with a notable over-evaluation in the mid-1990s and under-evaluation elsewhere. Jordan also shows important variations, although less pronounced than in Egypt. The Jordanian dinar is usually under-evaluated. This is the case also in Morocco and Tunisia.

Figure 2. Exchange rate misalignments 1990-2005



4. Competitiveness, the *REER*, and the *SREER*

In Section 2, we found that Morocco and Tunisia exhibit different evolutions of the *REER* and *SREERs* which could be interpreted as exchange rate management favoring macroeconomic equilibrium at the expense of export diversification. However, in Section 3, we found that Jordan, Morocco and Tunisia exhibit usually undervaluated currencies which could be interpreted as exchange rate management favoring export diversification over macroeconomic equilibrium. The two interpretations seem contradictory. However, they may not be for two reasons. First, exchange rate management may be pursuing another target or no target at all. In this case, the above results should not be interpreted in terms of priorities between macroeconomic equilibrium and export diversification. It is, however, beyond the scope of this paper to examine whether exchange rate management is pursuing a third target or no target. Second, for the interpretations to be contradictory the two objectives should be incompatible. This should show up in different evolutions of the *EREER* and the *SREERs*.

4.1. Are macroeconomic equilibrium and export diversification incompatible?

To explore the potential incompatibility, Table 3 compares the evolution of exchange rates over 3 sub-periods.

Table 3. Annual growth rates: REERs, EREERs and SREERs (1990-2005)

Sectors	1990-1994	1995-1999	2000-2005
Egypt			
Sector-based exchange rates (SEERs)			
Chemicals and related products	-6.23	7.05	-10.71
Manufactured goods classified chiefly by material	-5.04	6.11	-9.96
Miscellaneous manufactured articles	-4.68	3.89	-9.61
REER	-5.70	5.67	-9.75
EREER	-1.60	-4.13	3.19
Jordan			
Sector-based exchange rates (SEERs)			
Chemicals and related products	-0.62	5.70	-3.70
Machinery and transport equipment	-1.35	5.44	-2.88
Miscellaneous manufactured articles	0.79	3.01	-1.60
REER	-0.88	4.11	-1.81
EREER	-2.42	-0.14	1.20
Morocco			
Sector-based exchange rates (SEERs)			
Chemicals and related products	1.19	-1.21	1.18
Machinery and transport equipment	0.08	-1.52	2.41
Miscellaneous manufactured articles	2.87	-2.61	0.90
REER	2.33	1.28	-1.85
EREER	1.15	-0.02	0.04
Tunisia			
Sector-based exchange rates (SEERs)			
Chemicals and related products	0.16	-3.29	-0.30
Machinery and transport equipment	0.60	-4.53	-0.46
Miscellaneous manufactured articles	1.93	-4.28	-0.68
REER	1.39	-0.20	-3.81
EREER	-0.14	0.80	0.71

Sources. Idem table 1

As noticed before, the *REER* and the *SREERs* in Egypt are closely connected. They appreciate or depreciate by almost the same amounts across the 3 periods. However, such evolutions seem disconnected from the *EREER*. For instance, between 1995 and 1999 the *REER* and the *SREER* appreciated while the *EREER* depreciated. During this period, exchange rate policy could have depreciated the *REER*, which might have depreciated the *SREER* and fostered industries competitiveness. At the same, this would have reduced macroeconomic misalignment. That was not done. Between 2000 and 2005, the reverse holds. The *REER* and the *SREERs* depreciated while the *EREER* appreciated. Here, the objectives of macroeconomic equilibrium could have not been achieved without affecting export competitiveness.

The observation for Egypt over the periods 1995-1999 and 2000-2005, partially applies to the other countries, although the magnitude of the phases becomes smoother while moving from Egypt to Jordan, from Jordan to Morocco and Tunisia. To some extent, this hierarchy reflects the ability of officials to promote consistent policies for manufactured exports. In Egypt, the instability of the exchange rate may have been a source of disincentive. Instability accentuated in mid-nineties with the floating exchange rate regime and the overvaluation impact of international remittances. Moreover, incentive programs built around tax incentive programs did not work well because they pursued too many diffuse objectives and were administrated in overly bureaucratic fashion (Rodrik, 2009). Jordan also suffered from similar problems. Although monetary policy was officially targeted towards maintaining a fixed exchange-rate peg to the US dollar, the real exchange rate of the dinar appreciated in the mid-nineties with the increase in international remittances. This played against the long run interest of the export promotion strategy. In Morocco and above all in Tunisia, exchange rate policies were narrowly linked to the development of the real sector and the applications of the association agreement with the European Union. In the mid-eighties, Tunisia was especially efficient in combining both, exchange rate and industrial policies. Under the *Mise à niveau program,* firms were eligible to receive technical and financial assistance to upgrade their operations and become internationally competitive (Murphy, 2006; Rodrik, 2009).

Overall, the results suggest that there are instances where the objectives of export diversification and macroeconomic equilibrium are incompatible.

4. 2. Does export diversification have priority?

This section investigates whether countries give priority to exports diversification. To facilitate the presentation, we will use the "aggregate" *SREER* instead of the ones by good. As noted before, a deliberate support to export diversification implies that the *REER* movements precede the *SREERs*'. One possible way to address this question is to use the Granger causality approach to examine the leads and lags between the *REER* and the *SREER*. If the exchange rate is set by the monetary authorities in order to foster future export competitiveness, changes in the *REER* should be a good predictor (i.e. Granger cause) of the *SREER*.

The seminal paper by Granger in 1969 presented a simple test of causality. Consider two stationary variables x and y. Variable y is causing x if one is able to better predict x using past information on y than without using such information. In practice, an equation is estimated where x is regressed on its own lags and the lags of y. If y causes x, the statistic pertaining to the joint significance of the coefficients of the lagged y in the x equation should be above the critical level. Like for co-integration, the Granger test was for a long time conducted in a pure time series context. Now, new tests taking advantage of both the time series and the cross-section exist.

Here, we use the test by Hurlin (2004) which is similar in spirit to Pesaran (2004) presented in Appendix C. The average of the statistic (i.e. Wald statistics) pertaining to the joint significance is computed. If the computed value is higher than the critical level the existence of causality is accepted.

To test for causality in a panel (x_{it} , y_{it}); where *i* (=1, 2,….N) refers to individuals and *t* (=1, 2,….T) to time, conduct a traditional Granger regression for each individual. Denote the Wald statistics pertaining to the causality for individual *i* W_{iT} and compute their simple mean:

$$W_{N,T}^{Hnc} = \frac{1}{N} \sum_{i=1}^{N} W_{i,T} \qquad (6)$$

When *N* and *T* tend to infinity, Hurlin (2004) shows that this simple mean converges to a normal distribution. For finite *N* and *T*, the author provides critical values.

Table 4. The results of the tests of between the REER and the SREER

Null hypothesis: No causality running from REER to SREER	
Computed statistics all countries	462.50
Computed statistics by country:	
Egypt	*0.21*
Jordan	*1.27*
Morocco	*1434.41*
Tunisia	*121.84*
Computed statistics all countries but Morocco	41.26
Computed statistics all countries but Morocco and Tunisia	-0.30
Critical value	2.53

Sources. Idem table 1

Table 4 presents the results of the causality tests over the period 1980-2005. The first line gives the computed statistics considering the four-country-panel. The non-causality hypothesis is rejected. It seems that the *REER* is causing the *SREER*. However, looking at the relative size of the individual statistics suggests that Morocco and Tunisia are specials. Morocco exhibits a very high statistic followed by Tunisia. To check whether the results are driven by these 2 countries only, we rerun the tests excluding Morocco first. The results confirm the existence of causality running from *REER* to the *SREER*. Next, we rerun the test of causality from *REER* to the *SREER* excluding Morocco and Tunisia. We found no causality. Hence, with Morocco and Tunisia in the sample the results confirm that movements of the *REER* allow predicting those of the *SREER*. With only Egypt and Jordan in the sample, this is not the case. In our framework, this implies that export diversification has been given priority over macroeconomic equilibrium in Morocco and Tunisia but not in the two other countries.

4. 2. Is the priority paying off?

Although our results show that in the case of Tunisia and Morocco export diversification seems to have a certain priority, this is not the end of the story. A remaining important question concerns the extent to which such a strategy is rewarding. To complete the analysis one should, therefore, assess the extent of undervaluation pay off. The pay off is positive if keeping in track with the *SREER*, instead of keeping in track with the *EREER*, incites exporters of manufactures to sell more abroad. If there is no difference in exports of manufactures, the choice made by the countries might become unnecessary and even socially costly (due the potential induced misalignment). In contrast, if such export is higher when track is kept with the *SREER*, the choice induces benefits that might, at least in part, compensate for the cost.

To examine whether targeting the *SREER* instead of *EREER* incites exporters to sell more abroad, we use a simple model suggested by Balassa (1990) to study "incentive policies and export performance". The approach consists in modeling foreign demand of good *s* and domestic supply of the same good pertaining to country *j*, to estimate the effects of price incentives on exports. Foreign demand (X^F) is affected by the international competitiveness of the country's good, traditionally proxied by changes in the *REER*, and foreign incomes (Y^F). In turn, supply of country's exports (X^D) is affected by changes in the *REER* and a potential domestic capacity constraint (C^D). Equilibrium, implying $X = X^F = X^D$, gives an estimable reduced form equation. Given the difficulty to observe capacity constraint, Balassa estimated a slightly modified version of the reduced form, that is, X is scaled by a country's GDP. In our empirical model, we adopt the same strategy. The following equation has been estimated, using OLS with fixed effects,[4] on a pooled sample over 12 years (1992-2003), 5 goods (Chemicals and related products, Manufactured goods classified chiefly by material, Miscellaneous manufactured articles, Food products) and for the four MENA countries we refer to:

$$(X_{sjt} / GDP_{jt}) = \alpha_{0s} + \alpha_{0j} + \alpha_1 * (XW_{st} / GDPW_t) + \alpha_2 \ Exchange \ rate_j + \varepsilon_{sjt} \qquad (7)$$

where the ratio of world exports of good *s* (XW_{st}) over world products ($GDPW_t$) proxies the world demand for good *s*. Countries (*j*) and goods (*s*) fixed effect are respectively α_{0j} and α_{0s}, t is the time index and ε_{sjt} the error term.

To assess the extent of undervaluation pay off, one should examine how the change in manufactured exports depends on the monetary authority's choice. This can be examined in two ways. One uses the responsiveness of exporter to the changes in the *SREER* as compared to their responsiveness to the *EREER*. This is done by running Equation (7) using successively the *SREER* and the *EREER* instead of the *REER* and compare the coefficients. This is presented in Table 5. In Specification 1, the coefficient of the *SREER* is highly

[4] Ideally, we should use also co-integration techniques to estimate the equation. However, due to missing observations across time the approach would not make sense.

significant and negative as expected, providing the highest adjusted R^2. In Specification 2, the coefficient of the *EREER* is non-significant. It seems that exporters react to changes in the *SREER*, this index being close to microeconomic concerns through relative costs conditions on the four-digit products (i.e., long run profitability), but not to changes in the *EREER,* which reflects global macroeconomic equilibrium conditions. However, the literature uses, in general, the *REER* instead of the *EREER*. This implies that the two first specifications might suffer from an omitted variable bias. We address this potential problem in Specifications 4 by adding the new variable "*Misalignment"* as an additional explanatory. The variable "*Misalignment"* is computed simply as (*REER* - *EREER*); its increase means undervaluation. Therefore, we have the same specification as traditionally used in the literature except that we allow the two components of the *REER* to have different coefficients. By symmetry, we do the same for Specifications 3. Interestingly, the coefficient of the *EREER* remains non-significant but the coefficient of *Misalignment* is significantly negative. This confirms that undervaluation incites exporters to sell more abroad than a depreciation of the equilibrium exchange rate. In specification 4, the coefficient of the *SREER* remains significantly negative with a similar value as before. The coefficient of *Misalignment* is non-significant. Moreover, the coefficients of the *SREER* and *Misalignment* are not significantly different. The results of the four specifications suggest that exporters are more responsive to undervaluation or a depreciation of the *SREER* than to a depreciation in the *EREER*, which lends support to the hypothesis that undervaluation is paying off.

Table 5. Responsiveness of manufactured exports to exchange rate

Variables	Specifications			
	1	2	3	4
XW / GDPW	3.339	4.541	3.547	4.174
	4.372	***6.362***	***4.451***	***5.605***
SREER	-0.039		-0.034	
	-3.540		***-2.761***	
EREER		0.040		-0.025
		0.344		***-1.584***
Misalignment			-0.008	-0.041
			-0.622	***-2.575***
Number of observations	160	160	160	160
Adjusted R^2	0.346	0.230	0.343	0.327

Sources. Idem table 1. Note that t-statistics are in bold and estimates are heteroskedastic-consistent

The other way of assessing the extent of undervaluation pay off is to estimate the responsiveness of manufactured exports to changes in the *REER* and use the corresponding coefficient to simulate the levels of exports when monetary authorities keep on track with the *EREER* and when they keep on track with the *SREER*. Estimation of Equation (7) using the *REER* gives a significant coefficient of -0.036 and an Adjusted R^2 of 0.323. The simulations show that, except for Egypt, all countries have higher exports when the *SREER* is used. The ratios of the simulated exports with the *SREER* over the simulated exports with the *EREER* are 96% for Egypt, 140% for Jordan and 119% for Morocco and for Tunisia. Manufactured exports are higher if monetary authorities keep on track with the *SREER* than when they keep on track with the *EREER*. It seems, here again, that undervaluation is paying off.

5. Conclusion

In search of growth and development, developing countries have been seeking the promotion of the industrialization of their economy. A majority of them relied on import substitution strategy, which turned out to be a failure. Diversification did not occur and the productive systems suffered greatly from high trade barriers and distorted relative prices. A major policy shift then took place by the mid-1980s emphasizing trade liberalization and exchange rate management with a similar objective as before, i.e. enhancing growth by moving from primary commodity exports to manufactured exports. In this perspective exchange rate management was assigned a specific role on which this paper focused on.

Over the past decades, the literature on exchange rate management has varied significantly. Earlier work by Krueger and Balassa focused on the trade dimension: exchange rate change is determined according to the need to compensate producers for the impact of the tariff removal. In the turmoil of the eighties, exchange rate was seen as an instrument to adjust the economy to internal and external equilibrium. This equilibrium concept, initiated by Edwards, was used to shed light on the negative relation between a misalignment of the exchange rate and an economic growth penalized by the export performance. This implies that countries should keep their exchange rate as close as possible to the equilibrium level. Subsequently, however, theoretical and empirical analyses suggest that a proactive exchange rate strategy taking the form of depreciated national currency could be conductive to long run employment and growth.

At the present stage, exchange rate management is assigned two pro-growth objectives: macroeconomic equilibrium and export diversification. However, the two objectives might not always be compatible. When this is the case, a LDC is doomed to choose. This paper addresses three questions: i) whether the monetary authorities of the emerging countries are doomed to choose; ii) which objective is given priority and iii) is the choice paying off.

To address the first question, the paper first examines possible incompatibility between the requirements of macroeconomic equilibrium and those of manufacturing exports competitiveness using three exchange rate concepts: the macroeconomic Real Effective Exchange Rate (*REER*), the Equilibrium Real Effective Exchange Rate (*EREER*) computed at the macroeconomic level and the sector Real Effective Exchange Rate (*SREERs*). The results of four emerging countries (Egypt, Jordan, Morocco and Tunisia) confirm that the incompatibility is likely, that is, in some instances macroeconomic equilibrium requires the currency appreciation while export diversification requires depreciation.

The second question is addressed by examining whether export diversification is given priority. This issue is investigated considering the leads and lags between the three exchange rates. Giving the priority to export diversification implies that the exchange rate is set by the monetary authorities in order to foster future export competitiveness. If this is the case, changes in the *REER* should be a good predictor (i.e. Granger cause) of the *SREER*. The results show that movements in the *REER*, indeed, precede those of the *SREER* in Morocco and Tunisia but not in Egypt and Jordan. Morocco and Tunisia seem, therefore, to set the exchange rate in order to foster future export competitiveness even at the expense of macroeconomic equilibrium.

The third question is examined using a simple model of "incentive policies and export performance" where manufactured exports are determined by foreign demand and a proxy of exports competitiveness. The model is estimated on a pooled sample over 11 years, 5 goods and 4 countries. Using different proxies for exports competitiveness, the results lend support to the hypothesis that undervaluation is paying off.

Appendix A: Products involved in the computation of the SREER

EGYPT		**JORDAN**		**MOROCCO**		**TUNISIA**	
Product	Share	Product	Share	Product	Share	Product	Share
Rice,milled,semi-milled	4.61	Sheep and goats, live	2.59	Processed cheese, whole	1.31	Fish,fresh,chilled,whole	2.00
Potatoes,fresh,chilled	1.48	Tomatoes,fresh,chilled	9.37	Fish,fresh,chilled,whole	4.44	Crustaceans, frozen	3.62
Oranges, etc.	1.50	Oth.frsh,chll.vegetables	11.47	Fish,frozen ex.fillets	1.32	Molluscs	2.53
Carbon nes,carbon black	5.67	Fruit,fresh,dried, nes	1.57	Crustaceans, frozen	1.82	Flour of wheat, meslin	1.61
Medicaments, nes	3.73	Food waste,animal feeds	2.04	Molluscs	21.51	Veg.prepared,presrvd,nes	2.30
Detergents,except soap	2.12	Inorganic acid,oxide etc	9.68	Fish,prepard,presrvd,nes	11.73	Fruit,fresh,dried, nes	6.36
Nitrogenous chem.fertlzr	4.62	Medicaments,antibiotics	3.50	Tomatoes,fresh,chilled	4.87	Food preparations, nes	1.41
Polyethylene	1.72	Medicaments, nes	19.22	Oth.frsh,chll.vegetables	2.46	Inorganic acid,oxide etc	4.91
Tyres,pneumatic,new,bus	1.87	Soap	2.97	Veg.prepared,presrvd,nes	4.65	Phosphites,phosphate,etc	1.73
Cotton yarn,excl. thread	10.42	Detergents,except soap	3.50	Oranges, etc.	10.37	Phosphatic chem.fertlzrs	3.06
Cotton fabric,wvn,unblch	2.85	Nitrogenous chem.fertlzr	10.42	Fruit,fresh,dried, nes	1.60	Fertilizers, nes	5.45
Household linens	9.15	Paper,paperbrd,corrg,etc	2.75	Inorganic acid,oxide etc	13.44	Oth.elec power mach,part	2.07
Portland cement, etc.	4.18	Containers,etc.of paper	1.95	Phosphatic chem.fertlzrs	1.75	Switch.apparatus,<1000v	4.59
Building stone,workd.etc	3.88	Portland cement, etc.	4.69	Fertilizers, nes	7.25	Insultd wire,etc.condctr	8.70
Other ferro-alloys	1.63	Aluminium,alum.alloy,wrk	1.93	Insultd wire,etc.condctr	7.06	Other parts,motor vehicl	1.72
Flat,hot-rolld,prod.iron	2.32	Pub-transport pass vehcl	2.32	Diodes,transistors etc.	12.32	Trousers,breeches,etc.	17.94
Flat,hot-rolled s.steel	4.10	Suits and ensembles	4.59	Trousers,breeches,etc.	10.63	Shirts	2.68
Bar,rod iron,stl.hot-fd	4.99	Jackets and blazers	3.76	Shirts	3.19	Jackets	1.76
Alum.,alum.alloy,unwrght	8.13	Trousers,breeches,etc.	7.83	Jackets	2.10	Skirts & divided skirts	2.00
Aluminium,alum.alloy,wrk	1.61	Shirts	10.94	Dresses	1.37	Trousers, breeches etc.	7.40
Ceramic plumbng fixtures	7.86	Underwear,nightwear etc.	3.91	Skirts & divided skirts	3.01	Underwear,nightwear etc.	2.04
Trousers,breeches,etc.	4.05	Oth.garments,not knitted	1.93	Trousers, breeches etc.	10.88	Jersys,pullovrs,etc.knit	4.59
Shirts	2.10	Gold,silver jewelry,ware	4.10	Blouses,shirt-blouse,etc	2.92	T-shirts,othr.vests knit	3.96
Trousers, breeches etc.	2.03			Suits,dresses skirts etc	1.48	Brassieres,corsets,etc.	4.01
T-shirts,othr.vests knit	7.04			Underwear, nightwear etc	1.94	Swimwear	1.85
Builders'ware, plastics	2.33			Jersys,pullovrs,etc.knit	5.22	Oth.garments,not knitted	11.32
Gold,silver jewelry,ware	1.59			T-shirts,othr.vests knit	5.48	Oth.footwear,lthr.uppers	3.97
				Brassieres,corsets,etc.	3.36	Parts footwear,etc.	4.26
				Oth.garments,not knitted	2.64		
				Oth.footwear,lthr.uppers	2.53		
				Parts footwear,etc.	1.44		

Sources. Calculations from the CD-ROM; Personal Computer Trade Analysis System (PC-TAS) of the International Trade Centre (ITC).

Appendix B: Countries in the sample used to compute the EREER

Africa	Latin America	Asia
Algeria	Argentina	China
Benin	Bolivia	Iran
Burkina-Faso	Brazil	Thailand
Cameroon	Columbia	Pakistan
Chad	Costa-Rica	India
Comoros	Ecuador	Philippines
Congo, Rep	Mexico	Malaysia
Cote d'Ivoire	Paraguay	Jordan
Egypt	Venezuela	Syria
Gabon	Haiti	
Gambia	Honduras	
Ghana	Panama	
Guatemala	Uruguay	
Guinea, biss	Chile	
Kenya		
Lesotho		
Madagascar		
Malawi		
Mali		
Mauritania		
Mauritius		
Morocco		
Niger		
Panama		
Rwanda		
Senegal		
Sierra-Leone		
Sri Lanka		
Swaziland		

Appendix C: Co-integration analysis and estimation of Equation 4

To present co-integration simply, consider two time series x and y that are integrated of order one; I (1). This means that their first differences (i.e. Δx and Δy) are stationary; I (0). If the regression of x on y (that are I (1)) gives a time series of residuals that is I (0), the two series are called co-integrated. This means that there exists a long-term relationship between them. The latter is given by the regression coefficients of x on y. However, the OLS estimate of the coefficient is convergent but not efficient and other estimation techniques need to be used.[5] The methodology comprises 3 major steps. First, test whether the variables are I (1). Second, test whether the variables are co-integrated. Third, estimate the long-term relationship.

First developed in a "pure" time series context, co-integration analysis has been subsequently extended to data combining both the time series and the cross-section (commonly referred to as panel data) dimensions. The 3 steps for the analysis are the same as above except that the nature of the data (i.e. time series and the cross-section) involves a preliminary check regarding whether individuals (e.g. countries) are interdependent or not. This is important for the tests to be used in the co-integration analysis. This Appendix applies the panel-data-co-integration analysis to Equation (4).

To examine whether individuals are interdependent, we use a test suggested by Pesaran (2004). The test is based on the average of the correlations between the residuals from a regression on each individual separately. Practically, consider the variable y_i pertaining to the individual i. The variable is regressed on its first lag and the residuals are collected to compute ρ_{ij} which is the correlation coefficient between the residuals from individual i and j regressions. The statistics:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \qquad \text{(C.1)}$$

is shown to have a N (0, 1) distribution under the null hypothesis of independence. Where N is the number of individuals and T is the number of years.

The results of the test applied to our sample are presented in Table C.1. For all variables, the tests reject the null hypothesis of independence of individuals at the 1% level.

[5] There are other approaches to test for co-integration (e.g. Johansen and Juselius, 1990). It is not the aim of the paper to discuss them.

Table C.1. Tests of the independence of the variables across individuals

Variables	Calculated statistics
Cap	7.28
Open	16.06
rDebt	6.48
Gov	3.34
ToT	2.43
REER	14.32
GDPgap	12.04
BalSam	. 10.09

C.1 Stationarity tests

To examine stationarity, we should, therefore, use a test that incorporates the interdependence of individuals. Among the existing test, the one by Pesaran (2005) is the most adequate because it is targeted toward a situation where N (the number of individuals) is higher than T (the number of years). In addition, the test allows analyzing non-stationarity within a heterogeneous panel framework, i.e. a panel in which each country is allowed to evolve according to its own dynamics. The test builds on the well-known augmented Dickey-Fuller regressions. Practically, consider y_{it} pertaining to the individual *i* at time *t*. Run the regression:

$$\Delta y_{it} = \alpha_i + \rho_i y_{it-1} + \gamma_i \bar{y}_{t-1} + \delta_i \Delta \bar{y}_t + \vartheta_{it} \qquad \text{(C.2)}$$

and take the calculated Student statistics of ρ_i ; t_i. Where $\hat{y}_t$ is the average of y_{it} over all individuals at time *t*. The statistics:

$$CIPS\ (N, T) = \frac{1}{N}\sum_{i=1}^{N} t_i \qquad \text{(C.3)}$$

is used to test for stationarity but it does not have a standard distribution. We follow Pesaran (2005) and simulate the critical values using the Monte Carlo approach. If the computed statistics (*CIPS*) is above the critical value, one cannot reject the null hypothesis of stationarity.

Table C.2. Test of the stationarity of the variables

Variable	Stationarity in	
	Level	First difference
Cap	-2.01	-5.78
Open	-2.06	-4.89
rDebt	-1.75	-5.24
Gov	-1.80	-4.55
ToT	-1.93	-5.33
REER	-1.98	-4.65
GDPgap	-2.09	-4.03
BalSam	-1.92	-4.15
Critical value	-2.105	

Table C.2 presents the results. The tests reveal that all variable are I (1). Hence, if we find a relationship among the variables which gives stationary residuals, these variables will be considered as co-integrated.

C.2 Co-integration tests

The best-known tests are due to Pedroni (1995, 2004). They allow taking account of heterogeneity among individuals. The author proposed 7 versions of the co-integration test: 4 are suitable when studying the relationship of the variables within countries and 3 pertain to the relationship between variables of different countries. The former set of tests is the most suitable for our study. The procedure is the following. Consider a dependent variable y_{it} and set of explanatory variables x_{kit} observed for individual i at time t. To conduct the test, proceed in the 5 following steps:

1. Estimate the following co-integration regression over the panel:

$$y_{it} = \alpha_i + \delta_i t + \beta_{1t} x_{1it} + \beta_{2t} x_{2it} + \cdots + \beta_{kt} x_{Kit} + \varepsilon_{it}$$

2. Differentiate the original series for each member, and estimate the following regression over the panel:

$$\Delta y_{it} = b_{li} \Delta x_{1it} + \cdots + b_{Ki} \Delta x_{Kit} + \eta_{it}$$

3. Calculate L^2_{11i} as the long-run variance of η_{it} using, for instance, the Newey and West (1987) estimator.

4. Apply a DF and ADF regressions to the residuals ε_{it} and compute the long-run (σ_i^2) and the simple variances (s_i^2) from of the residuals of the DF regression as well as the simple variances (s_i^{*2}) from of the residuals of the ADF regression.

5. Using the above parameters, the following four statistics can be computed to test for co-integration:

Panel *v*- statistic:

$$T^2N^{3/2}Z_{vN,T} \cong T^2N^{\frac{3}{2}}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\,\hat{e}_{i,t-1}^{2}\right)^{-1}$$

Panel ρ- statistic:

$$T\sqrt{N}Z_{\hat{\rho}N,T^{-1}} \cong T\sqrt{N}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\,\hat{e}_{i,t-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_i\right)$$

Panel t- statistic:

$$Z_{tN,T} \cong \left(\tilde{\sigma}_{N,T}^{2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\,\hat{e}_{i,t-1}^{2}\right)^{-\frac{1}{2}}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_i\right)$$

Panel ADF statistic:

$$Z^{*}_{tN,T} \cong \left(\tilde{s}_{N,T}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\,\hat{e}_{i,t-1}^{*2}\right)^{-\frac{1}{2}}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{e}^{*}_{i,t-1}\Delta\hat{e}^{*}_{i,t}-\hat{\lambda}_i\right)$$

where $\lambda_i = 0.5\,(\sigma_i^2 - s_i^2)$

Pedroni (1995, 1997) showed that, with a slight correction, the statistics converge toward a normal distribution. Actually:

$$\frac{x_{NT} - \mu\sqrt{N}}{\sqrt{v}} \sim N(0,1)$$

where x_{NT} is one of the 4 statistics and μ and v are tabulated by Pedroni (1999). The results of the co-integration tests applied to Equation 4 are presented in Table C.3. Two tests suggest that the variables are co-integrated but two others suggest the reverse. We follow Pedroni (2004) who being faced with the same type of results concluded that the variables are co-integrated (See also Barisone et al., 2006).

Table C3. Test of co-integration

Statistics	Calculated value
Panel *v*- statistic	-3.18
Panel ρ- statistic	4.37
Panel t- statistic	-1.10
Panel ADF statistic	0.28

C.3 Estimation of the coefficients

Although the variables are co-integrated, the OLS estimates of the parameter are convergent but not efficient (Kao, Chiang and Chen 1999). Two methods are available to get efficient estimates of the parameters. One, labeled dynamic OLS (DOLS), was developed by Kao and Chiang (1998) and consists of adding to the co-integration equation lags of the explanatory variables in order to "clean" the error term from any autocorrelation and heteroskedasticity. The other, called Fully Modified OLS (FMOLS), was proposed by Pedroni (2000). It is little bit more complicated to explain in a non-technical way. Roughly explained, it consists in running an OLS estimate of the co-integration equation and using the residuals to compute their variance-covariance matrix. This is, then, used to perform a "sort of GLS" on the co-integration equation. Both methods were applied to Equation 4 and the results are presented in Table C.4. The overall quality of fit is good. Except for the variable Cap, the sign, level and significance of the coefficients are broadly similar. In the text, we will focus on the DOLS results.

Table C.4. Estimation results of Equation (4)

Variables	Estimation methods	
	DOLS	FMOLS
Cap	0.00	0.00
	4.02	**0.25**
Open	-0.52	-0.55
	-14.01	**-7.48**
BalSam	0.38	0.34
	7.90	**6.64**
rDebt	-0.11	-0.05
	-6.11	**-3.12**
Gov	0.25	0.17
	6.25	**11.67**
ToT	0.12	0.10
	3.31	**6.83**
GDPgap	-0.01	-0.01
	-1.75	**-2.45**
A-R^2	0.60	0.57

t-statistics are in bold

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