Assessing the Impact of the EURO on the Economies of Some MENA Countries: An Empirical Investigation Utilizing a Time-Varying Model to Forecast the Level and Volatility of the US Dollar / EURO Exchange Rate

by

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Abstract

This paper analyzes qualitatively the impact of changes in the level and variability of the US dollar / EURO exchange rate on the real GDP growth rate and trade balance positions of three MENA countries, namely Egypt, Jordan and Morocco. First, the analytical framework is presented by developing explicit relationships between (1) output growth and the variability of the nominal exchange rate; (2) per capita GDP and the variability and realignmrnt of the real exchange rate; and (3) commodity prices and nominal exchange rate volatility. Then, based on these models, the impacts of (1) an appreciation of the US dollar against the EURO and (2) an increase in the volatility of the US dollar / EURO rate are derived. Our results indicate that an appreciation of the US dollar /EURO rate or an increase in the volatility of this rate leads to a lower real GDP growth rate and worsening of the trade balance positions for Egypt and Jordan and the opposite for Morocco.

I. Introduction

January 1, 1999 marked the beginning of European economic integration as 11 European Union countries formed the European monetary union (EMU) and adopted a single currency, the EURO. The 11 countries have a population of around 300 million and a total GDP of around US $ 6 trillion. The economic size of the EMU, along with the envisaged expansion of capital markets in the integrated area, created initially the expectation that the EURO will become a challenging currency to the US dollar.

This report considers the potential economic and financial implications of the EURO's introduction on the economies of some MENA countries; namely Egypt, Jordan and Morocco. Specifically, these implications could be studied, inter alias, in terms of the anticipated impact on (1) economic growth, (2) trade performance, (3) foreign direct investment, (4) foreign debt and reserve management, (5) portfolio diversification, (6) banking system developments, (7) European interest rate volatility, and (8) the US dollar / EURO exchange rate volatility. We focus here on the first two items, especially on the channels of the US dollar / EURO rate changes on the economies of such countries.

The MENA countries export to the EMU countries primary commodities, such as cotton, fruits, and crude oil, and some light manufacturing goods, like textiles, while they import from EMU countries consumer and investment goods. The export trade with EMU critically depends on the impact of the rate of the EURO against other currencies on GDP growth of the EMU region, which drives its imports from abroad, including MENA countries. The implied elimination of exchange rate risk and reduction in transaction costs from the introduction of the EURO undoubtedly will result in increased economic integration and competition within the European Union

(EU) [Ruhashyankiko; 1999]. The spillover effects on the economic activity of MENA countries will also depend on the degree and nature of market integration between the EMU and MENA regions. These effects are transmitted through the prevailing exchange rate between the EURO and the MENA currencies. However, many of the MENA countries have their currencies pegged to either the EURO or the US dollar. Thus, the spillover effects will mainly depend on the volatility of the exchange rate between the EURO and the US dollar.

The extent of currency market volatility and exchange rate misalignments are major elements of market risk. For financial transactions, they represent both costs and profit opportunities. Currency market volatility raises the costs of hedging, for example, as indicated in the pricing of options. Increased volatility implies higher option premia and therefore higher hedging costs for investors and importers/exporters, but it may also contribute to generally higher profits for banks and other investment houses dealing in options. [Papaioannou; 2001].

The observed instability in currency markets during the last two decades has been seen as a consequence of at least five identifiable factors: (i) The present floating exchange rate system, which allows for wide currency fluctuations; (ii) The increased global financial integration caused by the emergence of free trade blocks and new currencies such as the EURO; (iii) The growth in capital flows as a result a result of the liberalization of trade in goods and services; (iv) The increased response of financial markets to emerging opportunities from interest rate differentials, misalignments, and market inefficiencies; and (v) The spread of information technology.

This report focuses on the study of the impact of the US Dollar / EURO exchange rate level and volatility on various economic aspects of some MENA countries. Specifically, we examine the (1) sensitivity of certain economic activity variables to changes in the level and volatility of the US dollar / EURO exchange rate, and (2) the behavior of trade relations in response to changes in this rate.

This report is organized as follows: In section II, we briefly describe existing equilibrium of asset price determination. In section III, we propose a methodology for forecasting the level and volatility of the US dollar / EURO rate. In section IV, we derive forecasted values of the volatility, which are used to assess the impact of the EURO on the economies of some MENA countries. Finally, in section V, we present a summary and some conclusions.

II. Exchange Rate Volatility and Economic Activity Variables

In this section, several economic activity models that relate exchange rate volatility with GDP and trade are analyzed: (1) an inter-temporal capital asset model is developed and its equilibrium solution is found. The solution relates GDP growth, among other variables, to exchange rate volatility. The sensitivity of GDP growth to volatility is calculated. Thus, using the functional form derived, one can infer of whether, ceteris paribus, GDP will change substantially with a change in the volatility of the exchange rate.

(2) The second model relates exchange rate volatility and misalignment to GDP growth. Again, the sensitivity of GDP growth to changes in exchange rate volatility and misalignment is explicitly calculated.

(3) The third model relates exchange rate volatility to trade through its impact on commodity prices. First, the sensitivity of commodity prices to exchange rate volatility is calculated. This will indicate the extent of commodity price changes

which is to be expected. Then, the impact of exchange rate volatility changes on import/export values is examined.

II.1 An Intertemporal Model Relating GDP Growth to Exchange Rate Volatility

In this analysis we use a model developed by Turnovsky [ch. 16; 2000]. This model employs a utility function that has as arguments an agent's consumption and portfolio preferences, which relate output and different assets to a set of relevant prices. The volatility of the exchange rate appears as a determinant of these prices. When maximizing the utility function, a set of equations that describe the evolution of the economy emerge as functions of the exchange rate volatility. In fact, these relations are employed to demonstrate the impact of the volatility of the US dollar / EURO exchange rate on GDP growth. The development of the model and the derivation of its equilibrium solution are in order.

We assume that there are four assets in this economy: domestic money, M, domestic government bonds, B, tradable foreign bonds, B*, and equity claims on capital, K. There are also three prices in this model: the domestic price of the traded goods, P; the foreign price level of the traded goods, Q; and the nominal exchange rate, E, measured in terms of domestic currency per unit of foreign currency. Q is assumed to be determined exogenously, while P and E are endogenous variables. The prices evolve following a Brownian motion as follows:

$$\frac{dP}{P} = \pi \, dt + dp \qquad \text{(II. 1)}$$

$$\frac{dQ}{Q} = \eta \, dt + dq \qquad \text{(II. 2)}$$

$$\frac{dE}{E} = \varepsilon \, dt + de \qquad \text{(II. 3)}$$

where π, η, ε are the respective expected instantaneous rates of change. The terms dp, dq, and de are temporally independent, normally distributed random variables with zero means and instantaneous variances of $\sigma_p^2 dt$, $\sigma_q^2 dt$, and $\sigma_e^2 dt$. Assuming free trade, the price level in the domestic economy must be related to that in the rest of the world by the purchasing power parity (PPP) relationship:

$$P = Q * E \tag{II. 4}$$

Taking the stochastic derivative of this relationship implies that:

$$\frac{dP}{P} = \frac{dQ}{Q} + \frac{dE}{E} + \frac{dQ}{Q}\frac{dE}{E} \tag{II. 5}$$

Notice the extra term $\frac{dQ}{Q}\frac{dE}{E}$ that does not appear in deterministic calculus.

Substituting equations (II. 1), (II. 2) and (II. 3) in equation (II. 5), one obtains the following identities:

$$\pi dt + dp = (\eta dt + dq) + (\varepsilon dt + de) + (\eta dt + dq)(\varepsilon dt + de)$$

$$= (\eta + \varepsilon + \eta de + \varepsilon dq)dt + (dq + de + dq\, de) + \eta\varepsilon (dt)^2 \tag{II. 6}$$

Notice that (dq de) is of order dt^2, (ηde) and (εdq) are of order dt. Retaining terms to order dt we obtain:

$$\pi = \eta + \varepsilon + \sigma_{qe} \tag{II. 6}$$

$$dp = dq + de \tag{II. 7}$$

where $\sigma_{qe} = \frac{1}{2}\varepsilon dq = \frac{1}{2}\eta de$, and $\sigma_{qe} dt$ is the instantaneous covariance between dq and de.

A close examination of equation (II. 6) reveals that a positive random shock in the foreign price level, i.e., an increase in η, or a stochastic depreciation of the domestic currency, i.e., an increase in ε, leads to a proportionate stochastic increase in the domestic price level, i.e., an increase in π. One should always keep in mind that the foreign price level, Q, and its volatility, σ_q^2, are exogenously determined.

Examining equation (II. 7) reveals that the volatility of the local price, σ_p^2, is the sum of the volatilities of the foreign price, σ_q^2, and the volatility of the exchange rate, σ_e^2, i.e.:

$$\sigma_p^2 = \sigma_q^2 + \sigma_\varepsilon^2 \qquad \text{(II. 7a)}$$

Thus, if the exchange rate volatility increases this will cause an increase in the local price level volatility. This, in turn, will increase the local price level instability.

Domestic and foreign bonds are assumed to be short-term bonds, paying nonstochastic nominal interest rates i and i*, respectively, over the period dt. Using the Ito calculus, the real rates of return to domestic residents on their holdings of money, R_M, the domestic bond, R_B, and the foreign bond, R_F, are respectively:

$$dR_M = r_M dt - dp; \qquad r_M = -\pi + \sigma_p^2 \qquad \text{(II. 8)}$$

$$dR_B = r_B dt - dp; \qquad r_B = i - \pi + \sigma_p^2 \qquad \text{(II. 9)}$$

$$dR_F = r_F dt - dp; \qquad r_F = i^* - \eta + \sigma_q^2 \qquad \text{(II. 10)}$$

Output, Y(t), is assumed to be generated from capital, K, by the stochastic process:

$$dY(t) = F(K)dt + H(K)dy, \quad F'(K) > 0, \ \text{ and } F''(K) < 0 \qquad \text{(II. 11)}$$

where F(K) is the mean rate of output per unit of time, dy is the productivity shock and assumed to be a temporally independent, normally distributed stochastic process having zero mean and variance $\sigma_y^2 dt$.

For constant returns technology, F(K) = H(K) = α K, where α is the constant marginal physical product of capital. In this case, the flow of domestic output, dY, is given as:

$$dY = \alpha K(dt + dy) \qquad \text{(II. 12)}$$

In the absence of adjustment costs to investment, the real rate of return on capital (equity) is:

$$dR_K = \frac{dY}{K} = r_K \; dt + dk = \alpha \; dt + \alpha \; dy \qquad \text{(II. 13)}$$

The representative consumer's asset holdings are subject to the wealth constraint:

$$W = \frac{M}{P} + \frac{B}{P} + \frac{E\,B*}{P} + K \qquad \text{(II. 14)}$$

where W denotes real wealth. It is also assumed that the representative consumer will consume output over the period (t, t+dt) at the nonstochastic rate C(t)dt generated by these asset holdings.

The objective of the representative agent is to select his rate of consumption and his portfolio of assets to maximize the expected value of lifetime constant elasticity utility function given by:

$$E_o \int_0^\infty dt \frac{1}{\gamma} \{C(t)^\theta [\frac{M(t)}{P(t)}]^{1-\theta}\}^\gamma \exp - \beta t \qquad 0 \le \theta \le 1; \; -\infty \le \gamma \le 1$$

(II. 15)

subject to the wealth constraint of equation (II. 14) and the stochastic wealth accumulation equation, expressed as:

$$dW = W[n_M dR_M + n_B dR_B + n_K dR_K + n_F dR_F] - C(t)dt - dT \qquad \text{(II. 16)}$$

where

$n_M = \dfrac{M / P}{W}$, share of portfolio held in money.

$n_B = \dfrac{B/P}{W}$, share of portfolio held in domestic government bonds.

$n_K = \dfrac{K}{W}$, share of portfolio held in terms of capital (equity).

$n_F = \dfrac{E\,B^*/P}{W} = \dfrac{B^*/Q}{W}$, share of portfolio held in foreign bonds.

dT , change in taxes paid to domestic government.

In a growing economy taxes grow with the size of the economy, measured by the real wealth. Thus, taxes, T, are related to wealth according to:

$$dT = \tau W\,dt + W\,dv \qquad \text{(II. 17)}$$

where dv is an intertemporally independent, normally distributed random variable with zero mean and variance $\sigma_v^2 dt$. The constant parameter τ must be set to ensure that the government's budget constraint is met.

Dividing equation (II. 16) by W and substituting the expressions of dR_M, dR_B, dR_K, and dR_F in equation (II. 16) we obtain:

$$\frac{dW}{W} = [n_M r_M + n_B r_B + n_K r_K + n_F r_F - \frac{C(t)}{W} - \tau]\,dt + dw \qquad \text{(II. 18)}$$

$$n_M + n_B + n_K + n_F = 1 \qquad \text{(II. 19)}$$

where

$$dw = -(n_M + n_B)dp + n_K \alpha\,dy + n_F\,dq - dv \qquad \text{(II. 20)}$$

The stochastic optimization problem is to maximize the utility function, equation (II.15), with respect to C/W and the portfolio shares n_M, n_B, n_K, n_F , subject to the constraints of equations (II. 18), (II. 19) and (II. 20). The resulting optimality conditions can be expressed as:

$$\frac{C}{W} = \frac{\theta}{1-\gamma\theta}[\beta - \rho\gamma - \frac{1}{2}\gamma(\gamma-1)\sigma_w^2] \qquad \text{(II. 21)}$$

where $\rho = n_M r_M + n_B r_B + n_K r_K + n_F r_F - \tau$

$$\sigma_w^2 = (n_M + n_B)^2 \sigma_p^2 + n_K^2 \alpha^2 \sigma_y^2 + n_F^2 \sigma_q^2 + \sigma_v^2 - 2(n_M + n_B) n_K \alpha \sigma_{Py}$$

$$- 2(n_M + n_B) n_F \sigma_{pq} + 2(n_M + n_B)\sigma_{pv} + 2 n_K n_F \alpha \sigma_{yq} - 2 n_K \alpha \sigma_{yv} - 2 n_F \sigma_{qv}$$

$$n_M = \frac{1-\theta}{\theta} \frac{C/W}{i} \qquad \text{(II. 22)}$$

The system dynamics, or set of stochastic equations, that describe the economy could be further expanded by adding equations relating to taxes, government expenditures, and other variables. Again,

$$dT = \tau W\, dt + W\, dv \qquad \text{(II. 23)}$$

The government expenditure, G, is modeled as:

$$dG = g\alpha K\, dt + \alpha K\, dz \qquad \text{(II. 24)}$$

where G is the government expenditure, g is a constant, dz is an intertemporally independent, normally distributed random variable with zero mean and variance $\sigma_z^2 dt$.

Then, one should define a proper utility function that includes the above variables. In turn, we maximize the utility function with respect to consumption and wealth, where the prices, P and Q, enter the optimization equations. The equilibrium solution that maximizes the utility function will change if these prices change. However, these prices change as function of the volatility of the exchange rate. In this way, the effect of changes in the exchange rate volatility on the economy will be able to be monitored.

If the utility function is logarithmic, the mean rate of growth of the economy (which, for practical purposes, is approximated by the GDP real rate of growth) at equilibrium, φ, is given by the following equation:

$$\varphi = \omega[\alpha(1-g) - \frac{1}{n_K}\frac{C}{W}] + (1-\omega)(i^* - \eta + \sigma_q^2) \qquad \text{(II. 25)}$$

where $\omega = \dfrac{n_K}{n_K + n_F} < 1$

This equilibrium equation reveals that the GDP rate of growth is negatively correlated with the foreign goods price level, η, and is positively correlated with the volatility of the foreign goods price, σ_q^2. Specifically:

$$\frac{\partial\varphi}{\partial\sigma_q^2} = (1-\omega) > 0 \qquad \text{(II. 26)}$$

For example, in the case of the MENA countries, the volatility of the prices of foreign traded goods, σ_q^2, can be approximated by the price volatility of the country (ies) with which each MENA country has concentrated trade relations. Then, depending on the exchange rate arrangement that the MENA country maintains, i.e., whether it is pegged to the US dollar or the EURO, σ_q^2 becomes a function of the volatility of the foreign country’s exchange rate relative to the US dollar. In effect, since we assume that the PPP relationship holds between currencies, we may proceed by (1) forecasting the volatility in the US dollar / EURO exchange rate, σ_ε^2, (2) forecasting the volatility of the domestic prices, σ_p^2, and (3) determine the volatility of σ_q^2 as:

$$\sigma_q^2 \approx \sigma_p^2 - \sigma_\varepsilon^2$$

Therefore, for the Egyptian pound and the Jordanian dinar, the exchange rate volatility between the local currency and the US dollar is considered zero since these currencies are effectively pegged to the US dollar. [1] / Thus, if foreign prices are approximated by that of US dollar-denominated goods, then σ_q^2 should be approximately equal to σ_p^2. And, if foreign prices are approximated by that of EURO-denominated goods, then $\sigma_q^2 \approx \sigma_p^2 - \sigma_\varepsilon^2$. However, for the Moroccan dirham, the exchange rate volatility between the local currency and the EURO is considered to be close to zero, while that between the Dirham and the US dollar as nonzero. [2] / Thus, if foreign prices are approximated by that of EURO-denominated goods, then σ_q^2 should be approximately equal to σ_p^2. And, if foreign prices are approximated by that of US dollar-denominated goods, then $\sigma_q^2 \approx \sigma_p^2 - \sigma_\varepsilon^2$.

II. 2 A Relation Between GDP and Exchange Rate Volatility and Misalignment

As stated above, the Egyptian and Jordanian currencies are considered to be pegged to the US dollar, while the Moroccan currency is considered to be pegged to the EURO. Therefore, changes in the US dollar / EURO exchange rate should be reflected in the exchange rate movements of the Egyptian pound and Jordanian dinar against the EURO, and the Moroccan dirham against the US dollar.

[1] / Egypt maintains exchange arrangements involving more than one market. In the major market, Egypt maintains a pegged exchange rate to the US dollar, with a horizontal band of ± 3 percent width. Jordan has a de jure peg to the SDR but a de facto peg to the US dollar.

[2] / Morocco maintains a fixed peg arrangement against a composite (basket) of currencies , including the EURO, the US dollar and the Japanese yen. Given Morocco's extensive trade relationship with EU countries, the EURO's relative participation in the basket is considered underweight. De facto, however, the EURO is the dominant currency in exchange rate valuation decisions. The official rate is fixed daily in terms of the French franc.

A statistical analysis performed by Domac and Shabsigh [1999] showed that real exchange rate volatility and misalignment play a major role in determining the per capita GDP growth rate of a country. The real exchange rate of the local currency against the US Dollar for the ith country at the year t, RER_{it}, is defined in Cottani et. al [1990] as:

$$RER_{it} = \frac{E_{it} * WPIUS_t}{CPI_{it}} \tag{II. 27}$$

where

E_{it} , the official, i.e., as determined by the authorities, nominal exchange rate for the ith country at the year t, measured as the amount of domestic currency per unit of US dollar

$WPIUS_t$, the US wholesale price index at year t

CPI_{it} , the domestic consumer price index for the ith country at the year t.

While there are several definitions for the real exchange rate misalignment for the ith country at year t, $RERMIS_{it}$, we will use an intuitive definition due its ease of calculations:

$$RERMIS_{it} = \frac{(\sum_{j=1}^{j=3} \max RER_{ij})/3}{RER_{it}} - 1 \tag{II. 28}$$

where

$(\sum_{j=1}^{j=3} \max RER_{ij})/3$, the average of the three highest values of the RER for the ith country during the period 1970-1997.

The regression analysis is performed on the following equation :

$$PCGR_{it} = \beta_0 + \beta_1 RERV_{it} + \beta_2 RERMIS_{it} + \beta_3 SIY_{it} + \beta_4 TOTG_{it} + \beta_5 POPG_{it} + \nu_{it} \tag{II. 29}$$

where

$PCGR_{it}$, the growth in real per capita GDP for the ith country at time t.

$RERV_{it}$, the real exchange rate variability for the ith country at time t, which is defined as one standard deviation of the RER around its mean [Cottani et al; 1990].

RER , the real exchange rate.

$RERMIS_{it}$, real exchange rate misalignment for the ith country at time t.

SIY_{it} , investment to GDP ratio for the ith country at time t.

$TOTG_{it}$, the terms of trade growth for the ith country at time t.

$POPG_{it}$, population growth for the ith country at time t.

v_{it} , residual error for the ith country at time t.

Using pooled data for four countries, Egypt, Jordan, Morocco, and Tunisia for the period of 1970-1997, the obtained regression coefficients are:

Variable	Estimated Coefficient	Absolute value of the t ratio
RERV	β_1 = - 0.0163	2.29
RERMIS	β_2 = - 0.1568	2.66
SIY	β_3 = 0.3911	3.86
TOTG	β_4 = 0.0007	0.27
POPG	β_5 = -1.4586	4.71
Intercept	β_0 =5.63	5.63

Note: All estimated parameters, except that for TOTG, are statistically significant at the 5 percent level.

As evidenced in the table, real exchange rate variability is negatively correlated with the GDP growth rate. Similarly, the real exchange rate misalignment variable is found to negatively affect GDP growth rate.

II.3 A Relation Between Commodity Prices and Exchange Rate Volatility

The European Union is a significant net exporter or net importer of a number of primary commodities from many developing countries. MENA countries rely heavily on EU for their primary commodity exports. It was found by Cuddington and Liang [2000] that there is a relation between the natural logarithm of a real commodity price index, $\log y_t$, which has a trend, and the volatility of the US dollar / EURO exchange rate. The relation is described as follows:

$$\log y_t = \alpha + \beta * time + e_t \tag{II. 30}$$

where e_t follows a possibly integrated ARMA process:

$$(1-\rho L) * A(L) * e_t = B(L) * \varepsilon_t \tag{II. 31}$$

A(L) and B(L) are autoregressive and moving average lag polynomials. The largest root in the AR polynomial, ρ, is factored out for convenience. The innovation, ε_t, is assumed to follow a GARCH(p,q) process as follows:

$$\varepsilon_t / I_{t-1} \sim N(0, h_t) \tag{II. 32}$$

with

$$h_t = \delta + \sum_{i=1}^{i=p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{j=q} \beta_j h_{t-j} \tag{II. 33}$$

where I_{t-1} is the information set through time t-1. The ε_t's are serially uncorrelated (but not stochastically independent because they are related through their second moments). According to the equation determining h_t, the variance of ε_t depends on past news about volatility (the lagged ε_{t-i}^2) and past forecast variance (the h_{t-i} terms).

For most of the monthly commodity price series, GARCH(1,1) provides a sufficiently good fit, as it does typically for financial market variables. The conditional variance could be replaced by:

$$h_t = \delta + \delta_{US/EURO} * \text{var\_}(US_t / EURO)_t + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \tag{II. 34}$$

where var_(US / EURO) is the US dollar / EURO volatility. That is, in this formulation, commodity prices are related to the US dollar / EURO exchange rate volatility through the variance of the error term.

III. Forecasting the Exchange Rate US Dollar / EURO Level and Volatility

We now turn to the other essential part of this study, which is the ability to forecast the US dollar / EURO exchange rate several periods ahead, as well as its associated volatility. If such forecasts are assessed to have adverse effects on the economy, the government might choose to intervene through changes in interest rates or other measures, including exchange market interventions. Thus, the interest in forecasting the course of exchange rates is linked to the growing recognition, among economists and policy makers, of the increasing impact of financial variables on the economy and thus on the economic policy in general. The Southeast Asian crisis is a good reminder of this fact [Hardy and Pazarbasioglu; 1998].

Combined with extensive data banks, and the greater availability of powerful computers, new forecasting techniques have emerged that rely heavily on the analysis of time-varying models. They are increasingly used not only by applied economists and policy makers, but also by major trading institutions and fund managers in their daily operations [Chow; 1987, Mills; 1993, Banerjee and Hendry; 1995, Abutaleb et. al; 1999, Abutaleb and Papaioannou; 2000]. These time-varying models are used for forecasting of the US dollar / EURO exchange rate.

A common method in forecasting exchange rates is the vector autoregressive (VAR) model. This model postulates that past levels of the exchange rate affect their current and future values. Since exchange rate series are usually found to have unit roots, i.e., are integrated of order one or more and therefore are non-stationary, VAR models are usually constructed for the differenced exchange rate series than the actual exchange rate levels.

When modeling exchange rates, a restricted VAR model is usually preferred. The restrictions arise from the fact that the predictions are, in general, not accurate and one has to, continuously, correct for this error. Thus, one might consider a model in which the forecast is affected by the past exchange rate and the error correction term. The resulting model is known as the error correction model (ECM). Forecasting with an ECM is reported in Clements and Hendry [1995], and Engle and Yoo [1987].

Better yet is to develop a time-varying model that relates a set of exogenous variables to an exchange rate. We propose a method where the time-varying parameters of the model are estimated using new concepts borrowed from the theory of optimal control. The conventional and proposed methods of forecasting are outlined in the next sections.

III. 1 Forecasting Using Conventional Methods

In this section, we describe a conventional statistical method used in forecasting exchange rates, which we will apply to predict the US dollar / EURO exchange rate. The proposed time-varying method is described in the next section.

Consider the problem of one-step forecasting of the process y(k) using the time-invariant-parameter model of a linear system

$$y(k) = \sum_i \alpha_i y(k-i) + \sum_l \sum_{j_l} \beta_{j_l} u_l(k-j_l) + \varepsilon(k) \qquad \text{(III. 1)}$$

where $u_l(k)$ denotes the lth stationary input signal (exogenous variable), y(k) the stationary output signal (the predicted endogenous variable), and $\varepsilon(k)$ is the white noise disturbance independent of $u_l(k)$. Notice that the coefficients are time-invariant.

For a finite set of data points, and if the coefficients are time-invariant, as commonly assumed, several methods exist that yield an accurate estimate of parameters. A popular method is the singular value decomposition. The measure of accuracy is the size of the error. The number of parameters is determined through the minimization of the Akaike information criterion (AIC). The parameter estimates are then used to predict the out of sample or the future value of y(k). If the parameters are statistically non zero, then Granger causality is established between y(k) and $u_l(k)$.

In many applications, however, the dependent and independent variables could be nonstationary. One could transform the variables into stationary processes, through differencing for example, or use the error correction model. The error correction model is related to the notion of co-integration. If a linear combination of two variables which are individually integrated of order one is stationary, the two variables are said to be co-integrated. The stationary linear combination of integrated variables is called the co-integration residual. The Engle-Granger [1997] representation theorem states that if two variables are co-integrated, there exists an ECM.

While earlier research focused on co-integrated residuals that are integrated of order zero, recent research examined the more general case in which the co-integration residuals follow a fractionally integrated process. An important feature of a fractionally integrated process is that its auto-correlation function dies down in a hyperbolic manner which is a characteristic of a long memory process. When the co-integration residual of two integrated series is fractionally integrated, the two series are said to be fractionally co-integrated.

Fractional co-integration has been found empirically in the literature. In examining the purchasing power parity relationship, PPP, it is found that the deviation from the parity has a long memory and may be described by a fractionally integrated process [Cheung and Lai; 1993]. Similar findings are established for various exchange rate series [Baillie and Bollerslev; 1994, Masih and Masih; 1997] and the three-month and one-year US Treasury bill rates [Dueker and Startz; 1994].

The importance of modeling the co-integration relationship by a fractional process lies in its incorporation of the effects of long memory. For example, in the stock market forecast, ECM models allow only the first-order lag of the co-integration residual to affect the futures prices. In contrast, the fractionally integrated ECM incorporates a long history of past co-integration residuals.

Let us assume that we have two variables, s(k) and f(k), where s(k) is the exchange rate and f(k) is an important variable that affects s(k). The fractionally integrated ECM model may be specified by:

$$\Delta s(k) = \alpha_0 + \sum_{i=1}^{i=I} \alpha_i \Delta s(k-i) + \sum_{j=1}^{j=J} \beta_j \Delta f(k-j) + \sum_{l=1}^{l=L} \gamma_l z(k-l) + \varepsilon(k) \qquad \text{(III. 1a)}$$

where

z(k) = the error correction term = s(k)-f(k),

Δ s(k) = s(k)-s(k-1),

Δ f(k) = f(k)-f(k-1)

For a GARCH model, the variance, $\sigma^2(k)$, of the error term, $\varepsilon(k)$, is defined as:

$$\sigma^2(k) = a_0 + \sum_{i=1}^{i=I} a_i \sigma^2(k-i) + \sum_{j=1}^{j=J} b_j \varepsilon^2(k-j) \qquad \text{(III. 1b)}$$

Equation (III. 1a) could be cast in the general form of equation (III. 1). Thus, we will be dealing with the format of equation (III. 1) in the sequel.

III. 2 Forecasting Using Time-Varying Methods

The accuracy of the prediction could be improved if one realizes that the relation between the exogenous variables, $u_l(k)$, and the endogenous variable, y(k), could be better presented by a time-varying parameter model as follows:

$$y(k)=\sum_i \alpha_i(k)y(k-i)+\sum_l \sum_{j_l} \beta_{j_l}(k)u_l(k-j_l)+\varepsilon(k) \qquad \text{(III. 2)}$$

If one was able to accurately estimate the time-varying parameters, $\alpha_i(k)$ and $\beta_{j_l}(k)$, using the available data, then forecasting would be much more accurate than that of the time-invariant case.

Equation (III. 2) could be cast in the familiar regression format:

$$y(k)=\underline{x}(k)\underline{\beta}(k)+\varepsilon(k) \qquad \text{(III. 3)}$$

where the row vector $\underline{x}(k)$ has the lagged values of y(k), the exogenous variables, $u_l(k)$, and their lagged values. $\underline{\beta}(k)$ is a vector of the unknown time-varying coefficients.

The problem of estimation of time-varying coefficients could be solved in at least four different ways:

(1) Assuming that the system coefficients are varying sufficiently slowly, one can track them using the localized (weighted or windowed) versions of the least squares or maximum likelihood estimators [Niedzwiecki; 1984, 1990, 2000].

(2) One could try to approximate the time-varying coefficients by a weighted combination of a certain number of known functions (basis functions). If the unknown weights are assumed to be constants, a number of the well known identification techniques could be used [Grenier; 1983, Van Trees; 1968].

(3) One might assume that the time-varying coefficients evolve in a Markovian way. In such case, the Kalman filter technique and its modification could be used for their estimation [Chow; 1987].

(4) The time-varying coefficients could be treated as unknown controllers that should be estimated to track the observed data. The method of Pontryagin maximum principle could be used to find the desired values [Abutaleb; 1986, Chen et al; 1998].

III. 2a Chow's Method (Using a Markov Model) In the Estimation of the Time-Varying Parameters

Since the proposed approach is a modification to the Chow method, and is a maximum likelihood approach, the Chow method is first presented in some detail.

As mentioned before, the observed data, y(k), could be modeled as a linear combination of known exogenous (independent) variables, $\underline{x}(k)$, plus noise, $\varepsilon(k)$, as follows:

$$y(k) = \underline{x}(k)\underline{\beta}(k) + \varepsilon(k) \qquad \text{(III. 3)}$$

where the row vector, $\underline{x}(k)$, has the lagged values of y(k), the exogenous variables, $u_l(k)$, and their lagged values. $\underline{\beta}(k)$ is a column vector of the unknown time-varying coefficients, and $\varepsilon(k)$ is normally and independently distributed with zero mean and variance σ_ε^2. The key in the Chow method is the assumption of a Markov model for the time-varying parameters. That is, the set of unknown parameters, $\underline{\beta}(k)$, could be modeled as a vector autoregressive (VAR) process as follows [Chow; 1987]:

$$\underline{\beta}(k) = M\,\underline{\beta}(k-1) + \underline{\eta}(k) \qquad \text{(III. 4)}$$

where $\underline{\beta}(k)$ is a column vector of m unknown values, M is an unknown matrix of dimensions m x m, and $\underline{\eta}(k)$ is an m-variate column vector normally distributed with zero mean and covariance matrix V= $\sigma_\varepsilon^2 P$.

Note that when M=I and V=0, this model is reduced to the standard constant coefficient model. When M=0 and V $\neq$ 0, we have a pure random model. When M=I, and V $\neq$ 0, we have, what is called, the random walk model.

If the matrix M is assumed to be time-varying, i.e., M(k), the estimation problem becomes more complicated. Then, we end up with the following model:

$$\underline{\beta}(k) = M(k)\,\underline{\beta}(k-1) + \underline{\eta}(k) \qquad \text{(III. 5)}$$

This model is more flexible, and could give accurate estimates of the unknown coefficients, $\underline{\beta}(k)$. It is obvious that the above mentioned models are special cases of the time-varying model of equation (III. 5).

Chow's method starts by assuming that M is diagonal and by assuming some initial guess for its entries $\hat{M}$. The initial estimate of $\underline{\beta}(0)$ is taken to be the time-invariant estimate. Thus, an estimate for the sequence $\{\underline{\beta}(1), \underline{\beta}(2), ..., \underline{\beta}(k)\}$ and, consequently, an estimate for the sequence {y(0), y(1), …, y(k)} are obtained through the equations:

$$\hat{\underline{\beta}}(k) = \hat{M}\,\hat{\underline{\beta}}(k-1) \qquad \text{(III. 6)}$$

$$\hat{y}(k) = \underline{x}(k)\hat{\underline{\beta}}(k) \qquad \text{(III. 7)}$$

The values of $\hat{M}$ are updated, through the gradient method, for example, where one tries to minimize the squared difference between the estimated observations, $\hat{y}(k)$, and the measured observations, y(k).

III. 2b The Proposed Time-Varying Prediction Algorithm

In this approach, we derive an explicit equation relating the observations, y(1), y(2), … y(k), to the current unknown parameter vector, $\underline{\beta}(k)$. This could be achieved by expressing the previous values, $\underline{\beta}(1)$, $\underline{\beta}(2)$, ... $\underline{\beta}(k-1)$ as functions of $\underline{\beta}(k)$. This equation has the form of a regression equation with colored noise. The likelihood function could, then, be easily derived [Chow; 1987], and maximized with respect to the unknowns.

Specifically, using the recursive equation

$$\underline{\beta}(k) = M(k)\,\underline{\beta}(k-1) + \underline{\eta}(k) \qquad \text{(III. 5)}$$

and assuming the existence of $M^{-1}(k)$ for all k, one could obtain an expression for each $\underline{\beta}(k-1),\ldots,\ \underline{\beta}(1)$ as a function of $\underline{\beta}(k)$ as follows:

$$\underline{\beta}(k-1) = M^{-1}(k)\underline{\beta}(k) - M^{-1}(k)\underline{\eta}(k) \qquad \text{(III. 8)}$$

$$\underline{\beta}(k-2) = M^{-1}(k-1)\underline{\beta}(k-1) - M^{-1}(k-1)\underline{\eta}(k-1)$$

$$= M^{-1}(k-1)M^{-1}(k)\underline{\beta}(k) - M^{-1}(k-1)M^{-1}(k)\underline{\eta}(k) - M^{-1}(k-1)\underline{\eta}(k-1)$$

$$\text{(III. 9)}$$

Following the same procedure, we continue till we get to $\underline{\beta}(1)$ as a function of $\underline{\beta}(k)$.

Combining these expressions with equation (III. 3), we get:

$$\begin{bmatrix} y(1) \\ y(2) \\ . \\ . \\ . \\ y(k-1) \\ y(k) \end{bmatrix} = \begin{bmatrix} \underline{x}(1)M^{-1}(2)\ldots M^{-1}(k) \\ \underline{x}(2)M^{-1}(3)\ldots M^{-1}(k) \\ . \\ . \\ . \\ \underline{x}(k-1)M^{-1}(k) \\ \underline{x}(k) \end{bmatrix} \underline{\beta}(k) + \begin{bmatrix} \varepsilon(1) \\ \varepsilon(2) \\ . \\ . \\ . \\ \varepsilon(k-1) \\ \varepsilon(k) \end{bmatrix} - \begin{bmatrix} \underline{x}(1)M^{-1}(2) & \underline{x}(1)M^{-1}(2)M^{-1}(3) & \ldots & \underline{x}(1)M^{-1}(2)\ldots M^{-1}(k) \\ 0 & \underline{x}(2)M^{-1}(3) & \ldots & \underline{x}(2)M^{-1}(3)\ldots M^{-1}(k) \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ 0 & 0 & \ldots & \underline{x}(k-1)M^{-1}(k) \\ 0 & 0 & \ldots & 0 \end{bmatrix} \begin{bmatrix} \underline{\eta}(2) \\ \underline{\eta}(3) \\ . \\ . \\ . \\ \underline{\eta}(k-1) \\ \underline{\eta}(k) \end{bmatrix}$$

$$\text{(III. 10)}$$

which has the form

$$\underline{Y}(k) = \underline{Z}(k)\underline{\beta}(k) + \underline{\varepsilon}(k) + A(k)\underline{v}(k) \qquad \text{(III. 11)}$$

where $\underline{Y}(k) = \begin{bmatrix} y(1) \\ y(2) \\ . \\ . \\ . \\ y(k-1) \\ y(k) \end{bmatrix}$, $\underline{Z}(k) = \begin{bmatrix} \underline{x}(1)M^{-1}(2)...M^{-1}(k) \\ \underline{x}(2)M^{-1}(3)...M^{-1}(k) \\ . \\ . \\ . \\ \underline{x}(k-1)M^{-1}(k) \\ \underline{x}(k) \end{bmatrix}$, $\underline{\varepsilon}(k) = \begin{bmatrix} \varepsilon(1) \\ \varepsilon(2) \\ . \\ . \\ . \\ \varepsilon(k-1) \\ \varepsilon(k) \end{bmatrix}$

A(k)= $\begin{bmatrix} \underline{x}(1)M^{-1}(2) & \underline{x}(1)M^{-1}(2)M^{-1}(3) & ... & \underline{x}(1)M^{-1}(2)...M^{-1}(k) \\ 0 & \underline{x}(2)M^{-1}(3) & ... & \underline{x}(2)M^{-1}(3)...M^{-1}(k) \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ 0 & 0 & ... & \underline{x}(k-1)M^{-1}(k) \\ 0 & 0 & ... & 0 \end{bmatrix}$, $\underline{v}(k) = \begin{bmatrix} \underline{\eta}(2) \\ \underline{\eta}(3) \\ . \\ . \\ . \\ \underline{\eta}(k-1) \\ \underline{\eta}(k) \end{bmatrix}$

Since both $\underline{\varepsilon}(k)$ and $\underline{v}(k)$ are independent, then the log likelihood function of the observations, given M(1), … M(k), V=σ_{ε}^{2}P, i.e., the covariance matrix of $\underline{\eta}(k)$, and σ_{ε}^{2}, could be expressed as:

$$\log L = cons\tan t - \frac{1}{2}\log\left|\sigma_{\varepsilon}^{2} I_{k}\right| - \frac{1}{2}\log|Q| - \frac{1}{2}\frac{[\underline{Y}(k) - \underline{Z}(k)\underline{\beta}(k)]^{T} Q^{-1}[\underline{Y}(k) - \underline{Z}(k)\underline{\beta}(k)]}{\sigma_{\varepsilon}^{2}} \qquad \text{(III. 12)}$$

where I_k is the unit diagonal matrix of dimensions kxk, and

$$Q = I_{k} + A(k)[I_{k-1} \otimes P]A^{T}(k) \qquad \text{(III. 13)}$$

with $\otimes$ being the Kronecker product.

As it is clear from equation (III. 12), the maximum likelihood estimate of M(k) can not be obtained analytically, and only numerical methods can be used to find the maximum. The maximization with respect to the other parameters, however, is straightforward and is given below:

The maximization of equation (III. 12) with respect to σ_ε^2 yields:

$$\hat{\sigma}_\varepsilon^2 = \frac{1}{k}[\underline{Y}(k) - \underline{Z}(k)\underline{\beta}(k)]^T Q^{-1}[\underline{Y}(k) - \underline{Z}(k)\underline{\beta}(k)] \qquad \text{(III. 14)}$$

The maximization of equation (III. 12) with respect to $\underline{\beta}(k)$ yields:

$$\hat{\underline{\beta}}(k) = [\underline{Z}^T(k)Q^{-1}\underline{Z}(k)]^{-1}\underline{Z}^T(k)Q^{-1}\underline{Y}(k) \qquad \text{(III. 15)}$$

Then, the proposed algorithm for estimating the time-varying parameters is as follows:

(1) Assuming a constant coefficient model, estimate the unknown parameters using conventional methods such as ordinary least squares. This should give an initial guess of the parameters, i.e., the coefficients and the variances.

(2) Use Chow's method [Chow; 1987], which assumes an AR model for the time-varying coefficients as in equation (III. 4), to get a second guess of the coefficients, $\underline{\beta}(k)$, M, and the variances.

(3) Use the proposed approach, equation (III. 5), with the guessed $\underline{\beta}(k)$ to get a refined estimate of $\underline{\beta}(k)$ by maximizing equation (III. 15).

(4) Test if any of the estimated parameters is constant and remove it from the time-varying list of parameters, and then repeat step 3.

(5) Substitute the estimated values of $\underline{\beta}(k)$ in equation (III. 7) to find the predicted value of y(k).

IV. Results and Discussion

In this section, the methods outlined in the forecasting section are used with the data of the exchange rate between the $US and the EURO. The forecast of the exchange rate is developed through a time-varying equation.

Through both the Augmented Dickey Fuller (ADF) test and the Philips Perron (PP) test, it was found that the exchange rate is integrated of order 1. It was also found that it is difference stationary and trend stationary. We could not differentiate between the two types. Thus, the trend was first removed and the residual was used in the prediction algorithm. Thus, the residual is the variable that we need to forecast, y(k).

The end-of-month exchange rate between the $US and the EURO is given in the following table.

Date	Exchange rate $US/EURO
29/01/1999	1.1363
26/02/1999	1.1023
26/03/1999	1.0766
30/04/1999	1.0565
28/05/1999	1.0428
25/06/1999	1.0428
30/07/1999	1.0705
27/08/1999	1.0463
24/09/1999	1.0437
29/10/1999	1.0548
26/11/1999	1.0164
31/12/1999	1.007
28/01/2000	0.9745
25/02/2000	0.9742
31/03/2000	0.956
28/04/2000	0.912
26/05/2000	0.931
30/06/2000	0.9523
28/07/2000	0.923
25/08/2000	0.902
29/09/2000	0.8837
27/10/2000	0.8394
24/11/2000	0.8383
31/12/2000	0.9416
30/01/2001	0.9265
24/02/2001	0.919
26/03/2001	0.8957

It was found that the exchange rate could be modeled as:

$$\$US/EURO(k) = \alpha_0 + \alpha_1 k + \alpha_2 k^2 + y(k) \qquad \text{(IV. 1)}$$

Where y(k) is the residual, and the first term, $(\alpha_0 + \alpha_1 k + \alpha_2 k^2)$, is the trend. The residual was modeled according to the time varying equation:

$$y(k) = \beta_1(k)y(k-1) + \beta_2(k)y(k-2) + \varepsilon(k) \qquad \text{(IV. 2)}$$

Where $\varepsilon(k)$ is white Gaussian noise with zero mean and unknown variance. The time varying coefficients, $\beta_1(k)$ and $\beta_2(k)$, are to be estimated using the method described in section III.

The estimated cefficients of the trend are given in the following table with the t-stat values:

Coefficient	Estimate	t-stat
α_0	1.14169265	59.62533682
α_1	-0.015760359	-5.000511298
α_2	0.000230435	2.109333587

The forecasted exchange rate has two components; the trend and the forecasted residual. The true exchange rate between the $US and the EURO from week 1, Jan1 1999, till week 136, March 26 2001, and the forecast from week 1, Jan 1, 1999 till week 164, Aug. 13, 2001, are given in Fig. 1. It seems that the EURO will continue to slide against the $US but will recover by mid August.

In figure 2, we present the exchange rate volatility which is defined as the square of the period to period change in the logarithm of the exchange rate. Both the true and forecasted volatilities are presented. Notice that there will be smaller values of the volatility and then will increase again by mid July. This should cause a lower prices then higher prices by the mid August. The volatility is defined as the square of the period to period change in the logarithm of the exchange rate.

Having obtained the forecast of the exchange rate between the $US and the EURO, we study the effect of the EURO on the economies of Egypt, Jordan, and Morocco in terms of : (1) Trade, (2) Commodity prices, and (3) Equilibrium model.

Having obtained the forecast of the US dollar / EURO exchange rate, we discuss the effects of the changes in the value of the EURO against the US dollar and its volatility on the economies of Egypt, Jordan, and Morocco in terms of (1)GDP growth, based on a reduced form equilibrium relationship; (2) and in terms of trade; (3) and commodity price developments.

IV. 1 Egypt

As indicated above, the mean rate of increase of the economy (GDP growth rate) is given by equation (II. 29):

$$\varphi = \omega[\alpha(1-g) - \frac{1}{n_K}\frac{C}{W}] + (1-\omega)(i^* - \eta + \sigma_q^2) \qquad \text{(IV. 1)}$$

where

φ , equilibrium mean rate of growth of real GDP

η , foreign goods price level

σ_q^2 , volatility of the foreign goods price

σ_p^2 , volatility of the domestic prices, with $\sigma_p^2 \approx \sigma_q^2 + \sigma_\varepsilon^2$

σ_ε^2 , volatility of the exchange rate between the local and foreign currency

For trade denominated (invoiced) in EURO, the relevant volatility is that of the local currency against the EURO, while for trade denominated in US dollar, the relevant volatility is that of the local currency against the US dollar. Since the Egyptian pound is pegged to the US dollar, the volatility of the Egyptian pound against the EURO is practically the same as that of the US dollar against the EURO, assumed to be equal to σ_ε^2. From equation (II. 7a), the volatility of the EU prices, σ_q^2, is approximately equal to the difference between the volatility of Egyptian pound prices, e.g., the volatility of the Egyptian CPI, σ_p^2, and the Egyptian pound / EURO exchange rate volatility, σ_ε^2, i.e., $\sigma_q^2 = \sigma_p^2 - \sigma_\varepsilon^2$. If σ_ε^2 increases, then, ceteris paribus, σ_q^2 will decrease. This will result in a decrease in the Egyptian real GDP growth rate. However, for Egyptian imports denominated in US dollar, $\sigma_\varepsilon^2 = 0$, and $\sigma_q^2 = \sigma_p^2$. Thus, the Egyptian CPI volatility will determine the direction of the real GDP growth.

Furthermore, Egypt has more than 40% of its trade with the EU [EIU_Egypt; 2000]. In the year 2000, more than 40% of the Egyptian exports were fuel, minerals, and metals, and agriculture (about 20%). Imports from the EU, predominantly capital goods, amount to about 40% of Egyptian imports and are invoiced in EURO. (The majority of the remaining 60% of imports is invoiced in US dollar.) Since the Egyptian pound is pegged to the US dollar, an appreciation of the US dollar relative to the EURO would lead to an increase in the prices of Egyptian exports in terms of EURO and a decrease in the prices of Egyptian imports in terms of Egyptian pounds. In turn, ceteris paribus, this will result in a decrease in the volume of exports to EU and an increase in the volume of imports from the EU. And, since the value of imports are about three times the value of exports, this will result in an accelerated increase in Egypt's trade deficit. Of course, part of these impacts would have been nullified if the Egyptian pound was pegged to a basket of (major) currencies instead of the US dollar alone.

IV. 2 Jordan

Jordan has more than 20% of its trade with the EU [EIU_Jordan; 2000]. In the year 2000, more than 30% of the Jordanian exports are minerals-related and about 10% agriculture-related. Since the Jordanian Dinar is pegged to the $US, the same arguments for GDP and trade developments hold as for Egypt.

IV. 3 Morocco

Morocco has a broad export base, with no single export commodity representing more than 12% of the total. In the year 2000, less than 20% of the Moroccan exports are raw materials and minerals, and about 30% are foodstuff, drink and tobacco. Goods trade with the EU represents more than 50% of its total trade. Both Morocco and Egypt compete in similar export goods markets. The same situation prevails in their exports of services, including tourism. In fact, over the past few years, both countries intensely compete to gain comparative advantage as tourist destinations. Since the Moroccan Dirham is pegged to the EURO, an appreciation of the US dollar relative to the EURO is not expected to have any effect on Moroccan exports to the EU, since Moroccan export prices in terms of EURO will not change, while its exports to the rest of the world are expected to increase. The import bill from the rest of the world, however, will increase. Since exports account for about 60% of total trade and depending on trade elasticities, one would expect that the net result is likely a net gain in the country's trade balance.

For Morocco, in contrast to Egypt and Jordan, the volatility in the prices of EU products is considered to be the same as the volatility of domestic price, and the US dollar / Dirham exchange rate is considered to be the same as the US dollar / EURO rate, except for a scale factor. Then, based on the PPP assumption, $\sigma_q^2 = \sigma_p^2$ implies that a change in the volatility of the US dollar / EURO exchange rate will have no direct effect on Moroccan exports to the EU or Moroccan imports from the EU. The only effect on the real GDP rate of growth will, then, come from changes in the volatility of domestic prices and the part of trade that is denominated in US dollar. The argument is exactly the same as for Egypt, with the US dollar replaced by the EURO.

If domestic price volatility, σ_p^2, is unchanged, then an increase in the volatility of the US dollar / EURO exchange rate, and consequently of the US dollar / Dirham exchange rate, σ_ε^2, will result in a decrease in the price volatility of the foreign commodities denominated in US dollar, as $\sigma_q^2 \approx (\sigma_p^2 - \sigma_\varepsilon^2) < \sigma_p^2$. Hence, the rate of growth of real GDP will decrease in the case of US dollar-denominated goods and will increase, decrease, or stay the same depending on whether σ_p^2 increases, decreases, or remains unchanged, respectively, in the case of EURO-denominated goods. The net effect on Morocco's GDP real rate of growth will be positive if the EURO-denominated goods dominate the country's trade relationships.

V. Summary and Conclusions

In this paper we analyze qualitatively the impact of changes in the level and variability of the US dollar / EURO exchange rate on the real GDP growth rate and trade balance positions of three MENA countries, namely Egypt, Jordan and Morocco. First, the analytical framework is presented by developing explicit relationships between (1) output growth and the variability of the nominal exchange rate; (2) per capita GDP and the variability and realignmrnt of the real exchange rate; and (3) commodity prices and nominal exchange rate volatility. Then, based on these models, the impacts of (1) an appreciation of the US dollar against the EURO and (2) an increase in the volatility of the US dollar / EURO rate are derived. Our results indicate that an appreciation of the US dollar /EURO rate or an increase in the volatility of this rate leads to a lower real GDP growth rate and worsening of the trade balance positions for Egypt and Jordan and the opposite for Morocco.

An appreciation of the EURO against the US dollar will encourage imports to and discourage exports from the EMU region to countries that peg their currencies to the US dollar. Such an appreciation tends to lower inflation in countries with EURO-denominated products, partly because of lower costs for the imported components. The lower inflation strengthens domestic purchasing power and domestic demand, thus further increasing the demand for imports. Therefore, a EURO appreciation will likely result in higher GDP growth rates for countries that have US dollar-denominated products, and will likely put competitiveness pressures on countries that have EURO-denominated products.

Based on their trade and financial market performance, countries should be ready to reconsider their exchange rate arrangements and / or the level of their exchange rates that they peg to other currencies. On December 13, 2001, Egypt devalued its currency by 8.4% against the US dollar, and left the bands at $\pm$ 3%. The central rate moved from EP 4.15 per US dollar to EP 4.50 per US dollar, which puts the top of the band to EP 4.635 per US dollar. This devaluation follows a 6% devaluation on August 5, 2001, along with a widening of the currency's trading band by $\pm$ 3% around the then new peg of EP 4.15 per US dollar, from $\pm$ 1.5% previously. Egypt's moves reflect the fact that it runs a current account deficit and is reliant on foreign investment flows, which have worsened during the current global slowdown. However, such moves may lead other MENA countries, who also run managed systems, to follow suit.

The resulting increased competitive pressures for Jordan and Morocco may make it imperative to consider devaluations so as to avoid overvaluation of their currencies. Jordan has maintained its current exchange rate level of 1.4104 US dollars per dinar since 1995. Morocco had devalued its dirham by 5% in April 2001, its first adjustment in over 10 years. Any decision on a further devaluation of the Moroccan dirham will certainly be influenced by the expected moves of the US dollar / EURO exchange rate. Overall, a fixed currency regime, like that adopted by most MENA countries, can be inflexible in times of a downturn because, except for one-off devaluations which can be destabilising, the currency cannot freely adjust to allow for a more competitive exchange rate.

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Fig. 1, True, Trend, and Predicted Exchange Rate between $US and EURO

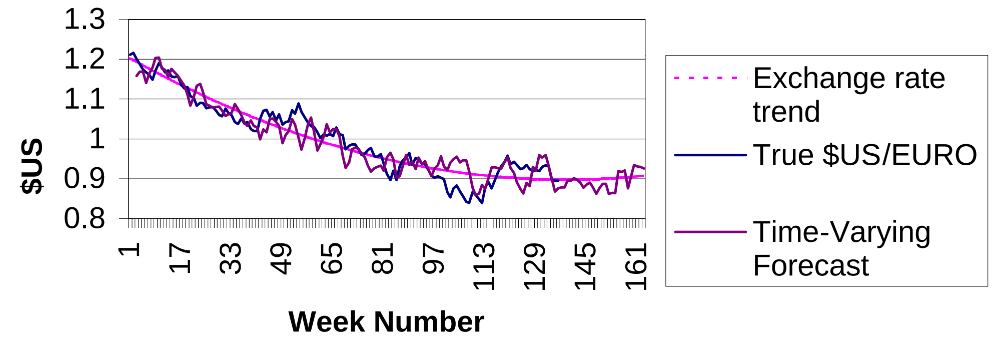

Fig. 2, Volatility of the Exhange Rate between the $US and the EURO