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Estimation of the Equilibrium Real Exchange Rate for Malawi

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Abstract

This paper computes Malawi's equilibrium real exchange rate as a function of its fundamentals as derived from economic theory. It finds evidence in favor of the equilibrium approach to exchange rate determination, with several variables (particularly government consumption and real per capita growth) found to drive movements in the time-varying equilibrium real exchange rate. The results also indicate that following a shock there is a rapid reversion of the real exchange rate to its time-varying equilibrium, with a half-life of reversion of about 11 months.

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Contents Page

Appendices

Figures

Tables

I. Introduction

This paper estimates the path of the equilibrium real exchange rate for Malawi. Based on a dynamic model of a small, open economy, the paper identifies and discusses the dynamics between certain fundamental variables and the real exchange rate. It also investigates the presence of a long-run relationship between the real exchange rate and the explanatory variables and estimates both the equilibrium real exchange rate and the speed at which it converges toward its equilibrium level. The paper concludes with a short discussion on episodes of discrepancies between the real effective exchange rate and its equilibrium level.

The Malawi equilibrium exchange rate is treated as time varying, defined by a set of long-run fundamental determinants. This approach is chosen for two reasons. First, the real effective exchange rate (REER) series[2] contains a unit root (i.e., it is I(1)), so a traditional purchasing power parity (PPP) approach is not applicable. This is because nonstationarity of the real exchange rate prevents it from returning to a long-run equilibrium, as is implied by PPP. Second, certain characteristics of the Malawian economy, such as the importance of one export commodity (tobacco), capital account restrictions, and the lack of a forward foreign exchange market, affect the plausibility of interest rate parities and render models developed for industrial countries less useful when they are applied to Malawi.

The main objective of the analysis is to compute the equilibrium real exchange rate as a function of its fundamentals. The first task is therefore to establish that a long-run relationship exists among the posited variables (using the Johansen cointegration procedure), then compute the equilibrium levels of the determinants of the real exchange rate (using the Gonzalo and Granger (1995) procedure). Having used the cointegration analysis to calculate the equilibrium real exchange rate measure of the actual REER, the long-run relationship among the REER and the explanatory variables in the cointegration vector is then decomposed (using the Gonzalo and Granger method) into a permanent I(1) component and a transitory I(0) component representing deviations from the permanent component.

This paper defines the equilibrium real exchange rate (ERER) as the relative price of nontradables to tradables, which, for given sustainable values of certain fundamental variables, results in internal and external equilibrium. Internal equilibrium occurs when the market for nontradables clears in the present and is expected to clear in the future, while external equilibrium holds when present and future tradable goods markets clear.

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[2] Not seasonally adjusted. Based on IMF, Information Notice System (INS) methodology and Malawian authorities' 1994 trade weights.

II. THEORETICAL MODEL OF THE EQUILIBRIUM REAL EXCHANGE RATE

Edwards's (1989) dynamic model of a small, open economy in which both tradables and nontradables are exchanged provides a coherent framework to identify the fundamental variables that are associated with an equilibrium real exchange rate.[3] The original intertemporal general equilibrium model has two periods to capture the short- and long-run behavior of the economy. Only real factors—the "fundamentals"—can influence the equilibrium exchange rate. Although Edwards is using the model to describe nominal misalignment in fixed exchange rate regimes by separating factors that can affect the long-run equilibrium real exchange rate with permanent changes and short-run misalignments of the nominal exchange rate stemming from policy variables, the model can be applied with certain modifications to countries with flexible exchange rate regimes.

Edwards's model considers a three-good — exportables, importables, and nontradables — small, open economy in full employment, with no price rigidities and no intertemporal credit rationing. It is assumed that this small economy is comprised of a large number of profit-maximizing firms that produce three goods—exportables (*X*), importables (*M*) and nontradables (*N*)— using constant returns-to-scale technology, under perfect competition. There is perfect foresight, so agents respond immediately to an unsustainable current account by changing their consumption and investment decisions. Any debt accumulated in period 1 must be repaid in the second period (i.e., no Ponzi condition). Consumers maximize an intertemporal utility function and consume all goods. The government consumes both tradables and nontradables. Both the private and public sectors are subject to budget constraints, the private sector having to fully repay all debt by the end of period 2 and the discounted value of government expenditure having to equal the discounted value of income from taxation, respectively. Finally, the model has only real variables: neither money nor other nominal assets are in the model.

The following conventions are used for notation. A tilde ($\tilde{}$) over a variable indicates that it is a period-2 variable, and subscripts refer to partial derivatives with respect to that variable. The world price of the exportable commodity *(X)* is used as the numeraire throughout the model. Any other world price is indicated by an asterisk (*).

The production side of the model is characterized by a revenue function that gives the maximum revenue *R*, that optimizing firms obtain from producing the three goods (*X, M* and *N*), subject to prevailing prices, available technology — summarized by the production possibility function F() — and the available factor of production:

$$R = \max\ \{Q_X + pQ_M + qQ_N \mid F(Q, V) \leq 0\}, \qquad (1)$$

where Q_X, Q_M, and Q_N are quantities produced of exportables, importables, and nontradables. Q is a vector that summarizes these quantities produced; V is a vector of production; F( ) is

[3] The model is discussed in depth in Williamson (1994).

the production function that summarizes the existing technology; p is the domestic price of importables relative to exportables; and q is the price of nontradables relative to exportables. Equation (1) can be rewritten in the following way:

$$R = R(p,q,V). \tag{2}$$

Regarding consumption, a representative consumer in this economy maximizes the present value of utility, subject to the two-period intertemporal budget constraint. Assuming a homothetic and time-separable utility function, the consumer's maximization problem can be written as the following:

$$\text{Max } W\{U(C_X, C_M, C_N), \tilde{U}(\tilde{C}_X, \tilde{C}_M, \tilde{C}_N)\} \tag{3}$$

subject to the intertemporal constraint

$$C_X + pC_M + qC_N + \delta(\tilde{C}_X + \tilde{p}\tilde{C}_M + \tilde{q}\tilde{C}_N) \leq \text{Wealth}, \tag{4}$$

where W is the utility function; U and $\tilde{U}$ are period-1 and period-2 subutility functions; C_X, C_M, and C_N, ($\tilde{C}_X$, $\tilde{C}_M$, and $\tilde{C}_N$) are the consumption levels of X, M, and N in period 1 (2); and p and q ($\tilde{p}$ and $\tilde{q}$) are the prices of importables relative to exportables and of nontradables relative to exportables in period 1 (2), respectively.

Wealth is the discounted sum of the consumer's income from both periods, which accrues to the consumer from labor service, income from renting of capital to firms, and government transfers. In period 1, wealth can therefore be expressed as

$$\text{Wealth} = (R(p,q;V,K) + \delta\tilde{R}(\tilde{p},\tilde{q};\tilde{V},K+I) - I(r) - T - \delta\tilde{T}, \tag{5}$$

where R is the revenue function in period 1; K is the capital stock in period 1; $I(r)$ is investment in period-1 as a function of the real interest rate, r; and T is a lump-sum tax (transfer), discounted in the second period by the domestic discount factor, δ.

The consumption problem can be rewritten as an expenditure problem in the following form:

$$E = \text{Min}\{C_x, pC_M, qC_N, \delta(\tilde{C}_X, \tilde{p}\tilde{C}_M, \tilde{q}\tilde{C}_N)\}, \qquad s.t. W(U,\tilde{U}) \leq \overline{W}. \tag{6}$$

Given the assumption of homotheticity, exact price indices (π and $\tilde{\pi}$) for periods 1 and 2 can be introduced to define unit expenditure functions in the form:

$$E = E\ \{\pi(p, q), \delta\tilde{\pi}(\tilde{p}, \tilde{q}); W\}. \tag{7}$$

From this function, compensated demand functions for each commodity in both periods can be derived by differentiating with respect to the relevant price:

$$\delta E\delta\pi/\delta\pi\delta i \quad = E_{\pi}\pi_i = D(i) \qquad \text{for } i = p,\ q,\ \tilde{p},\ \tilde{q}, \tag{8}$$

where D*(i)* is the compensated demand function for the importables and nontradables in each period. This demand function can also be reinterpreted as the share of overall private expenditure on commodities *M* and *N*.

The government in this economy consumes exportables, importables, and nontradables. Government revenue derives from lump-sum taxes, proceeds from import tariffs, taxation of foreign borrowing by the private sector, and borrowing from abroad. The government's budget constraint, as mentioned above, can be expressed the following way:

$$G_X+p^*G_M+QG_N+\delta^*(\tilde{G}_X+\tilde{p}^*\tilde{G}_M+\tilde{q}\tilde{G}_N) = \tau(E_p-R_p)+\delta^*\tilde{t}(E_{\tilde{p}}-R_{\tilde{p}})+b(NCA)+T+\delta^*\tilde{T}, \tag{9}$$

where G_X, G_M, G_N ($\tilde{G}_X$, $\tilde{G}_M$, $\tilde{G}_N$) are the government consumption levels of *N*, *M*, and *X* in period 1 (2); p^* is the price of importables net of tariff; δ is the world discount factor—which is assumed to be equal to the inverse of the world interest factor, $(1+r^*)^{-1}$; τ is the import tariff rate; *b* is equal to the discounted value of tax payments per unit borrowed from abroad (δ^*-δ); *NCA* is the noninterest current account of the private sector in period 2; and *T* is the lump-sum transfer from the private sector.

Equilibrium in this economy is defined by the budget constraint of the private sector, given by equations (4) and (5), and the government budget constraint given by equation (9), as well as the following market-clearing conditions for the nontradables sector:

$$R_q = E_q+G_N \qquad \text{and} \qquad \tilde{R}_{\tilde{q}} = \tilde{E}_{\tilde{q}} + \tilde{G}_N; \tag{10}$$

As well as the following price equations:

$$p = p^*+\tau \qquad \tilde{p} = \tilde{p}^* + \tilde{\tau}; \tag{11}$$

and the definitions of the price indices of tradables as a weighted average price of importables and exportables:

$$P_T^* = \gamma P^*_M+(1-\gamma)P^*_X \qquad \tilde{P}_T^* = \gamma\tilde{P}^*_M+(1-\gamma)\tilde{P}^*_X,\ (P^*_X = \tilde{P} = 1). \tag{12}$$

Given these conditions and the assumption that the marginal productivity of capital in period 2 equals the domestic interest rate, there is only one equilibrium real exchange rate (*ERER*) for each period, defined as the domestic price of nontradables (*PN*) over the international price of tradables, that can satisfy all equilibrium conditions. The reduced-form equation describing the *ERER* can therefore be written as

$$ERER = \mathrm{HH}(p^*, \tilde{p}^*, \tau, \tilde{\tau}, \delta, \delta^*, V, T, \tilde{T}, G_X, \tilde{G}_X, \ldots),$$

$$\widetilde{ERER} = \widetilde{\mathrm{HH}}(p^*, \tilde{p}^*, \tau, \tilde{\tau},, \delta, \delta^*, V, T, \tilde{T}, G_X, \tilde{G}_X, \ldots). \quad (13)$$

III. Applying the Theoretical Model to Malawi

Although Edwards's model was developed to describe nominal misalignment in fixed exchange rate regimes, it is well suited to identify the fundamental variables that determine the Malawian equilibrium real exchange rate. First, Malawi is a low-income country, where public expenditure accounts for almost one-third of GDP, driven partly by large flows of development assistance. It is also a relatively open economy, with imports and exports exceeding 50 percent of GDP, and dependent on tobacco exports. Malawi is very dependent on imported goods, both for consumption and investment. Finally, although the kwacha was floated in the mid-1990s, it has since undergone periods of remarkable stability vis-à-vis the U.S. dollar.

The explanatory variables derived from Edwards's model and used in this analysis are briefly discussed below, as are the expected signs of their coefficents:

- **Government consumption excluding salaries and wages as a share of GDP.**[4] The expected sign is positive, although dependent on the share of tradables and nontradables in government consumption. If government spending is mainly directed toward nontraded (traded) goods, the effect is expected to have a positive (negative) sign. Most empirical studies with similar theoretical framework as this paper, including Cerra and Saxena (2000) on India and Mongardini (1998) on Egypt, find that government spending tend to result in a real appreciation of the exchange rate.

- **Government salaries and wages as a share of GDP.** The expected sign is negative, as civil servants constitute the middle-income class, and any real increment in wages and salaries is expected to increase consumption of (imported) tradables more than nontradables.

- **Investment.** The expected sign is ambiguous, as supply-side effects depend on the relative ordering of factor intensities across sectors.

- **Terms of trade of goods.** The expected sign is positive. The terms of trade affects the real exchange rate through the wealth effect which stipulates that, in the case of a positive

[4] Data on government consumption of nontradables and tradables are unavailable. Spending on public wages and salaries is excluded because the impact on the real exchange rate may differ from general government consumption. Moreover, general government consumption as a share of GDP was found to be stationary in the levels, thus preventing this variable from being cointegrated with the real exchange rate.

terms of trade shock, there will be an increase in domestic demand, and, hence, the price of nontradables.[5]

- **Technological progress.** The expected sign is positive. The Balassa-Samuelson effect posits that an increase in the productivity of tradables versus nontradables of one country relative to foreign countries raises its relative wage, thus increasing its relative price of nontradables and inducing an appreciation of the real exchange rate.

- **Capital flows.** The expected sign is positive. Although an incomplete measure, changes in net foreign assets net of trade flows as a share of GDP are used as a proxy for capital flows, capturing Malawi's substantial official and private transfers.[6] Moreover, higher net foreign assets would allow a larger trade deficit and a more appreciated exchange rate in the future.

- **Macroeconomic (fiscal and monetary) policies.**[7] The expected sign is ambiguous. With a fixed nominal exchange rate higher government deficits that are monetized as well as domestic credit creation generate a higher domestic price level inducing an appreciation of the RER. However, in the classical Mundell-Flemming framework overly expansionary fiscal and monetary policies cause a balance of payments deficit and a nominal exchange rate depreciation. Whether this nominal depreciation is also reflected in the real exchange rate depends on the speed of domestic price adjustment.

A. Data and Key Observations

The data reveal shocks to several of the variables in the mid-1990s (Figure 1). This period was marked by turmoil associated with the transition to a multiparty democracy and the initiation of an economic reform program, including the floating of the exchange rate.[8]

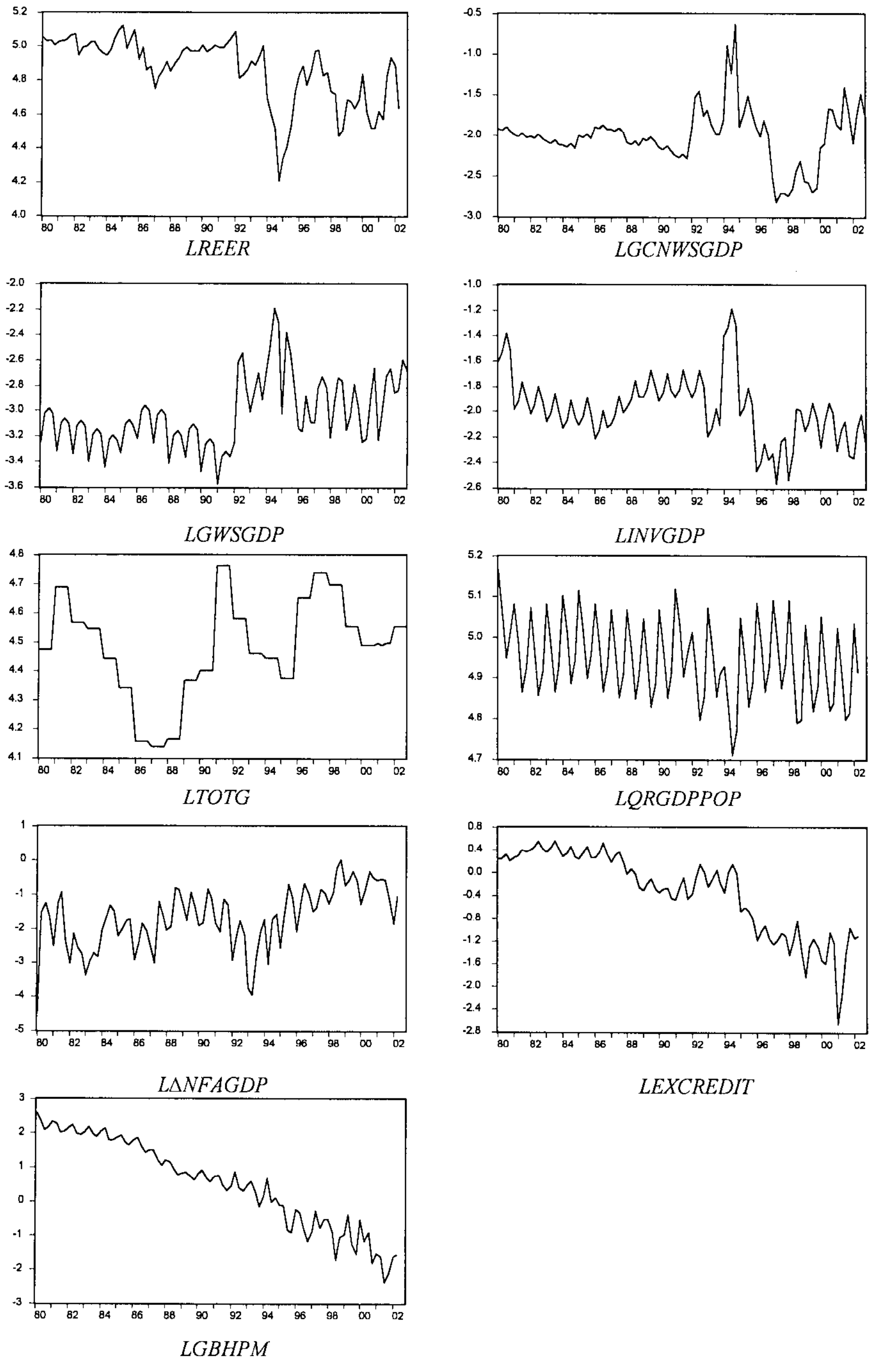
[5] An alternative approach is to use real commodity-export-prices instead of terms of trade (Cashin, Céspedes, and Sahay (2003)).

[6] Including the trade balance yields largely the same results (see Mathisen (2002)).

[7] Capital controls and nominal devaluations, identified by Edwards as having a short term impact on the real exchange rate, have been omitted in this study given that capital controls are still in place in Malawi, and the exchange rate was liberalized only in mid-1990s.

[8] The analysis uses quarterly data from the *International Finance Statistics (IFS)*, staff estimates, and Malawian authorities that, in some cases are interpolated from annual data. The variables and the data sources are listed in Appendix I.

Figure 1. Malawi: The Real Exchange Rate and Its Determinants, 1980–2002[9]



[9] See Appendix I for data sources and definitions of variables.

B. The Empirical Model

Edwards's theoretical model described above identifies the following "fundamental variables" as the most important ones in determining the *ERER*: the level and composition of government consumption, external terms of trade, investment, and capital flows. In addition, a variable has been introduced to capture the Balassa-Samuelson effect (MacDonald and Ricci, 2001 and 2002), and two variables have been added to capture the (temporary misalignments) induced by inconsistent macroeconomic policies. Hence, the empirical model for the *ERER* is

$$\text{Ln}\,(e_t^*) = \beta_0+\beta_1\ln(gcnwsgdp)+\beta_2\ln(gwsgdp)+ \beta_3\ln(invgdp)+\beta_4\ln(totg)+\beta_5\ln(qrgdppop)+ \beta_6\ln(\Delta nfagdp)+ \beta_7\ln(excredit)+ \beta_8\ln(gbhpm)+\varepsilon_t, \quad (14)$$

where the logarithm of the real exchange rate (e_t^*) is a function of the logarithms of government consumption (excluding wages and salaries) as share of GDP (*gcnwsgdp*), government spending on wages and salaries as share of GDP (*gwsgdp*), investment as share of GDP (*invgdp*), terms of trade of goods (*totg*), technological progress (*qrgdppop*), capital flows (*Δnfagdp*), and monetary (excredit) and fiscal (*gbhpm*) policies, as well as an error term, ε.

This analysis focuses on permanent changes in the explanatory variables that bring about changes in the long-run *ERER*. The observed real exchange rate has two components — the *ERER* and deviations from the *ERER*. The *ERER* is associated with the fundamental variables in their steady state levels. Deviations of these variables from their respective steady state levels result in deviations from the *ERER*. This approach prevents the bias introduced by using the observed values to estimate the long-run cointegrating relationship between the real exchange rate and the fundamentals, as a temporary shock would have a permanent impact on the *ERER*.

C. Econometric Characteristics

In order to estimate the empirical model as shown in equation (14), we first test for stationarity of the fundamental variables (Table 1), then for cointegration (Table 2), using the Johansen cointegration test (Johansen, 1988), and finally we proceed with the estimation procedure described in Appendix II.[10]

[10] An alternative statistical method to determine the permanent component of the real exchange rate is to simply take the cyclical component out of the data using a Hodrick-Prescott smoothing filter (see Mathisen (2002)).

Table 1. Unit Root Tests[11]

	Lag Length[12]	ADF Statistics	1 Percent Level	5 Percent Level	10 Percent Level
LREER	0	-2.56	-3.51	-2.89	-2.58
D(*LREER*)	0	-8.87*	-3.51	-2.89	-2.58
LGCNWSGDP	0	-3.47	-3.50	-2.89	-2.58
D(*LGCNWSGDP*)	0	-11.55*	-3.50	-2.89	-2.58
LGWSGDP	8	-2.09	-3.51	-2.89	-2.58
D(*LGWSGDP*)	7	-3.30	-3.51	-2.89	-2.58
LINVGDP	2	-3.02	-3.50	-2.89	-2.58
D(*LINVGDP*)	1	-11.14*	-3.50	-2.89	-2.58
LTOTG	0	-1.96	-3.50	-2.89	-2.58
D(*LTOTG*)	0	-9.38*	-3.50	-2.89	-2.58
LQRGDPPOP	8	-2.61	-3.51	-2.90	-2.59
D(*LQRGDPPOP*)	7	-3.21	-3.51	-2.90	-2.59
LΔNFAGDP	4	-2.08	-3.51	-2.90	-2.59
D(*LΔNFAGDP*)	2	-11.61*	-3.51	-2.90	-2.59
LEXCREDIT	8	-1.15	-3.51	-2.90	-2.59
D(*LEXCREDIT*)	7	-2.44	-3.51	-2.90	-2.59
LGBHPM	11	1.25	-3.51	-2.90	-2.59
D(*LGBHPM*)	11	-2.95	-3.51	-2.90	-2.59

**Denotes the rejection of the null-hypothesis of a unit root a 1 percent significance level.

[11] See Appendix I for data sources and definitions of variables.

[12] Based on the Schwarz information criterion.

Table 2. Johansen Cointegration Tests

Model 1

Hypothesized Number of Cointegrating Equations	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.566139	182.5768	124.24	133.57
At most 1 **	0.357942	109.9291	94.15	103.18
At most 2 *	0.319644	71.38137	68.52	76.07
At most 3	0.218206	37.87424	47.21	54.46
At most 4	0.093115	16.45797	29.68	35.65
At most 5	0.072595	7.954623	15.41	20.04
At most 6	0.015939	1.397874	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5percent (1 percent) level.
Trace test indicates 3 cointegrating equation(s) at the 5 percent level.
Trace test indicates 2 cointegrating equation(s) at the 1 percent level.

Model 2

Hypothesized Number of Cointegrating Equations	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.674247	262.3767	192.89	204.95
At most 1 *	0.397928	164.7960	156.00	168.36
At most 2	0.341569	120.6542	124.24	133.57
At most 3	0.292320	84.29724	94.15	103.18
At most 4	0.261618	54.21584	68.52	76.07
At most 5	0.156905	27.82932	47.21	54.46
At most 6	0.087972	12.98055	29.68	35.65
At most 7	0.053893	4.96917	15.41	20.04
At most 8	0.001716	0.14937	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5percent (1 percent) level.
Trace test indicates 3 cointegrating equation(s) at the 5 percent level.
Trace test indicates 2 cointegrating equation(s) at the 1 percent level.

Using augmented Dickey-Fuller (ADF) statistics and selecting the number of lags based on the Schwarz information criterion, the results show that all explanatory variables are stationary in the first differences, as is the REER (Table 1). The first difference stationarity of the REER is consistent with other studies of the real exchange rate and renders the PPP, in its traditional form at least, less useful. In all model specifications tested by using the Johansen cointegration test, the null hypothesis of zero cointegrating equations can be rejected; in some cases there appear to be two cointegrating equations (Table 2).[13] The lag length for the error-correction model (ECM) was determined by backward selection, beginning with a lag of seven. The likelihood ratio test indicates that ECM(2) is the most appropriate. Table 3 and 4 show the estimated elasticities of the ECMs: model 1, the specification closest to the theoretical model includes only the fundamental variables derived from the theoretical model; model 2, also captures the impact of the macroeconomic policy variables, and model 3, a parsimonious specification where the insignificant variables have been eliminated.

IV. Estimation Results

The results for the equilibrium real exchange rate for Malawi (model 1) are given in its error-correction form in equation (15). The detailed estimation results are given in Tables 3 and 4. The coefficient before the term brackets is the speed-of-adjustment coefficient.[14] The coefficients in the brackets form the cointegrating vector (i.e., the long-term elasticities) for the equilibrium real exchange rate. The (statistically significant) short-term variables are listed after the term brackets. The resulting equation is as follows:

$$\begin{aligned} \Delta LREER = & -0.27(-0.29 LGCNWSGP(-1)+0.26 LGWSGDP(-1)-0.17 LTOTG(-1)- \\ & 4.33 LQRGDPPOP-0.22 LINVGDP(-1) -0.04 L\Delta NFAGDP(-1)) - 0.12\Delta\, LGCNWSGP(-1) \\ & - 0.12\Delta LGCNWSGP(-2) -0.83\Delta LRGDPPOP-0.55\Delta LRGDPPOP(-2). \end{aligned} \tag{15}$$

The results of the estimation are consistent with the theoretical model. Public consumption, excluding wages and salaries, has a positive (appreciating) impact on the real exchange rate, indicating that most government spending in Malawi is directed toward nontradables. In contrast, the long-run impact of wages and salaries on the real exchange rate is negative, confirming that a larger wage bill in terms of GDP tends to put pressure on the external current account. The terms of trade of goods are positively correlated with the real exchange rate, consistent with a possible wealth effect. The relatively high long term impact of GDP per capita is mitigated by a short term negative impact. However, this could be more due to this variable capturing tobacco production, which represent about 80 percent of export earnings but less then 10 percent of GDP, than a strong Balassa-Samuelson effect. Moreover, investment is also positively correlated with the real exchange rate. However, when the

[13] The results in Tables 3 and 4 are obtained by estimating the ECM by imposing one cointegrating vector for ease of interpretation.

[14] The inverse of this coefficient determines how many quarters it takes for 50 percent of the deviation from the long-term equilibrium to be eliminated.

macroeconomic policies are added to the model specification (model 2), the terms of trade are found not to be significant. Finally, while the nominal depreciation associated with overly expansionary monetary policies has offset the effect on the domestic price level, overly expansionary fiscal policies were found to be not statistically significant.

Table 3. Results from the Cointegrating Equation[15]

	Model 1	Model 2	Model 3
LREER(-1)	1.0000	1.0000	1.0000
LGCNWSGDP(-1)	-0.2928	-0.3104	-0.1694
Standard error	0.0757	0.0637	0.0576
t-statistics	-3.8661	-4.8727	-2.9422
LGWSGDP(-1)	0.2576	0.3825	0.3084
Standard error	0.1016	0.0919	0.0885
t-statistics	2.5357	4.1639	3.4861
LTOTG(-1)	-0.1748	0.0379	
Standard error	0.0946	0.0899	
t-statistics	-1.8473	0.4210	
LQRGDPPOP(-1)	-4.3278	-4.2146	-3.9196
Standard error	0.5127	0.4858	0.4358
t-statistics	-8.4414	-8.6765	-8.9937
LINVGDP(-1)	-0.2177	-0.2838	-0.2135
Standard error	0.0793	0.0789	0.0753
t-statistics	-2.7442	-3.5962	-2.8351
LΔNFAGDP(-1)	-0.0417	0.0568	-0.0581
Standard error	0.0264	0.0365	0.0321
t-statistics	-1.5810	1.5530	-1.8068
LEXCREDIT(-1)		0.2363	0.0874
Standard error		0.1062	0.0397
t-statistics		2.2255	2.2048
LGBHPM(-1)		-0.0478	
Standard error		0.0537	
t-statistics		-0.8913	
Constant	17.0037	15.9724	14.8097

[15] The dependent variable is LREER. For definitions of variables, see Appendix 1.

Table 4. Results from Error-Correction Models with DLREER as Dependent Variable

Variable	Model 1	Model 2	Model 3
CointEq1	-0.2737	-0.2064	-0.2786
Standard error	0.0836	0.0838	0.0960
T-statistics	-3.2738	-2.4617	-2.9020
DLREER(-1)	0.0710	-0.0146	0.0556
Standard error	0.1325	0.1313	0.1344
T-statistics	0.5361	-0.1114	0.4138
DLREER(-2)	0.0727	0.0429	0.0769
Standard error	0.1313	0.1291	0.1332
T-statistics	0.5536	0.3320	0.5777
DLGCNWSGDP(-1)	-0.1194	-0.1230	-0.1080
Standard error	0.0637	0.0683	0.0627
T-statistics	-1.8741	-1.8021	-1.7215
DLGCWSGDP(-2)	-0.1210	-0.1093	-0.0993
Standard error	0.0580	0.0599	0.0576
T-statistics	-2.0871	-1.8261	-1.7246
DLGWSGDP(-1)	0.0188	0.0390	0.0719
Standard error	0.0968	0.1046	0.1047
T-statistics	0.1937	0.3731	0.6873
DLGWSGDP(-2)	0.0334	0.1021	0.0833
Standard error	0.0888	0.0984	0.0970
T-statistics	0.3766	1.0374	0.8594
DLTOTG(-1)	0.0272	0.0787	
Standard error	0.1562	0.1595	
T-statistics	0.1741	0.4934	
DLTOTG(-2)	-0.1493	-0.0765	
Standard error	0.1563	0.1585	
T-statistics	-0.9551	-0.4822	
DLQRGDPPOP(-1)	-0.8319	-0.6393	-0.7199
Standard error	0.2669	0.2917	0.2806
T-statistics	-3.1165	-2.1918	-2.5659
DLQRGDPPOP(-2)	-0.5458	-0.2828	-0.5819
Standard error	0.2644	0.3031	0.2798
T-statistics	-2.0645	-0.9329	-2.0798
DLINVGDP(-1)	-0.0288	-0.0724	-0.0695
Standard error	0.0928	0.0955	0.0953
T-statistics	-0.3106	-0.7581	-0.7290
DLINVGDP(-2)	0.0925	0.0968	0.0775
Standard error	0.1045	0.1084	0.1040
T-statistics	0.8860	0.8930	0.7450
DLΔNFAGDP(-1)	-0.0157	0.0003	0.0042
Standard error	0.0257	0.0268	0.0271
T-statistics	-0.6099	0.0110	0.1549
DLΔNFAGDP(-2)	0.0030	0.0014	0.0117
Standard error	0.0218	0.0222	0.0220
T-statistics	0.1374	0.0649	0.5295
DLEXCREDIT(-1)		0.0505	0.0295
Standard error		0.0632	0.0618
T-statistics		0.7989	0.4780
DLEXCREDIT(-2)		-0.0468	-0.0465
Standard error		0.0699	0.0659
T-statistics		-0.6700	-0.7062
DLGBHPM(-1)		-0.0730	
Standard error		0.0486	
T-statistics		-1.5018	
DLGBHPM(-2)		-0.0915	
Standard error		0.0437	
T-statistics		-2.0933	
Constant	-0.0067	-0.0148	-0.0082
Standard error	0.0110	0.0116	0.0113
T-statistics	-0.6071	-1.2771	-0.7320
Memorandum items:			
R-squared	0.2313	0.2814	0.2173
Adj. R-squared	0.0689	0.0776	0.0519
S.E. equation	0.1011	0.1006	0.1020
F-statistic	1.4245	1.3807	1.3137
Log likelihood	84.7915	87.7195	84.0017
Akaike IC	-1.5814	-1.5568	-1.5633
Schwarz SC	-1.1279	-0.9899	-1.1098
Mean dependent	-0.0046	-0.0046	-0.0046
S.D. dependent	0.1047	0.1047	0.1047

The finding that changes in net foreign assets were not significant might be due to the choice of this variables as proxy capital flows. One possible explanation might be that, while the data set starts in 1980, tobacco export earnings and balance of payments assistance became a substantial part of net foreign assets only during the 1990s. It could also be that the terms of trade have an indirect impact through net foreign assets. As model 3 indicates, an increase in net foreign assets could indeed have a positive impact on the real exchange rate as long as terms of trade are omitted from the model specification.

The long-run relationship between the equilibrium real exchange rate and the key explanatory variables can be summarized as follows (Table 3):

- A 1 percent increase in the level of government consumption as share of GDP, excluding wages and salaries, is associated with an appreciation of the REER of 0.2-0.3 percent.

- A 1 percent increase in the level of government wages and salaries as share of GDP is associated with a depreciation of the REER of 0.3-0.4 percent.

- A 1 percent increase in the terms of trade of goods appears to be associated with an appreciation of the REER of about 0.2 percent (as long as the specification excludes the monetary and fiscal policy variables).

- A one percent increase in (annual) real GDP per capita is associated with an appreciation of the REER of about 1 percent.

- A 1 percent increase in investment as share of GDP is associated with an appreciation of the REER of 0.2-0.3 percent.

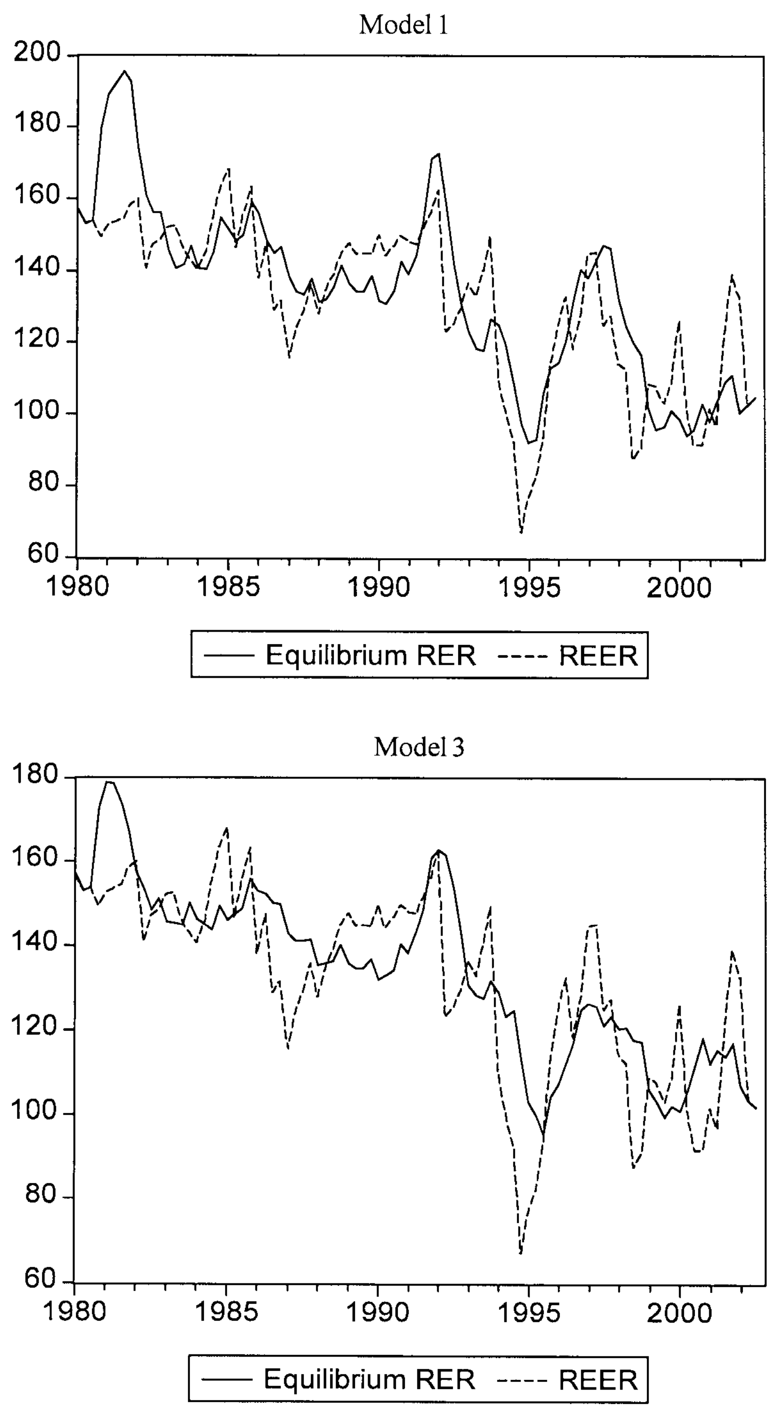
- A 1 percent increase in credit to government as share of GDP is associated with a depreciation of the REER of 0.1-0.2 percent.

- A 1 percent increase in net foreign assets as share of GDP is associated with an appreciation of the REER of about 0.06 percent (as long as terms of trade and the fiscal variable are omitted).

A. Adjustment Speed

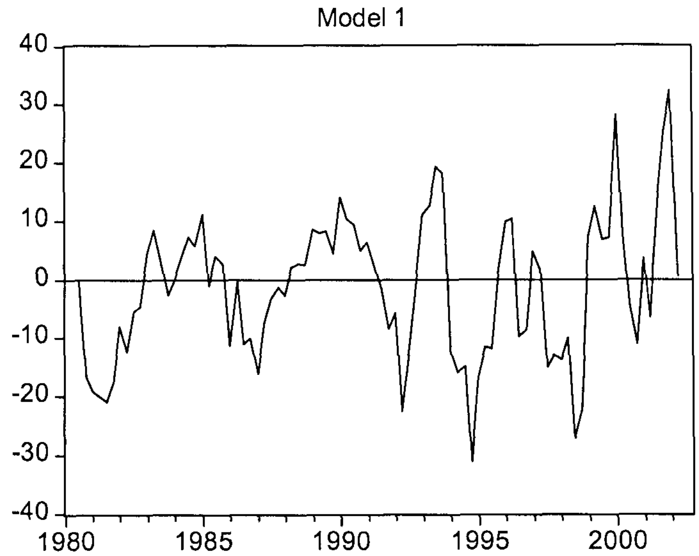
When there is a gap between the value of the real exchange rate and its equilibrium level, the real exchange rate will tend to converge to its equilibrium level. Depending on the cause of the gap, the adjustment requires that the real exchange rate either move progressively toward a new equilibrium level or return from its temporary deviation to the original equilibrium value.

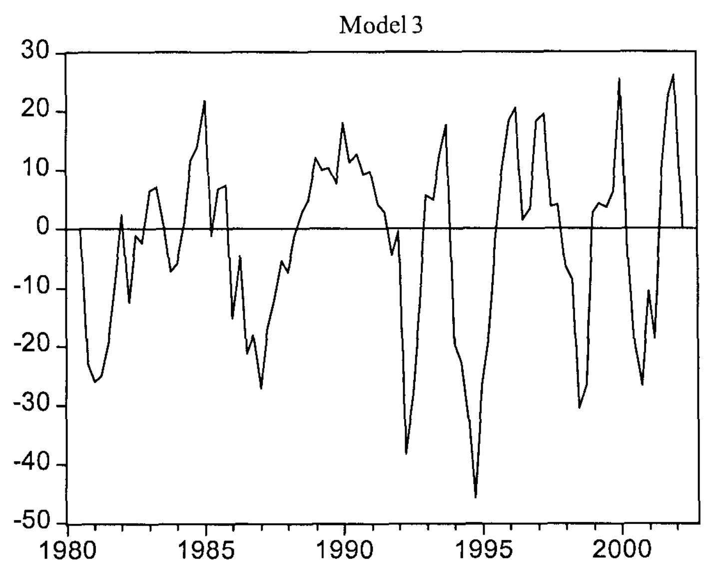
Figure 2. Malawi: Actual and Equilibrium Real Exchange Rates, 1980-2002
(1994=100)



Sources: IFS and author's calculations.

Figure 3. Malawi: Real Effective Exchange Rate Minus Equilibrium Exchange Rate, 1980-2002
(In percent)





Sources: IFS and author's calculations.

This study estimates that some 20 percent of the gap is eliminated every quarter, implying that, in the absence of further shocks, half of the gap would be eliminated within about 11 months. This adjustment speed is relatively fast compared with the half-life of a shock to the real exchange rate in South Africa, estimated to be about 2½-3 years (Ricci, 2003), and a lot quicker than that of Rogoff's (1996) estimate of three to five years. However, the results are similar to that of larger studies as that done by Cashin, Céspedes, and Sahay (2003), which found Malawi's adjustment speed to be about 7 months.

V. The Gap Between the Real Exchange Rate and the Equilibrium Level

During the last decade, there were several episodes when the ERER and REER were misaligned (Figure 2).[16] Two major droughts, in 1992 and 1994, caused food prices to rise substantially, reversing the gains made in reducing inflation. As the Malawi kwacha was pegged to a basket of seven major currencies until February 1994, this led to an overvalued real exchange rate (Reserve Bank of Malawi, 2000). Following the flotation of the exchange rate and the sharp depreciation of the nominal exchange rate, the REER became undervalued. This was reversed in 1996, when the REER peaked as the Reserve Bank of Malawi (RBM) maintained the nominal exchange rate at MK15.3 per U.S. dollar and the expansionary monetary and fiscal policies resulted in high inflation. The subsequent adjustment program had some initial success in bringing down inflation; this however, was lost in 1999 when the RBM maintained a steady nominal exchange rate vis-à-vis the U.S. dollar. The results suggest that the REER was in equilibrium in late 2001 and early 2002 (Figure 3).

VI. Conclusion

The paper shows that the ERER in Malawi is determined by standard fundamental variables, as well as by monetary policies. Government consumption, excluding wages and salaries, has a positive impact on the real exchange rate, consistent with most government spending being directed toward nontradables. In contrast, the long-run impact of wages and salaries on the real exchange rate is negative, indicating that a larger wage bill in terms of GDP tends to put pressure on the external current account. The terms of trade of goods appear to be positively correlated with the real exchange rate, confirming the impact of the wealth effect. Also real per capita growth and investment are positively correlated with the real exchange rate. Finally, a loose monetary policy is associated with a depreciating real exchange rate.

The results also indicate a rapid adjustment of any deviation of the real exchange rate from its equilibrium value. The paper shows that, in the absence of further shocks, about half the gap between the actual value of the REER and its equilibrium values could be eliminated within about 11 months.

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[16] Based on the long-run relationship summarized in Table 3 and some short-run deviations (Table 4), the ERER was estimated for 1980-2002.

APPENDICES

I. Variables: Definitions and Sources

The quarterly data set from March 1980 to June 2002 consists of the following variables:

- *LGCNWSGDP*: Natural logs of government consumption excluding wages and salaries as share of GDP. Sources: *IMF, International Financial Statistics (IFS)*; and staff estimates.
- *LGWSGDP*: Natural logs of government wages and salaries as share of GDP. Sources: *IFS*; and staff estimates.
- *LINVGDP*: Natural logs of investment as share of GDP. Source: National Statistical Office, Malawi.
- *LTOTG*: Natural logs of terms of trade of goods. Sources: *IFS*; and staff estimates.
- *LREER*: Natural logs of the real effective exchange rate. Source: *IFS*.
- *LRGDPPOP*: Natural logs of quarterly real GDP per capita. Source: National Statistical Office, Malawi; and staff estimates.
- *LΔNFAGDP*: Changes in net foreign assets minus changes in the trade balance as a share of GDP. Sources: *IFS*; and Reserve Bank of Malawi.
- *LEXCREDIT*: Natural logs of the ratio of domestic credit to nominal GDP. Sources: *IFS*; and staff estimates.
- *LGBHPM*: Natural logs of 10,000 minus the nominal government balance as a share of high-powered money.[17] Sources: *IFS*; and staff estimates.

A "D" prefixed to a variable indicates that a differencing operation has been performed.

[17] Arbitrary chosen number to ensure that the logarithmic value exists; choosing other values yields similar results as those presented in the paper.

II. Cointegration and Orthogonal Decomposition

This paper relies on an econometric technique developed by Gonzalo and Granger (1995) to decompose the observed real exchange rate (RER) into a transitory and a permanent component. The estimated ERER is taken to be the permanent component, while the transitory component reflects deviations from equilibrium.

In order to understand the link between equilibrium and cointegration, it is useful to depart from the theory of purchasing power parity (PPP), which implies a constant value of ERER. In econometric terms, PPP implies a stationary process for the RER (i.e., that the RER is integrated of order zero (I(0)). However, if the RER contains a unit root (i.e., if it is an I(1) variable), no constant equilibrium can be defined for RER, and the PPP hypothesis is rejected.

The failure of PPP to hold does not necessarily imply that no equilibrium exists, but rather that the equilibrium may be time varying. In this case, if ln(*gcnwsgdp*), ln(*gwsgdp*), ln(*invgdp*), ln(*totg*), ln(*qrgdppop*), ln(Δ*nfagdp*), ln(*excredit*), and ln(*gbhpm*) are cointegrated, the RER will fluctuate around a time-varying equilibrium characterized by the long-run cointegrating relationship $[1\text{-}\beta_1\text{-}\beta_2\text{-}\beta_3\text{-}\beta_4\text{-}\beta_5\text{-}\beta_6\text{-}\beta_7\text{-}\beta_8]$. Thus, cointegration among a set of variables allows for the presence of a time-varying equilibrium and presents a very desirable property: it allows for the decomposition of the relationship among the variables into two components. The permanent component, which would be I(1), describes the long-run properties of the relationship among the variables and can be identified with a time-varying equilibrium path; a transitory component, which would be I(0), corresponding to deviations over time from the permanent component and would represent departures of the fundamentals from their steady state values.

Gonzalo and Granger (1995) propose a way of solving the econometric problem so that the permanent (equilibrium) component of the key endogenous variable, the real exchange rate, can be constructed by means of the permanent components, rather than by the actual values of the fundamental determinants. Their approach is to derive a decomposition in which the transitory component does not "Granger cause" the permanent component in the long run, and in which the permanent component is a linear component of contemporaneous observed variables. The first restriction implies that the changes in the transitory component will not have an effect on the long–run values of the variables. The second restriction makes the permanent component observable and assumes that the contemporaneous observations contain all the information necessary to extract the permanent component.

The Gonzalo and Granger procedure is as follows. Let X_t be a (p x 1) vector of I(1) series with mean 0 and assume that there exists a matrix α_{pxr} of rank r such that $\alpha' X_t$ is I(0). Then the vector X_t has the following ECM representation:

$$\Delta X = \underset{pxr}{\gamma} \underset{rxp}{\alpha'} X_{t-1} + \sum_{i=1}^{\infty} \Gamma_i \Delta X_{t-i} + \varepsilon_t, \qquad (16)$$

where Δ is the lag operator.

The elements of X_t consist of $(p-r)$ I(1) variables, f_t, known as the common factors, plus some I(0) components, as follows:

$$\underset{px1}{X_t} = \underset{pxk}{A_1} \underset{kx1}{f_t} + \underset{px1}{\widetilde{X}}, \tag{17}$$

where $k = p\text{-}r$. Gonzalo and Granger define $A_1 f_t$ and $\widetilde{X}_t$ as the permanent and temporary components of X_t, respectively, such that only the innovations from the permanent component can affect the long-run forecast of X_t. Innovations to the temporary components of all the endogenous variables, including the fundamental determinants, do not affect the long-run, "equilibrium" forecast of X_t.

The only linear combination of X_t that precludes $\widetilde{X}_t$ from having any long-run impact on X (the conditions sufficient to identify the common factor f_t) is given by

$$f_t = \underset{kxp}{\gamma'_{\perp}} \underset{px1}{X_t}, \tag{18}$$

where $\gamma_{\perp}$ is the orthogonal complement of γ (i.e., $\gamma_{\perp}'\gamma = 0$) and $k = p\text{-}r$. Once the common factors f_t have been identified, the matrix $(\gamma_{\perp}, \alpha)'$ can be inverted to obtain the permanent-transitory decomposition as follows:

$$\underset{px1}{X_t} = \underset{pxk}{A_1} \underset{kxp}{\gamma'_{\perp}} X_t + \underset{pxr}{A_2} \underset{rxp}{\alpha'} X_t, \tag{19}$$

where $A_1 = (\gamma_{\perp}' \alpha_{\perp})^{-1}$ and $A_2 = (\alpha' \gamma)^{-1}$. The first term on the right-hand side provides the permanent component at each point in time, t, for the vector of endogenous variables (the RER and the fundamental variables).

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