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REAL EXCHANGE RATE MISALIGNMENTS AND GROWTH

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ABSTRACT

Real exchange rate (RER) misalignment is now a standard concept in international macroeconomic theory and policy. However, there is neither a consensus indicator of misalignment, nor an agreed upon methodology for constructing such an indicator. This paper constructs an indicator of RER misalignment for a large sample of developed and developing countries. This indicator is based on a well-structured but simple extension of an IS-LM model of an open economy. The paper then uses regression analysis to explore whether RER misalignments are related to country growth experiences. Interestingly the work finds that there are important non-linearities in the relationship. Only very high over-valuations appear to be associated with slower economic growth, while moderate to high (but not very high) under-valuations appear to be associated with more rapid economic growth.

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I. Introduction

Real exchange rate (RER) misalignment refers to a situation in which a country's actual RER deviates from some notion of an implicit "ideal" RER. An exchange rate is labeled "undervalued" when it is more depreciated than this ideal, and "overvalued" when it is more appreciated than this ideal. Such misalignments are widely believed to influence economic behavior. In particular, Overvaluation is expected to hinder economic growth while undervaluation is sometimes thought to provide an environment conducive to growth. But unless the "ideal" is explicitly specified, the concepts of RER misalignment remain subjective. The objectives of this paper are first to develop and construct explicit measures of RER misalignment, and second to explore systematically the relationships between misalignment and economic growth.

Conceptually, a RER is misaligned when it deviates from the underlying RER that would have prevailed in the absence of price rigidities, frictions and other short run factors. A more structured definition of misalignment uses the notion of an "equilibrium RER". This typically refers to the theoretical RER that would have prevailed if the economy were simultaneously in internal and external balance. Internal balance refers to the economy operating at full employment and at full capacity output. External balance refers to a sustainable current account position given a country's desired capital position, as a net lender or borrower. A RER misalignment can then be defined as the deviation of the actual RER from this "equilibrium RER".

A number of empirical papers attempt to measure RER misalignments by operationalizing the theoretical concept of an "equilibrium RER".[1] (See Razin 1996a for additional discussion of this

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[1] This literature includes Williamson (1995), Bayoumi, Clark, Symansky, and Taylor (1994), Borenzstein (1995), Edwards (1989, 1995), Elbadawi (1995), Cottani, Cavallo, and Kahn (1990) and Ghura and Grennes (1993).

literature.) This empirical work includes very different types of analysis for developed and for developing countries. That for developed countries typically takes advantage of both extensive available data and the findings from large multi-country macro models (like the IMF's Multimod). These models can simulate "equilibrium RERs" which are consistent with constructed proxies of external and internal balances. Both types of information can then be used to provide benchmark RERs for policy makers. Williamson (1995) provides one example of this work.

Such extensive information is not available for the developing countries (LDCs). Data is much less detailed and incomplete, and there are no comparable dynamic simulation models. Existing empirical work here is done mostly at a cross country level, using pooled data and estimating cross country regressions. Further, the analysis is typically done for relatively small samples of countries. For example, Edwards (1995) develops a model for a small economy. He shows how both nominal and real factors play a role in determining the RER[2] in the short run, while only real factors influence the (steady state) "equilibrium exchange rate". Edwards estimates a version of his model using pooled data on a panel of 12 developing countries. His results provide support for the model -- RER movements do respond to both nominal and real disturbances, and inconsistent macroeconomic policies tend to generate a RER overvaluation.

A key objective of this paper, therefore, is to develop and empirically implement a methodology for constructing RER misalignment indicators for a very large sample of both industrial and developing economies. The work focuses on the misalignment that arises as a result of short run price rigidity. An open economy macro model developed by Frenkel and Razin (1995) provides a unified framework for analysis. As shown below, an estimable equation is derived from the model's structural solution for the RER. The resulting estimates are then used to construct RER misalignment measures, for 93 countries, over 16 to 18 year periods since 1975. These

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[2] Edwards defines the RER is as the relative prices of tradables and nontradables,

misalignment indicators are then used as explanatory variables in growth regressions.

There are at least two possible channels through which RER misalignments might influence growth. First, they could influence domestic and foreign investment, thereby influencing the capital accumulation process. Capital accumulation is a well established "engine of growth". Second, a RER that is out of line could effect the tradables sector, and the competitiveness of this sector vis a vis the rest of the world. This sector's performance is also generally though to be an important component of the economy's overall growth.

Misalignment volatility could also have an impact on growth. Theoretical and empirical work shows that a volatile economic environment (for example volatility of the terms of trade, exchange rates, money supply, productivity) has a harmful effect on economic performance.[3] Misalignment volatility is possibly another such factor.

The paper is organized as follows. Section II focuses on RER misalignments. It begins by outlining the theoretical framework that is the basis for the work. It then uses the framework to construct indicators of RER misalignment for. Section III uses the now standard methodology of growth regressions to explore the effects of RER misalignment on growth. An innovation of this analysis is to consider potentially non-linear relationships between key variables. The final section contains concluding remarks.

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[3] For example, see Campa (1993), Dixit and Pindyck (1994), Gavin, Hausmann and Leiderman (1995) and Leahy and Whited (1995).

II. Real Exchange Rate Misalignment

The empirical analysis implements the stochastic version of the Mundell-Fleming open economy model developed by Frenkel and Razin (1995). The model consists of a set of simple equations which represent linear approximations to underlying behavioral equations. This model is particularly appropriate for usage in constructing indicators of RER misalignment because its solution distinguishes between an RER that is affected by short run rigidities and an RER that would obtain in the absence of such rigidities. As noted above, this is precisely what is meant by "misalignment" in this paper. The model also explicitly distinguishes between perfect capital mobility and full capital controls. This provides a structure for exploring differences between industrial and developing counties, which typically differ in the extent of capital restrictions. The discussion below highlights key features of the model, and then focuses on the implied solutions for the RER that are used in the estimations. Readers are referred to Razin (1996a) and Frenkel and Razin (1995) for a detailed presentation of the model, and a derivation of the solution.

Theoretical framework

The model is based on the standard IS-LM model of a small open economy that produces a single traded good. Aggregate demand depends on the real exchange rate, and on real interest rates. Equilibrium is determined simultaneously in the goods and money markets. This basic framework is extended in two ways. First, output supply, money supply and domestic demand are assumed to be stochastic processes, through the introduction of independent and identically distributed (iid) shocks.

Second, price rigidities are introduced by specifying the price level as an average of the free market -- *flex* -- price and a one-period contract price set in period t-1 based on expectations about the market clearing price in period t. Thus, the model has both the standard *flex-price* solution,

which assumes prices are fully flexible, and a *full-fledged* solution, which incorporates the price rigidities.

Just as for a standard IS-LM set-up, this model can be solved under different assumptions about the extent of international capital mobility. Of particular interest in the current context, the determinants of the real exchange rate are somewhat different in the perfect capital mobility case than they are in the full capital controls case.

The empirical analysis in this paper is based on the solutions for the equilibrium real exchange rate (RER) that come from the model outlined above. All variables (except interest rates) are in logarithms. Define the RER as follows: $q_t = s_t + p_t - p_t^*$, where s is the foreign currency price of domestic currency, and p and p* are domestic and foreign price levels respectively. Note that exchange rates have been defined so that a rise implies an appreciation.

It can be shown that the *full-fledged* solution for the RER is the *flex-price* solution, g( ), plus a linear combination of stochastic shocks, f( ):

(1) *capital mobility:* $q_t = g_1(y_t^s, d_t, i^*) + f_1(\varepsilon_{mt}, \varepsilon_{yt})$

(2) *capital controls:* $q_t = g_2(y_t^s, d_t^X) + f_2(\varepsilon_{mt}, \varepsilon_{yt}, \varepsilon_{dt}^A)$

where f_1, f_2, g_1, g_2 are all linear functions; y^s is output supply; i* is the world interest rate; d is the exogenous component of aggregate demand and ε_y ,ε_m are stochastic shocks to output and money supply. In the capital controls case, aggregate demand has been decomposed into domestic absorption and the trade balance. Thus, d^X is the exogenous component of demand for net exports, while ε_d^A is the stochastic shock to domestic absorption.

Equation (1) shows the determinants of the RER under perfect capital mobility. The *flex-price* solution, g_1, depends on the fundamental determinants of domestic supply and aggregate

demand, as well as on world interest rates. In the absence of price rigidities, the RER will appreciate in response to higher output or world interest rates, but depreciate in response to higher aggregate demand. The function f( ) shows how the RER will deviate from its *flex-price* level given price rigidities -- money supply shocks will cause short term real appreciations while output supply shocks will cause short-run real depreciations.

Under full capital controls, the RER must adjust so as to maintain external balance. Thus, in the solution for the RER given in (2), conditions in world capital markets no longer determine the *flex-price* solution. Instead of total aggregate demand, it is now the exogenous component of demand for net exports that matters. As before, increased long-run output supply is associated with an RER appreciation. Due to short-run price rigidities, the RER will deviate from this *flex-price* solution because of money and output shocks, as in the capital mobility case. In addition, positive shocks to domestic absorption will cause a temporary RER appreciation.

The model thus provides a clear distinction between a "flex-price" RER and the model's "full fledged" solution RER. The "flex-price" RER is determined by fundamental (or long-run) variables related to domestic supply, demand, and the external economy. In the empirical analysis, deviations of the actual RER from (an estimated) flex-price level will be taken as indicators of exchange rate misalignment. As shown above, these deviations arise from short-term rigidities, and are associated with various types of shocks.

The model also distinguishes between high and low capital mobility. Two key differences that arise in the solution for the RER are considered in the empirical analysis. First, factors related to external balance are important determinants of the flex-price RER under capital controls, but not under full capital mobility. Second, domestic absorption shocks cause deviations from the flex-price RER under capital controls, but not under full capital mobility.

An attractive feature of this model is its relative simplicity. The RER solutions are well

defined, yet general enough to provide a useful framework for empirical implementation. One drawback is that the model is not a fully dynamic framework, and can not capture dynamic forward looking behavior. (See Elbadawi (1995) for an argument for such models in this context.)

Empirical Implementation

The solutions for the "full-fledged" RER are the basis for the construction of indicators of RER misalignment. A country's actual RER each year is assumed to be a linear function of two sets of determinants. In equation (3), W denotes long-run (or fundamental) variables that would determine its RER in the absence of any rigidities. Z denotes key shocks. The error term is included to capture additional shocks omitted from Z. It would also reflect unobserved fundamentals.

(3) $$q_{it} = W_{it}\alpha + Z_{it}\beta + \gamma_{it} \quad ; \qquad i = 1, \ldots, M \;\; ; t = 1, \ldots, T$$

As before, q_{it} is the (log of the) RER of country i at time t. W_{it} is a vector of variables for country i at time t that capture longer-run factors, and are thus relevant for the "flex-price" RER; and Z_{it} is a vector of variables for country i at time t that proxy short-run shocks. γ_{it} is an iid error term for country i at time t.

This equation was estimated separately for developed and developing countries. In both cases, the empirical analysis tested whether fixed country effects was the appropriate specification. Two additional econometric issues are raised, but not pursued, here. One is the potential non-stationarity of the RER. See Razin (1996a) for further discussion. The other is the potential endogeneity of variables chosen as long-term factors.

Misalignment indicators are then constructed for each country at each time period, where misalignment is defined as:

(4) $mis_{it} = (q_{it} - W_{it}\alpha) = (Z_{it}\beta + \gamma_{it})$

Thus a "misalignment" is the deviation of the actual RER from a linear combination of variables that proxy the "flex-price" RER, due to the short run shock proxies and the error term of the regression.

The analysis is undertaken for a total of 93 countries over the period 1975 to 1992. However, smaller time periods were used for some countries. The sample was divided into two sub panels -- one with 20 developed countries, and a total of 322 observations; the other with 73 "developing" countries, and a total of 1190 observations. (Appendix A gives a list of countries.)

The real exchange rate

Implementation requires a measure of the real exchange rate for a very large panel of developed and less-developed (LDC) countries. Previous analyses of this type have either focused on developed economies, or used smaller groups of LDCs. In particular, previous work (Razin, 1996a) used data on real effective exchange rates from Morgan Guaranty for 19 developed and 23 developing countries.[4]

The procedure followed here is to use data on the price of consumption goods (and services) from the PENN World Tables. These series are attractive for use in this context because they are available for such a large cross section of countries and years, and because they were constructed to

[4] Previous work explored links between the misalignment indicators constructed from Morgan Guaranty REERs and economic growth. Overall, the results were similar to those reported here. However, in some instances, the relatively small sample size made it difficult to draw conclusive results.

be internationally comparable.[5] Higher consumption goods prices can be interpreted as reflecting more appreciated exchange rates. The data for each country were then indexed (1987=100).[6]

Table 1 reports means and standard deviations of the log RER (LRER) for developed and developing countries. The figures illustrate the well known fact that there is considerably more exchange rate volatility among developing than industrial countries. Note that the similarity of the means for the two country groups reflects the indexation procedure.

Long- versus short-term factors -- the W and Z matrices

The next step is to specify right-hand side variables. As discussed above, variables included in the W matrix should reflect underlying fundamentals, or the longer-run, while those included in the Z matrix should proxy short run shocks. The model also suggested somewhat different variables were relevant depending on the degree of capital mobility -- both sets will be considered in the analysis. All data discussed here are from the World Bank's World Tables.

For the W matrix the theoretical model points to variables related to output supply, the exogenous components of demand in general and the trade balance more specifically, and world interest rates. Accordingly, five variables are chosen as candidates for W. Both to incorporate a

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[5] See Summers and Heston (1991) for further discussion of these data, and Bosworth, Collins and Chen (1996) for additional discussion of this series as a measure of RERs. Note that this measure of domestic relative to foreign prices is consistent with the form of the RER assumed in the model. Edwards (1995) follows an alternative approach, specifying the RER as the domestic price of tradeable relative to non-tradeable goods.

[6] Indexing does remove much of the cross-country variation. However, the within-country variation in the data proved insignificant in the regression analysis when non-indexed series were used. Indexing the RERs lessens the influence of the between country average (although it is still relatively strong), and gives substantially more sensible estimates for constructing misalignments. There is a second justification for the indexation. It is well known that the consumption price series from the PENN World Tables is systematically related to country income level. (See Bosworth, Collins and Chen 1996 for further discussion.) Various procedures have been used to adjust for this bias. The usage of indices (1987=100) here are one means of adjustment.

longer run perspective and reduce potential endogeneity problems, each of these variables was specified as a five-year moving average. Table 1 reports means and standard deviations for developing and industrial country groups.

GYL5 is growth in output per worker. This variable is used as an indicator of trends in labor productivity -- a fundamental determinant of domestic output supply. As shown productivity growth was somewhat slower on average among developing countries, but exhibited considerably greater variability.

MG5 is annual money growth in excess of output growth. This variable is taken as an indicator of the overall stance of monetary policy. Thus, it is interpreted as an underlying determinant of domestic demand. Not surprisingly, this indicator implies that LDCs maintained considerably looser monetary policy on average, than industrial countries.

In addition, three variables are included as potential indicators of external conditions. TOT5 is the (log of the) terms of trade. KY5 is annual long-term capital inflows as a share of GDP. Finally, RBY5 is the annual resource balance (exports minus imports of goods and non-factor services) also as a share of GDP. Table 1 shows that LDCs as a group enjoyed much larger long-term capital inflows, but ran much larger external deficits. If, as postulated, industrial economies exhibit greater capital mobility than LDCs, then these variables related to external balance should be important in the estimated equation for LDCs.

The Z matrix should include variables that proxy short run shocks to output, absorption and money supply. Thus, the three indicators considered are SHOCKY, SHOCKA and SHOCKM, which are respectively, yearly deviations of (the logs of) GDP, absorption, and money supply from fitted ARMA(1,1) processes. Again, the model implies that we should expect to see differences between high capital mobility developed countries and lower capital mobility LDCs. Domestic absorption shocks should matter more for the LDCs, while output and money supply shocks should

be relevant for both groups. Means and standard deviations for these variables are given in Table 2. A key difference between LDCs and industrial economies is in the average size of monetary shocks. There is also much more variability for all three variables in the LDC sample.

RER Regression Results

The results from the panel regressions of LRER on the long-term factors and shocks are reported in Table 3. Note that the specifications for each country group were chosen on the basis of the significance of estimated coefficients and robustness to outliers. Future work could explore alternative explanatory variables and specifications. The results are quite interesting, and are broadly consistent with the model developed above. In particular, there are significant differences between the estimated coefficients for developed countries versus LDCs, and many of these can be interpreted in terms of more extensive capital controls among LDCs. However, there are also some surprises.

Using a Hausman-Wu test, the fixed effects specification could be rejected for developed but not for developing countries. Overall, the fit is considerably better for LDCs than for developed countries. This likely reflects both the usage of fixed effects, and the fact that the right hand side variables exhibit significantly more variation for the LDC sample.

Consider first the role of long-term factors in determining RER movements. As expected, variables directly related to external balance are much more important for LDCs than for developed countries. Indeed, both long-term trends in net trade relative to GDP (RBY5) and long-term capital inflows relative to GDP (KY5) are strongly significant in the LDC equation, but insignificant for developed countries. Greater net trade surpluses in LDCs are associated with more depreciated RERs while greater long-term capital inflows are associated with more appreciated RERs. The terms of trade enters significantly in both regressions -- TOT improvements are associated with more appreciated RERs. However, the TOT has both greater statistical significance, and a larger

coefficient estimate for LDCs.

The results for other long-term variables are somewhat surprising. GDP per worker, a proxy for productivity growth, does not enter significantly in either regression. The growth of money relative to GDP enters only for LDCs, and has an unexpected sign. Especially given the surprising results for money shocks, it would be interesting to explore other proxies for the long and short-term monetary variables.

Consider next the role of shocks. As discussed above, the model implies absorption shocks should be more important in developing countries, to the extent that they are characterized by less capital mobility. Table 3 shows that although positive absorption shocks are associated with RER appreciation in both groups, the coefficient is larger and more significant for LDCs. The model also implies that output and money shocks should be relevant for both country groups. As shown in Table 3, output shocks appear to matter only for LDCs (positive shocks are associated with RER depreciations). Money shocks enter only in the developed country equation -- as expected, a positive money shock is associated with RER depreciation.

Misalignment Indicators

The next step is to construct misalignment indicators for each country in each time period. Recall that "misalignment" as defined in (4) is the deviation of the actual RER from a linear combination of variables that proxy the "flex-price" RER, due to the short run shock proxies and the error term of the regression. A positive value signifies an overvaluation of the actual RER relative to the "flex price" RER, and a negative value signifies an undervaluation. Thus, annual misalignment indicators were constructed using the coefficient estimates reported in Table 3. (See Razin (1996a) for an extensive discussion of the behavior of similarly constructed misalignment indicators in a number of individual countries.)

The growth analysis in the next section requires country characteristics, including RER misalignment over longer time periods. Thus, the annual data were then divided into two sub-periods: 1975-77 to 1983 (period 1) and 1984 to 1990-92 (period 2). The early period includes the years leading up to the international debt crisis, while the latter period encompasses the aftermath, and early recovery. For each country and sub-period, averages and standard deviations of the yearly values were constructed. This gives a total of 170 observations, each characterized by a country and a period. Both variables were multiplied by 100 to convert them to percentages.

Table 4 provides some statistics on RER misalignments in each time period, where LDCs have been divided into six regional groupings. According to the indicator developed and constructed here, RERs were overvalued in most of the LDC regions during the earlier period, with the misalignments most pronounced in Sub-Saharan Africa, South Asia and especially Europe and Central Asia. In contrast, RERs were relatively undervalued in all regions on average in the later period. Of course, such broad regional and time averages can mask significant differences among individual countries and over time.

III. Growth Analysis

This section explores the link between real exchange rate misalignment and economic growth using regression analysis.[7] Many previous growth studies have included real exchange rate indicators as explanatory variables, typically finding RER instability to be associated with significantly slower growth. (For example, see Gavin, Hausmann and Leiderman (1995)). This work uses RER proxies directly, without attempting to construct measures of misalignment. Arguably, it is misalignment, not the level or variability of the RER per se, that should be associated with slower growth.

The approach followed here is to add misalignment measures to the right-hand side variables that are now standard in this literature. Indeed, choice of explanatory variables is heavily influenced by the classic analysis in Barro and Lee (1994). As in their work, right hand side variables include indicators for initial conditions, the external environment, and macroeconomic policy. In this context, the actual RER (level, change or standard deviation) has frequently been included as an indicator of macroeconomic policy. The finding that RER volatility (measured by the standard deviation) is negatively associated with growth has been interpreted as evidence that "unsustainable" macroeconomic policies cause exchange rate misalignments and hinder growth. But this may be a poor proxy for RER misalignment. Further, any misalignments should reflect not only policy variables, such as monetary and fiscal policies, but also the effects of various shocks. Thus, the present analysis includes as a right-hand side variable the measure of RER misalignment constructed above.

A difference between the present analysis and work by Barro and Lee and others is the

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[7] For further discussion of the large and growing literature using growth regressions, see Barro and Lee (1994), Collins and Bosworth (1996), and Levine and Renelt (1992). Note that one drawback to the growth regression approach is the difficulty in addressing difficulties related to the potential endogeneity of explanatory variables other than initial conditions.

relatively short time period considered. The intent in analysis presented here is to select a time period that is short enough for the misalignment indicator to be meaningful, but long enough that growth is not primarily determined by cyclical factors.

Summary statistics for the variables used in the growth regressions are reported in Table 5. In the table, observations are averaged over both time periods, but disaggregated by region. The dependent variable is *gypc* -- average annual growth in GDP per capita. The four indicators of initial conditions are all for 1970. These are *gdp, life, prim* and *sec*, defined respectively as per capita GDP in U.S. dollars, life expectancy at birth and primary and secondary school enrollments (as percentages of total relevant age group). Initial income is included to capture "catch-up" while the other variables are taken as measures of initial health and education. [8] Change in the terms of trade, *gtot*, and standard deviation in the terms of trade, *sdtot*, are included to capture cross country differences in the relevant external environment. Finally, government consumption as a percentage of GDP, *govcon*, is included as an indicator of fiscal policy.[9] As with misalignment, these variables are measured as percents. All data are from the World Bank, World Tables. Variables were constructed for each country for the same sub-periods as the misalignment measures. Data were available for 152 of the 170 observations.

Growth Regressions

Table 6 presents the basic results. All observations are pooled, and regional dummies are

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[8] Barro (1991) and Barro and Lee (1994) show the importance of conditional convergence of growth rates of countries with different initial incomes - initial income is negatively associated with growth when accounting for other initial conditions (such as initial human capital). The data are 1970 values of GDP (in constant 1985 dollars), life expectancy when born (years), primary and secondary school enrollment rates (ratios of actual number of students to the number of children in the relevant age group).

[9] Barro and Lee (1994) stress that government size is potentially associated negatively with growth.

included. Consider first regression 1. All the variables, except possibly the initial conditions for schooling, have the expected signs. The variable "govcon" has a significant negative coefficient, which accords with the arguments given by Barro and Lee. The initial conditions -- life expectancy and income level -- are significantly associated with growth as expected. Although schooling has a somewhat surprising negative coefficient, the estimate for primary schooling is only marginally significant, while that for secondary schooling is insignificant.[10] The coefficients on the regional dummies for East Asia and the developed countries are positive (although not significant), those on the dummies for Sub Saharan Africa and Latin America are negative and marginally significant. Somewhat surprisingly, the external conditions do not enter significantly.

Regression 1 also finds that average misalignments (and the standard deviation of misalignment) are negatively associated with growth. However, the result is only weakly significant. The remainder of the paper explores the possibility that this weak finding is due to non-linearities in the relationship.

Over- versus under-valuation

Misalignments may have a very different effect on growth depending on whether they reflect over- or under-valuations of the RER. To test this hypothesis, the misalignment variable was split into two pieces. Those observations in which misalignment is positive are labeled "overvaluation" while those in which it is negative are labeled "undervaluation".

As shown in regression 2 (Table 6) overvaluation does has a negative and statistically significant effect on economic growth. The effect is also economically significant -- the estimated coefficient implies that a 10% overvaluation of a country's RER is associated with a decline in real

[10] See Collins and Bosworth (1996) for additional discussion of the links between education and growth, and for references.

per capita output growth of 0.6 percentage points. Interestingly, the estimation does not find a significant relationship between RER undervaluation and growth. These findings motivated a closer look at a various groupings of the data.

Additional non-linearities

The final part of the analysis looks for additional non-linearities in the relationships between growth and both misalignment and the volatility of misalignment. This work should be viewed as exploratory. The approach taken is to further sub-divide the groups of 90 over-valued RERs (misalignment >0) and 62 under-valued RERs (misalignment <0) into low, medium, high and very high categories. In each case, low refers to a relatively small misalignment (near zero), while very high refers to the observations with the greatest percentage misalignments. Similarly, the observations for the standard deviation of RER misalignment were divided into four groups, with low referring to those with the most stable misalignment indicator, and very high referring to those with the greatest volatility in RER misalignment.

In creating these sub-divisions, the intent is to identify both a meaningful differentiation among groups with respect to the variable in question, while ensuring that sub-groups are of similar size. For the four undervalued RER groups and the four standard deviation groups, this was accomplished by division into quartiles. For the four overvalued RER groups, the observations were first divided according to the overall average and then each of the resulting groups was split in half. In the resulting groups, the undervaluations ranged from 1.2% in the "low" group to 10% in the "very high" group. Those with high undervaluation are primarily from the later time period, but include all regions. Overvaluations ranged from 0.9% in the "low" group to 11.7% in the "very high" group. Observations with high overvaluation are predominantly in the earlier time period, and are concentrated in Sub-Saharan Africa and Latin America. Standard deviations range from an

average of 2.2% in the "low" group to 13.9% in the "very high" group. Observations with very high standard deviations of misalignment are concentrated in Africa and Latin America. However, they come from both time periods, and include observations with undervaluation and overvaluation.

Estimations are reported in Table 7. The first column shows the results when all twelve misalignment indicators are included. It is perhaps not surprising that most do not enter significantly. However, the results do show that the previously reported finding that overvaluations slow growth is due to the observations with very high overvaluations. Smaller amounts of overvaluation do not appear to have a significantly deleterious effect. The second column of the table reports the results when a sub-set of these misalignment indicators are included. This sub-set came from a step-wise elimination of variables, based on the size of their t-statistics. These results should be viewed as preliminary. None-the-less, they are quite provocative. In addition to the strong, negative effect of very high over-valuation, the results suggest that high (but not "very high") undervaluations may help to promote growth. However, this analysis has failed to find a significant relationship between the volatility of misalignment and economic growth.

IV. Concluding Remarks

This paper empirically explores the relationship between RER misalignment and economic growth for a large sample of developed and developing countries. It seeks to make two contributions to the existing literature. First, it develops and implements an indicator of RER misalignments. This indicator is based on a well-structured but simple extension of an IS-LM model of an open economy. The framework introduces short-run price rigidities and shows that the solution for the RER can be decomposed into a RER that would obtain if prices were fully flexible, and a deviation from this level that arises because of various short run shocks. This framework is then used as the basis for a RER regression. Interestingly, the estimation results are consistent with key model predictions about the differences between RER determination in industrial countries, with relatively high capital mobility, versus developing economies, with relatively extensive capital restrictions. The estimation results are then used to construct indicators of misalignment.

The second half of the paper uses growth regression analysis to study the determinants of economic growth. In addition to the now standard explanatory variables -- initial conditions, external environment and fiscal policy stance -- the level and standard deviation of RER misalignment is included on the right hand side. These variables are conceptually preferable to simply including the change or standard deviation in the RER, as various other studies have done. While recognizing the problems arising from potential endogeneity of the policy and RER indicators, the results are provocative. The analysis finds there are important non-linearities in the relationship between misalignment and growth. In particular, it is only very high over-valuations that appear to be associated with slower economic growth. Furthermore, moderate to high (but not very high) undervaluations appear to be associated with more rapid economic growth.

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Table 1.
Variables for the X matrix -- Long-Run Factors

	variable	Definition	developing countries		developed countries	
			average	st. dev.	average	st. dev.
1.	LRER	log of the yearly constructed real exchange rate	2.0669	0.1591	2.0030	0.0327
2.	TOT5	5 year MA of the log of the yearly terms of trade	2.0602	0.0851	1.9909	0.0516
3.	RBY5	5 year MA of the ratio of the resource balance to GDP	-0.0720	0.1056	0.0031	0.0324
4.	MG5	5 year MA of the money supply growth minus GDP growth	0.0079	0.0288	0.0019	0.0113
5.	KY5	5 year MA of the ratio of net long term capital inflows to GDP	0.0424	0.0384	0.0019	0.0327
6.	GYL5	5 year growth of GDP per worker	0.0147	0.0642	0.0282	0.0242

Note: See text for data sources and variable definitions. MA -- moving average.

Table 2.
Variables for the Z matrix -- Shocks

	variable	Definition	Developing		developed	
			average	st. dev.	average	st. dev.
1.	SHOCKY	yearly log of GDP minus the 5 year MA of the series	0.0280	0.0329	0.0231	0.0140
2.	SHOCKA	yearly log of absorption minus the 5 year MA of the series	0.0264	0.0438	0.0262	0.0264
3.	SHOCKM	yearly log of the money supply minus the 5 year MA of the series	0.2122	0.2438	0.1024	0.0631

Notes: See text for data sources and variable definitions. MA -- moving average.

Table 3.
RER Regressions
(For Construction of Misalignment Indicators)

Variable	Developing countries	Developed countries
Constant	Fixed effect	1.76484
		(21.4)
RBY5	-0.18774	
	(-3.72)	
TOT5	0.389938	0.121548
	(9.30)	(2.92)
KY5	0.835939	
	(7.47)	
MG5	0.48991	
	(4.94)	
GYL		-0.10682
		(-1.28)
SHOCKY	-0.71121	
	(-4.34)	
SHOCKA	0.473968	0.249905
	(4.29)	(2.57)
SHOCKM		-0.07161
Adj. R^2	0.664	0.378

1. Dependent variable is LRER

In parentheses are t-statistics, critical values are 1.28 (10%), 1.96 (2.5%), 2.57 (0.5%)

Table 4.
Summary statistics for the constructed misalignments

Type	Region	Period	No. of obs.	Average	Standard deviation
Developing countries	Sub Saharan Africa	1	27	2.698	7.854
		2	27	-5.121	7.572
	East Asia and Pacific	1	7	1.816	6.698
		2	9	-4.328	5.425
	Latin America and Caribbean	1	20	1.479	6.238
		2	17	-1.872	6.620
	Middle East and North Africa	1	4	-0.4007	4.972
		2	9	-1.726	4.649
	South Asia	1	3	2.501	1.464
		2	4	-6.026	1.394
	Europe and Central Asia	1	3	4.706	2.169
		2	3	-4.7065	2.1691
Developed countries		1	20	-1.441	4.909
		2	17	-0.948	2.454

Table 5
Summary Statistics for Variables used in Growth Regressions

variable	Sub Saharan Africa	East Asia and Pacific	Latin America and the Caribbean	Middle East and North Africa	South Asia	Europe and Central Asia	developed countries
	average (st. dev.)	ave. (st.dev)	average (st. dev.)	average (st. dev.)	average (st. dev.)	average (st. dev.)	average (st. dev.)
1. gypc (%)	-0.1907	1.720	0.0583	0.3839	1.207	0.8334	0.8381
	(0.9908)	(1.293)	(0.8967)	(1.752)	(0.2402)	(0.4845)	(0.3919)
2. gtot (%)	-0.8075	-0.7786	-0.8718	-0.9821	-0.7855	-0.1171	-0.0571
	(1.563)	(1.337)	(1.575)	(1.2457)	(0.7672)	(1.557)	(0.8476)
5. sdtot	17.65	13.47	19.73	18.06	10.09	8.625	6.201
	(14.60)	(8.656)	(12.31)	(12.13)	(5.124)	(5.522)	(3.792)
6.govcon(%	15.02	13.35	11.84	19.26	11.22	12.51	18.38
	(5.358)	(5.582)	(4.330)	(6.749)	(1.148)	(5.095)	(4.077)
7. life	43.90	56.81	59.98	58.30	48.37	65.97	72.17
(years)	(6.003)	(6.87)	(6.36)	(8.27)	(2.30)	(6.60)	(1.32)
8. prim (%)	56.86	87.14	97.34	80.80	56.00	104.4	101.4
	(27.92)	(18.19)	(15.41)	(16.84)	(16.53)	(5.31)	(10.24)
9. sec	8.40	28.28	28.93	35.18	16.72	50.85	75.73
	(6.19)	(14.62)	(13.52)	(19.17)	(8.98)	(16.49)	(10.36)
10. gdp	1180	1605	2987	3330	990.2	3200	8889
	(868.4)	(638.4)	(1838)	(2858)	(203.1)	(835.7)	(2328)
no. of obs.	43	14	33	13	5	7	37

Sources: World Bank, World Tables.
Notes: see text for full variable definitions.

Table 6.
Growth Regressions -- Basic Results

Variable	definition	Regression 1	regression 2
Govcon	percent of govt. consumption in GDP	-0.0424 (-2.66)	-0.0443 (-2.80)
Gtot	growth of the TOT (%)	0.0470 (1.10)	0.0599 (1.40)
Sdtot	standard deviation of the TOT	-0.0067 (-0.97)	-0.0051 (-0.75)
Life	life expectancy at birth in 1970 (years)	0.0493 (3.28)	0.0458 (3.05)
Prim	primary school enrollment rate in 1970 (%)	-0.0072 (-1.49)	-0.0059 (-1.23)
Sec	secondary school enrollment rate in 1970 (%)	-0.0028 (-0.35)	-0.0025 (-0.32)
Gdp	GDP per capita in 1970 ($)	-0.0001 (-3.35)	-0.0001 (-3.57)
Dummies			
SSA	Sub Saharan Africa	-0.7690 (-1.34)	-0.5436 (-0.94)
EAP	East Asia and Pacific	0.6901 (1.07)	0.9363 (1.44)
LAC	Latin America and Caribbean	-0.7800 (-1.20)	-0.5162 (-0.78)
MENA	Middle East and North Africa	-0.1651 (-0.24)	-0.0727 (-0.10)
SA	South Asia	0.1516 (0.22)	0.3650 (0.53)
ECA	Europe and Central Asia	-0.1471 (-0.20)	0.1695 (0.23)
DED	developed countries	0.4437 (0.64)	0.7331 (1.05)
Mis	average misalignment (%)	-0.0213 (-1.73)	
1. 90 obs. with an undervaluation	absolute value of average misalignment		-0.0143 (-0.65)
2. 62 obs. with an overvaluation	average misalignment		-0.0647 (-2.56)
Sdmis	standard deviation of the yearly misalignments	-0.0309 (-1.34)	-0.0206 (-0.87)
no. of obs..		152	152
adj. R^2		0.403	0.415

1. Dependent variable is gypc
2. In parentheses are t-statistics, critical values are 1.28 (10%), 1.96 (2.5%), 2.57 (0.5%)

Table 7.
Growth Regressions -- Additional Results

Variable	regression 3	regression 4
Govcon	-0.0490	-0.0458
	(-3.27)	(-3.21)
Gtot	0.0459	0.0547
	(1.08)	(1.34)
Prim	0.0057	-0.0059
	(-1.16)	(-1.31)
Life	0.0467	0.0415
	(3.83)	(4.51)
Gdp	-0.0001	-0.0001
	(-3.68)	(-4.00)
Dummies		
SSA	-0.5724	-0.6426
	(-2.49)	(-3.26)
EAP	0.7356	0.8297
	(2.49)	(2.98)
LAC	-0.6635	-0.6401
	(-2.67)	(-2.67)
DED	0.6548	0.7749
	(1.82)	(2.35)
mis, undervalued		
1. low	0.0804	
	(0.34)	
2 medium	-0.0921	
	(-0.82)	
3. high	0.0586	0.0940
	(0.94)	(2.31)
4. very high	-0.0266	
	(-0.97)	
mis, overvalued		
1. low	-0.3080	
	(-1.11)	
2. medium	-0.1027	
	(-1.12)	
3. high	-0.0059	
	(-0.10)	
4. very high	-0.0773	-0.0625
	(-2.54)	(-2.67)

Table 7. (cont.)

Sdmis		
1. low	-0.1197	-0.0633
	(-0.72)	(-0.84)
2. medium	-0.0103	
	(-0.09)	
3. high	-0.0199	
	(-0.03)	
4. very high	-0.0221	-0.0190
	(-0.59)	(-1.23)
5. extreme		
no. of obs.	152	152
adj. R^2	0.440	0.452

1. Dependent variable is gypc
2. In parentheses are t-statistics, critical values are 1.28 (10%), 1.96 (2.5%), 2.57 (0.5%)

Appendix A - Country list
- Countries in the growth analysis

1. Sub Saharan Africa
Benin
Burkina Faso
Cameroon
Central African Federation
Chad
Cote d'Ivoire
Gabon
Gambia
Kenya
Madagascar
Mali
Mauritania
Mauritus
Nigeria
Rwanda
Senegal
Sierra Leone
South Africa
Sudan
Togo
Zaire
Zambia
Zimbabwe

2. Middle east and North Africa
Algeria
Cyprus
Egypt
Iran
Israel
Kuwait
Marocco
Syria
Tunisia

3. East Asia and Pacific
China
Indonesis
Korea
Malaisya
Papua New Guinea
Philippines
Singapore
Thailand

4. Latin America and the Caribbean
Bolivia
Brazil
Chile
Costa Rica
Dominican Republic
Ecuador
El Salvadore
Guatamala
Guyana
Honduras
Jamaica
Mexico
Nicaragua
Paraguay
Peru
Trinidad and Tobago
Uruguay
Venezuela

5. South Asia
Bangladesh
India
Pakistan

(*) Poland is not part of the dummy for ECA

Appendix A: (cont.)

6. Europe and Central Asia
Greece
Poland (*)
Portugal
Turkey

7. Developed Countries
Australia
Austria
Belgium
Canada
Denmark
England
Finland
France
Germany
Iceland
Ireland
Italy
Japan
Netherland
New Zealand
Norway
Spain
Sweden
United States

- Additional countries
(not in the growth analysis)
Argentina
Colombia
Congo
Ghana
Malawi
Myanmar
Somalia
Sri Lanka