

The Real Exchange Rate and Economic Growth*

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Abstract

I show that undervaluation of the currency (a high real exchange rate) stimulates economic growth. This is true particularly for developing countries. This finding is robust to using different measures of the real exchange rate and different estimation techniques. I also provide some evidence that the operative channel is the size of the tradable sector (especially industry). These results suggest that tradable goods suffer disproportionately from the government or market failures that keep poor countries from converging towards higher-income levels. I present two categories of explanations as to why this may be so, focusing on (a) institutional weaknesses, and (b) product-market failures. A formal model elucidates the linkages between the level of the real exchange rate and the rate of economic growth.

1 Introduction

Economists have long known that poorly managed exchange rates can be disastrous for economic growth. Avoiding significant overvaluation of the currency is one of the

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most robust imperatives that can be gleaned from the diverse experience with economic growth around the world, and it is one that appears to be strongly supported by cross-country statistical evidence (Razin and Collins 1997, Johnson, Ostry, and Subramanian 2007, Rajan and Subramanian 2007). The results in the well-known papers of Dollar (1992) and Sachs and Warner (1995) on the relationship between outward orientation and economic growth are largely based on indices that capture degrees of overvaluation (Rodriguez and Rodrik 2001). Much of this literature on cross-national policy regressions is now in disrepute (Easterly 2005, Rodrik 2005). But it is probably fair to say that the admonishment against overvaluation remains as strong as ever. In his pessimistic survey of the crossnational growth literature, Easterly (2005) agrees that large overvaluations have an adverse effect on growth (while remaining skeptical that moderate movements have determinate effects).

The reason behind this regularity is not always theorized explicitly, but most accounts link it to macroeconomic instability (e.g. Fischer 1993). Overvalued exchange rates are associated with shortages of foreign currency, rent-seeking and corruption, unsustainably large current account deficits, balance-of-payments crises, and stop-and-go macroeconomic cycles—all of which are damaging to economic growth.

I argue in this paper that this is not the whole story. Just as overvaluation hurts growth, undervaluation facilitates it. For most countries, high-growth periods are associated with undervalued currencies. In fact, there is little evidence of non-linearity in the relationship between a country's (real) exchange rate and its economic growth. An increase in undervaluation boosts economic growth just as powerfully as a decrease in overvaluation. But this relationship holds only for developing countries; it disappears when we restrict the sample to richer countries and gets stronger the poorer the country. These suggest that more than macroeconomic stability is at stake. The relative price of tradables to non-tradables (the real exchange rate) seems to play a more fundamental role in the process of economic convergence. Recently, Bhalla (2007), Gala (2007), and Gluzmann et al. (2007) have made similar arguments as well.

Here are a few pictures to make the point as directly as possible. Figures 1-7 depict the experience of seven countries during 1950-2004: China, India, South Korea, Taiwan, Uganda, Tanzania, and Mexico. In each case, I have graphed side-by-side my measure of real exchange rate undervaluation (to be defined more precisely below) against the country's economic growth rate in the corresponding period. Each point on the chart represents an average for a 5-year window.

To begin with the most fascinating (and globally significant) case, the degree to which economic growth in China tracks the movements in my index of undervaluation is uncanny. The rapid increase in economic growth starting in the second half of the

1970s is very closely tracked by the increase in the undervaluation index (from an *overvaluation* close to 100 percent to an undervaluation of around 50 percent¹), as is the plateauing of the growth rate in the 1990s. Analysts who focus on global imbalances have of course noticed in recent years that the Renminbi is undervalued (given China's large current account surplus). They have played less attention to the role that undervaluation seems to have played in driving the country's economic growth.

Turn next to India (Figure 2), the other growth superstar of recent years. The figure is less clearcut than that for China, but its basic message is quite clear and the same. India's economic growth has steadily climbed from slightly above 1 percent in the 1950s (in per-capita terms) to 4 percent by the early 2000s, while its real exchange rate has moved from a small overvaluation to an undervaluation of around 60 percent. Figures 3 and 4 display the experience of two East Asian tigers—South Korea and Taiwan—which were growth champions of an earlier era. What is interesting in these instances is that the growth slowdowns in recent years are in each case accompanied by increased overvaluation or reduced undervaluation. In other words, both growth and undervaluation exhibit an inverse-U shape over time.

These regularities are hardly specific to Asian countries. Figures 5 and 6 depict two African experiences, those of Uganda and Tanzania. In each case, the undervaluation index captures the turning points in economic growth exceptionally well. Slowdown in growth is accompanied by increasing overvaluation, while a pickup in growth is accompanied by a rise in undervaluation. Finally, Figure 7 shows a somewhat anomalous Latin American case, Mexico. Here the two series seem quite a bit out of sync, especially since the 1980s when the correlation between growth and undervaluation turns negative rather than positive. Those familiar with the recent economic history of Mexico will recognize this to be a reflection of the capital-inflows induced growth cycles of the country. Periods of capital inflows are associated with consumption-led growth booms and currency appreciation; when the capital flows reverse, the economy tanks and the currency depreciates. The Mexican experience is a useful reminder that there is no reason a priori to expect a positive relationship between growth and undervaluation. It also suggests the need to go beyond individual cases and undertake a more systematic empirical analysis.

In the next section I do just that. First I construct a time-varying index of real exchange rate undervaluation, based on Penn World Tables data on price levels in individual countries. My index of undervaluation is essentially a real exchange rate

¹Recent revisions in purchasing power parity indices are likely to make a big difference to the levels of these undervaluation measures, without greatly affecting their trends over time. See the discussion below.

adjusted for the Balassa-Samuelson effect. It captures the relative price of tradables to non-tradables, adjusting for the fact that as countries grow rich the relative prices of non-tradables tend to rise (due to higher productivity in tradables). I next show in a variety of fixed-effects panel specifications that there is a systematic positive relationship between growth and undervaluation, especially in developing countries. So the Asian experience is not an anomaly. I subject these baseline results to a series of robustness tests, employing different data sources, a range of undervaluation indices, and varying estimation methods. While ascertaining causality is always difficult, I argue that in this instance causality is likely to run from undervaluation to growth rather than the other way around. I also present evidence that undervaluation works through its positive impact on the share of tradables in the economy, especially industry.

Hence developing countries achieve higher growth when they are able to increase the relative profitability of their tradables. These results suggest strongly that there is something "special" about tradables at low- to middle-income levels. In the rest of the paper I examine the reasons behind this regularity. What is the precise mechanism through which an increase in the relative price of tradables (and therefore the sector's relative size) increases growth? I present two classes of theories that would account for the stylized facts. In one, tradables are "special" because they suffer disproportionately (compared to non-tradables) from the institutional weakness and contracting incompleteness that characterize low-income environments. In the other, tradables are "special" because they suffer disproportionately from the market failures (information and coordination externalities) that block structural transformation and economic diversification. In both cases, an increase in the relative price of tradables acts as a second-best mechanism to (partially) alleviate the relevant distortion, foster desirable structural change, and spur growth. While I am unable to discriminate sharply between the two theories and come down in favor of one or the other, I present some evidence that suggests that these two sets of distortions do affect tradable activities more than they do non-tradables. This is a necessary condition for my explanations to make sense.

In the penultimate section of the paper I develop a simple growth model to elucidate how the mechanisms I have in mind might work. The model is that of a small open economy in which tradable and non-tradable sectors both suffer from an economic distortion. For the purposes of the model, whether the distortion is of the contracting kind or of the conventional market-failure kind is of no importance. The crux is the relative magnitude of the distortions in the two sectors. I show that when the distortion in tradables is larger, the size of the tradable sector is too small in equilibrium. A policy or other exogenous shock that can induce a real

exchange rate depreciation would have a growth-promoting effect. For example, an outward transfer, which would normally reduce domestic welfare, can have the reverse effect because it increases the equilibrium relative price of tradables and can increase economic growth. The model clarifies how changes in relative prices can produce growth effects in the presence of distortions that affect sectors differentially. It also clarifies the sense in which the real exchange rate is a "policy" variable: changing the level of the real exchange rate requires complementary policies (here the size of the inward or outward transfer).

I summarize and discuss some policy issues in the concluding section of the paper.

2 Undervaluation and growth: the evidence

2.1 An undervaluation index

I will use a number of different indices in what follows, but my preferred overvaluation index is a Balassa-Samuelson adjusted measure of the domestic price level, which has the advantage that it is comparable across countries as well as over time. I compute this index in three steps. First, I use data on exchange rates ($XRAT$) and PPP conversion factors (PPP) from Penn World Tables 6.2 (Heston, Summers, and Atina 2006) to calculate a "real" exchange rate (RER):

$$\ln RER_{it} = \ln(XRAT_{it}/PPP_{it})$$

where i is an index for countries and t is an index for (5-year) time periods. $XRAT$ and PPP are expressed as national currency units per U.S. dollar.² When RER is greater than one it indicates that the value of the currency is lower (more depreciated) than is indicated by purchasing-power parity. However, in practice non-traded goods are also cheaper in poorer countries (as per Balassa-Samuelson), which requires an adjustment. So in the second step I account for the Balassa-Samuelson effect by regressing RER on per-capita GDP ($RGDPCH$):

$$\ln RER_{it} = \alpha + \beta \ln RGDPCH_{it} + f_t + u_{it} \tag{1}$$

where f_t is a fixed effect for time period and u_{it} is the error term. This regression yields an estimated $\hat{\beta} = -0.24$ (with a very high t-statistic around 20), suggesting a strong and well-estimated Balassa-Samuelson effect: when incomes rise by 10 percent, real exchange rates appreciate by around 2.4 percent. Finally, to arrive at my index

²The variable p in the Penn World Tables (called the "price level of GDP") is equivalent to RER . I have used p here as this series is more complete than $XRAT$ and PPP .

of undervaluation I take the difference between the actual real exchange rate and the Balassa-Samuelson-adjusted rate:

$$\ln UNDERVAL_{it} = \ln RER_{it} - \ln \widehat{RER}_{it}$$

where $\ln \widehat{RER}_{it}$ is the predicted values from equation (1).

Defined in this way, *UNDERVAL* is comparable across countries and over time. Whenever *UNDERVAL* exceeds unity, it indicates that the exchange rate is set such that goods produced at home are cheap in dollar terms: the currency is undervalued. When *UNDERVAL* is below unity, the currency is overvalued. In what follows I will typically use its logarithmic transform, $\ln UNDERVAL$, which is centered at 0 and has a standard deviation of 0.48 (see Figure 8). The figures I presented above use this index.

My procedure is fairly close to that followed in recent work by Johnson, Ostry, and Subramanian (2007). The main difference is that these authors estimate a different cross-section for (1) for each year, whereas I estimate a single panel (with time dummies). My method seems preferable for purposes of comparability over time. I emphasize that my definition of "undervaluation" is based on price comparisons, and differs substantially from an alternative definition which relates to the external balance. The latter is typically operationalized by specifying a small-scale macro model and estimating the level of the (real) exchange rate that would achieve balance-of-payments equilibrium (see Aguirre and Calderon 2005, Razin and Collins 1997 and Elbadawi 1994 for some illustrations.)

One issue of great significance for my calculations is that the International Comparison Program (ICP) has recently published revised PPP conversion factors for a single benchmark year, 2005 (see ICP 2007). In some important instances, these new estimates differ greatly from those previously available and on which I have relied here. For example, the price levels in both China and India are now estimated to be higher by around 40% (compared to the previous estimates for 2005), indicating that these countries' currencies were not nearly as undervalued in that year as the old numbers suggest (15-20% as opposed to 50-60%). This is not as damaging to my results as it may seem at first sight, however. Virtually all my regressions are based on panels and include a full set of country and time fixed effects. In other words, I will be identifying the growth effects of undervaluation from *changes within* countries (and not from *differences in levels* across a cross-section of countries)—as was also done implicitly in Figures 1-7 above. So my results would remain unaffected if the revisions to the PPP factors turn out to consist of largely one-time adjustments to the estimated price levels of individual countries, without altering much their time trends. Even though the time series of revised PPP estimates are not yet available,

preliminary indications suggest that this will be the case.

In any case, the revised data yield a cross-sectional estimate of β for 2005 which is virtually the same as the one presented above (-0.22, with a t-stat of 11). In other words, the magnitude of the Balassa-Samuelson effect is nearly identical when estimated with the new data.

2.2 The baseline panel evidence

The data set consists of a maximum of 184 countries and eleven 5-year time periods from 1950-54 through 2000-04. My baseline specification for estimating the relationship between undervaluation and growth takes the form:

$$growth_{it} = \alpha + \beta \ln RGDPCH_{it-1} + \delta \ln UNDERVAL_{it} + f_i + f_t + u_{it} \quad (2)$$

This allows for the standard convergence term (initial income level, $RGDPCH_{it-1}$) and a full set of country and time period dummies (f_i and f_t). Our primary interest lies in $\hat{\delta}$. Given the fixed-effects framework, what I am estimating is the "within" effect of undervaluation, namely the impact of *changes* in undervaluation on changes in growth rates within countries. I will present regressions with additional covariates, as well as cross-sectional specifications, in a later subsection.

The results are shown on Table 1. When estimated for the panel as a whole, the regression yields a highly significant estimate for δ : 0.017. However, as columns (2) and (3) reveal, this effect operates only for developing countries. In the richer countries of the sample $\hat{\delta}$ is small and statistically indistinguishable from zero, while in the developing countries $\hat{\delta}$ rises to 0.026 and is highly significant. The latter estimate suggests that a 50 percent undervaluation—which corresponds roughly to one standard deviation in $UNDERVAL$ —is associated with a contemporaneous growth boost (during the same 5-year sub-period) of 1.3 percentage points per annum (0.50×0.026). This is a sizable effect. I will discuss the plausibility of this estimate later in the paper, following robustness tests and theoretical explanations.

The results in column (4) confirm further that the growth impact of undervaluation depends heavily on a country's level of development. When $UNDERVAL$ is interacted with initial income, the estimated coefficient on the interaction terms comes out negative and is highly significant. Using the estimated coefficients from column (4) the growth effects of a 50% undervaluation for Brazil, China, India, and Ethiopia at their current levels of income are 0.47, 0.60, 0.82, and 1.46 percentage points respectively. The estimates imply that the growth effect disappears at an income of \$19,635, roughly the level of Bahrain, Taiwan, or Spain.

Interestingly, the estimated impact of undervaluation seems to be independent of the time period under consideration. When we split the panel into pre- and post-1980 subperiods, the value of $\hat{\delta}$ remains basically unaffected (columns 5 and 6). This indicates that the channel(s) through which undervaluation works has little to do with the global economic environment; the estimated impact is if anything smaller in the post-1980 era of globalization when markets in rich countries were considerably more open. So the explanation cannot be a simple export-led growth story.

2.2.1 Robustness: outliers

As noted in the introduction, the literature on the relationship between exchange rate policy and growth has focused to date largely on the deleterious consequences of large overvaluations. In his survey of the cross-national growth literature, Easterly (2005) warns against extrapolating from large black market premia for foreign currency—for which he can find evidence of harmful effects on growth—to more moderate misalignments in either direction—for which he does not. However, the evidence strongly suggests that the relationship I have estimated does not rely on outliers: it is driven at least as much by the positive growth effect of undervaluation as by the negative effect of overvaluation. Furthermore, there is little evidence of non-linearity in either direction.

The partial scatter plot associated with column (3) of Table 1 is displayed in Figure 9. Ocular inspection suggests a linear relationship over the entire range of *UNDERVAL* and no obvious outliers in the sample. To check this more systematically, I estimate the regression for successively narrower ranges of *UNDERVAL*. The results are shown in Table 2. Column (1) of Table 2 reproduces the baseline result from Table 1. Column (2) excludes all observations with *UNDERVAL* < -1.50 (i.e., overvaluations greater than 150%), column (3) excludes observations with *UNDERVAL* < -1.00, and so on. The final column restricts the range to undervaluations or overvaluations that are smaller than 50%. The remarkable finding is that these sample truncations do very little to the estimated coefficient on $\ln \text{UNDERVAL}$. The coefficient we get when we eliminate all overvaluations greater than 25% is identical to that for the entire sample (column 5). And the coefficient we obtain when we eliminate all under- or overvaluations above 50% is still highly significant. Unlike Aguirre and Calderon (2005) and Razin and Collins (1997), I find little evidence of non-linearity in the relationship between undervaluation and economic growth.³

³I have also tried entering *UNDERVAL* in squared form, distinguishing between positive and negative values of *UNDERVAL*. I find some mild evidence that extreme overvaluations (large

2.2.2 Robustness: different real exchange rate measures

There are some potential concerns with relying exclusively on *UNDERVAL*. One issue is the uncertain reliability of the price level measures in the Penn World Tables. As I mentioned above, the most recent revisions to these data have revealed the estimates to be problematic in quite a few countries (even though the implications for changes over time within countries may not be as severe). This suggests the need to check the validity of my results using real exchange rate series constructed using other data sources.

Another worry relates to my adjustment for Balassa-Samuelson (B-S) effects. While this adjustment is proper and does not introduce any bias when there is a direct feedback from incomes to price levels as indicated in (1), it may be problematic under some other circumstances. For example, if the B-S effect is created by a third variable ("productivity") which affects both per-capita incomes and price levels, the coefficient estimates on *UNDERVAL* in the growth regressions may be biased upward (as discussed by Michael Woodford in his comments on this paper). This suggests the need to employ alternative measures of real exchange rates that do not incorporate the B-S adjustment. Even though estimates from regressions that use such alternative measures are in turn likely to be downwardly biased (in the presence of B-S effects that operate over time within countries), such estimates are still useful insofar as give us a lower bound on the growth effects of undervaluation.

So I use four additional real exchange rate indices in the regressions that follow, to complement the results with *UNDERVAL* presented above. First, I use simply the inverse of the index of the price level from the Penn World Tables, but without the B-S adjustment:

$$\ln RER_PWT = \ln(XRAT/PPP)$$

This measure has all the problems of the Penn World Tables since it is constructed from that source, but for the purposes of our robustness tests it has the virtue that it is not subject to the sort of bias mentioned in the previous paragraph. Next I use the real effective exchange rate index of the IMF, $\ln REER_IMF$, which is a measure of the value of home currency against a weighted average of the currencies of major trade partners divided by a price deflator or index of costs. This is a multilateral measure of competitiveness and is available for a large number of industrial and developing countries, although the coverage is not nearly as complete as the Penn World Tables. The third index is a simple bilateral real exchange rate measure

negative *UNDERVALs*) are proportionately more damaging to growth, but the effect is not that strong, and the main coefficient of interest remains unaffected.

vis-a-vis the U.S. constructed using wholesale price indices:

$$\ln RER_WPI = \ln \left(\frac{E \times PPI_{US}}{WPI} \right)$$

where E is the home country's nominal exchange rate against the U.S. dollar (in units of home currency per dollar), PPI_{US} is the producer price index for the U.S., and WPI is the home country's wholesale price index. All of the data are from the IMF's *International Financial Statistics* (IFS). Since the IFS does not report wholesale price indices for many countries, I also use as my final index a bilateral real exchange rate constructed using consumer prices:

$$\ln RER_CPI = \ln \left(\frac{E \times PPI_{US}}{CPI} \right)$$

where CPI stands for the home country's consumer price index. Note that the (levels of the) last three measures are not comparable across countries, but this is of no consequence for our panel regressions, which track the effects of changes in real exchange rates *within* countries.

I have re-run the baseline specification from Table 1 substituting each one of these measures for *UNDERVAL*. Table 3 shows the results for the full and developing-country samples separately. The numbers tell a remarkably consistent story, despite the differences in data sources and in the construction of the index. When the regression is run on the full country sample, the growth impact of real exchange rate depreciations is small and often statistically insignificant. But when the sample is restricted to developing countries (countries with real per capita GDP below \$6,000 as before) the estimated effect is strong and statistically significant in all cases. (The estimate using *REER_IMF* narrowly misses the 5% significance threshold and is significant only at the 10% level.) The coefficient estimates range between 0.012 and 0.029 (using *RER_CPI* and *RER_WPI* respectively) and bracket the estimate with *UNDERVAL* reported earlier (0.026). Note in particular that the coefficient estimate with *RER_PWT* is highly significant, and as expected smaller than the estimate with *UNDERVAL* (0.016 versus 0.026). It is hard to say how much of this difference is due to the lack of correction for the Balassa-Samuelson effect (and hence a downward bias in the estimation when using *RER_PWT*) and how much is due to the correction of a previous bias in the estimation with *UNDERVAL*. Even if the "correct" estimate is the lower one of 0.16, it still establishes a relationship between real exchange rate undervaluations and economic growth that is strong enough to hold our attention. (A fifty percent undervaluation would produce a growth boost of 0.8 percent per annum.)

2.2.3 Robustness: additional covariates

The specifications I have reported up to this point are rather sparse ones. No other regressors are included besides a convergence factor, the fixed effects, and the undervaluation measure itself. Of course, the fixed effects serve to absorb any growth determinants that are time-invariant and country specific or time-specific and country-invariant. But there is still the possibility that we may have left out some time-varying country-specific determinants that may be correlated with *UNDERVAL* and may cause omitted variable bias. So the regressions in Table 4 augment the baseline specification and undertake a series of robustness tests using additional covariates. I include measures of institutional quality ("rule of law"), government consumption, the external terms of trade, inflation, human capital, and saving rates.⁴ One limitation here is that many of the standard growth determinants are not available over long stretches of time, so we lose lots of observations when we add regressors. For example, the "rule of law" index (from the World Bank [2008] governance data set) starts only in 1996. So rather than include all the additional regressors simultaneously, which would reduce the sample size excessively, I try various combinations, dropping those variables that seem to enter insignificantly or cause us to lose too many observations.

The bottom line of the results in Table 4 is that including these additional regressors does not make much difference to the coefficient on *UNDERVAL*. The estimated value of this coefficient moves somewhat (from a high of 0.063 to a low of 0.016), but remains strongly significant throughout with the t-statistic never falling below 2.9. The variation in these estimates seems to derive in any case as much from changes in the sample as from the effect of the covariates. Indeed, given the range of controls considered and the significant changes in sample size (from a low of 191 to a high of 790), the robustness of the central finding on undervaluation is quite striking. Note in particular that *UNDERVAL* remains strong even when we control for changes in the terms of trade, government consumption and saving rates, three variables which are among the main drivers of the real exchange rate (see below).

2.2.4 Robustness: cross-section regressions

A final robustness check is to run a cross-section regression where we try to identify the growth effects of undervaluation solely through differences *across* countries.

⁴The data source for most of these variables is the World Bank's World Development Indicators data base. "Rule of law" comes from Kaufmann et al. (2008) and "years of education" from Barro and Lee (2000).

These results are shown in Table 5. The dependent variable here is the growth rate of each country averaged over a twenty-five year period (1980-2004). Undervaluation is similarly averaged over the same quarter century, while initial income is the level of per-capita GDP in 1980. The regressors include all the covariates considered in Table 4 (except for the terms of trade) along with regional dummies.

The results are quite consistent with those in the vast literature on cross-national growth empirics. Economic growth over such time horizons tends to increase with human capital, quality of institutions, and saving. Growth tends to decrease with government consumption and inflation. The Africa dummy tends to be negative and statistically significant. Interestingly, the Asia dummy is negative and significant as well if we control for saving rates (and not if we do not). Most importantly for our purposes the estimated coefficient on *UNDERVAL* is highly significant and virtually unchanged in all these specifications, fluctuating between 0.019 and 0.022. It is interesting—and comforting—that this coefficient and the one we obtain from panel regressions are so similar.

Given the difficulty of controlling for all the country-specific determinants of growth, there are good reasons to distrust estimates from cross-sectional regressions of this kind. That is why panels with fixed effects are my preferred specification. Nevertheless, the results in Table 5 represent a useful and encouraging robustness check.

2.3 Causality

A possible objection to these results is that they do not capture a relationship that is truly causal. The real exchange rate is the relative price of tradables to non-tradables in an economy, and as such is an *endogenous* variable. Does it make sense to stick it (or some transformation thereof) on the right-hand side of a regression and talk about its effect on growth? Perhaps not in a world where governments did not care about the real exchange rate and which left it to be determined purely by market forces. But we do not live in such a world, and with the exception of a handful of advanced countries, most governments pursue a variety of policies with the explicit goal of affecting the real exchange rate. Fiscal policies, saving incentives (or disincentives), capital-account policies, and interventions in currency markets are part of an array of such policies. In principle, moving the real exchange rate requires changes in real quantities, but we have known for a long time that even policies that affect nominal magnitudes can do the trick—for a while. One of the key findings of the open-economy macro literature is that nominal exchange rates and real exchange rates move quite closely together, except in highly inflationary environments. Levy-

Yeyati and Sturzenegger (2007) have recently shown that sterilized interventions can and do affect the real exchange rate in the short- to medium-term. So interpreting our results as saying something about the growth effects of different exchange-rate management strategies seems plausible.

We still have to worry about the possibility of reverse causation and omitted variables bias, of course. The real exchange rate may respond to a variety of shocks besides policy, and these may confound the interpretation of $\hat{\delta}$. The inclusion of some of the covariates we considered in Tables 4 and 5 serve to diminish concern on this score. For example, an autonomous reduction in government consumption or increase in domestic saving will both tend to depreciate the real exchange rate *ceteris paribus*. To the extent that such policies are designed to move the real exchange in the first place, they are part of what I have in mind when I talk of "a policy of undervaluation." But if not, the results in Table 4 and 5 indicate that undervaluation is associated with higher growth even when those policies are controlled for.

A more direct approach is to treat *UNDERVAL* explicitly as an endogenous regressor, which is what is done in Table 6. Note first that a conventional instrumental-variable approach is pretty much ruled out here since it is difficult to think of exogenous regressors that influence the real exchange rate without plausibly also having an independent effect on growth. I will present regressions on the determinants of *UNDERVAL* later in the paper (Table 10); all of the regressors in those regressions have been used as independent variables in growth regressions. So I use instead a dynamic panel approach with GMM à la Arellano and Bond (1991) and Blundell and Bond (1998). These models use lagged values of regressors (in levels and in differences) as instruments for right-hand side variables, and also allow lagged endogenous (left-hand side) variables as regressors in short panels.⁵ Table 6 presents results for both the "difference" and "system" versions of GMM. As before, the estimated coefficients on *UNDERVAL* are positive and statistically significant for the developing countries (if somewhat at the lower end of the range of coefficients reported earlier). They are not significant for the developed countries. Hence when we allow *UNDERVAL* to be endogenous the pattern of estimated coefficients we get is quite in line with the results above, which is reassuring.

It is worth reflecting about the sources of endogeneity bias a bit more. Many of the plausible sources of bias that we can think of would induce a negative relationship between undervaluation and growth, not the *positive* relationship I have documented. So to the extent that endogenous mechanisms are at work, it is not clear that they generally create a bias that works against my findings. Economic growth is expected to appreciate the exchange rate on standard Balassa-Samuelson grounds (which we

⁵See Roodman (2006) for an accessible user's guide.

control for by using *UNDERVAL*). Shocks that depreciate ("undervalue") the real exchange rate tend to be shocks that are bad for growth on conventional grounds—a reversal in capital inflows or a terms of trade deterioration for example. Good news about the growth prospects of an economy are likely to attract capital inflows and *appreciate* ("overvalue") the real exchange rate. So on balance it is unlikely that our positive coefficient results from the reverse effect of growth on the real exchange rate.

2.4 Evidence from growth accelerations

A different way to look at the cross-national evidence is to look at countries that have experienced noticeable growth spurts and to ask what has happened to *UNDERVAL* before, during, and after these growth accelerations. This way of parsing the data throws out a lot of information, but has the virtue that it focuses us on a key question: have those countries that managed to engineer sharp increases in economic growth done so on the back of undervalued currencies?⁶

In Hausmann, Pritchett, and Rodrik (2005), my colleagues and I identified 83 distinct instances of growth accelerations. In each one these instances, growth picked up by 2 percentage points or more and the spurt was sustained for at least eight years. Figure 10 displays the average values of *UNDERVAL* for a 21-year window centered on the date of the growth acceleration (the two ten-year periods before and after the acceleration plus the year of the acceleration). The chart shows interesting patterns in the trend of *UNDERVAL*, but is especially telling with respect to the experience of different subgroups.

For the entire sample of growth accelerations, there is a noticeable, if moderate decline in overvaluation in the decade prior to the onset of the growth spurt. The increase in *UNDERVAL* is of the order of 10 percent, and is sustained into the first five years or so of the episode. Since these growth accelerations include quite a few rich countries in the 1950s and 1960s, I next restrict the sample to growth accelerations that occurred after 1970. There is a much more distinct trend in *UNDERVAL* for this sub-sample: the growth spurt takes place after a decade of steady increase in *UNDERVAL* and takes place immediately after the index reaches its peak value (at an undervaluation of 10 percent). The third cut is to focus on just Asian countries. These countries reveal the most pronounced trends, with *UNDERVAL* pointing to an average undervaluation of more than 20 percent at the start of the growth acceleration. Moreover, undervaluation is sustained into the growth episode, and in fact increases further by the end of the decade. This is to be contrasted with

⁶Asimilar exercise was carried out for a few, mostly Asian, countries by Hausmann (2006).

the experience of African growth accelerations, for which the image is virtually the mirror opposite. In Africa, the typical growth acceleration takes place after a decade of increased *overvaluation* and the timing of the acceleration coincides with the peak of the overvaluation.

As is well known, Asian growth accelerations have proved significantly more impressive and lasting than African ones. The contrasting behavior of the real exchange rate may offer an important clue as to the sources of the difference.

2.5 Size of the tradables sector as the operative channel

The real exchange rate is a relative price: it represents the price of traded good in terms of non-traded goods:

$$RER = P_T/P_N$$

An increase in RER enhances the relative profitability of the traded-goods sector and causes it to expand (at the expense of the non-traded sector). I now provide some evidence that these compositional changes in the structure of economic activity are an important driving force behind the empirical regularity I have identified. I show two things in particular. First, undervaluation has a positive effect on the relative size of tradables—especially of industrial economic activities. Second, the effects of the real exchange rate on growth operate (at least in part) through the associated changes in the relative size of tradables. Countries where undervaluation induces resources to move towards tradables (again, mainly industry) grow more rapidly.

Table 7 displays the relevant regressions. Columns (1)-(4) are standard panel regressions where five-year average sectoral shares (in real terms) are regressed on income levels, a complete set of fixed effects, and my measure of undervaluation. I had initially lumped agriculture and industry together since both are nominally tradable, but as these regressions show, they have quite a different relationship with real exchange rates. Whether measured by its share in GDP or in employment, the relative size of industry is strongly and positively dependent on the degree of undervaluation (cols 1 and 2).⁷ Simply put, undervaluation boosts industrial activities. Agriculture, on the other hand, does not have a consistent relationship with undervaluation. Its GDP share depends negatively on the level of the real exchange rate (col. 3), while its employment share depends positively (but insignificantly) on

⁷Blomberg et al. (2005) report some evidence that countries with larger manufacturing sectors have greater difficulty to sustain currency pegs. But it is not immediately evident which way this potential reverse causality cuts.

it (col. 4). This difference possibly reflects the prevalence of quantitative restrictions in agricultural trade, which typically turn many agricultural commodities into non-tradables at the margin.

Columns (5) and (6) are two-stage panel growth regressions (with a full set of fixed effects as always) which test whether the effect of undervaluation on growth operates through its impact on the relative size of industry. The strategy consists of checking whether the component of industrial shares directly "caused" by undervaluation—that is, industrial shares as instrumented by undervaluation—enter positively and significantly in our growth regressions. The answer is affirmative. These results indicate that undervaluations cause resources to move towards industry, and that this in turn promotes economic growth.⁸

The estimates in Table 7 also provide a useful check on the quantitative magnitudes involved. They break the undervaluation-growth relationship into two separate links, one from undervaluation to the size of tradables (industry) and the other from the size of industry to economic growth. If undervaluation has a potent effect on growth, that is because each one these two links is estimated to be quite strong. A 50 percent undervaluation is estimated to increase the share of industry in total employment by 2.1 percentage points (0.042×0.50), which is quite sizable given that the typical industrial employment share in developing countries is around 20%. An increase in the industrial employment share is in turn estimated to raise growth roughly one-for-one.

⁸See also the supporting evidence in Rajan and Subramanian (2007). This paper finds that real exchange rate appreciations induced by aid inflows have adverse effects on the relative growth rate of exporting industries as well as on the growth rate of the manufacturing sector as a whole. Rajan and Subramanian argue that this is one of the more important reasons for why aid fails to induce growth in recipient countries. Gluzmann et al. (2007) by contrast find little role for the tradables channel, and argue that real exchange rate undervaluations promote growth through redistributions of income that raise domestic saving (and ultimately investment). However, their argument seems to require that the current account be invariant to the real exchange rate, which is contradicted by considerable evidence. See also Galvarriato and Williamson (2008) on the role played by favorable relative prices in the rapid industrialization of Latin American countries such as Brazil and Mexico after 1870 and Freund and Pierola (2008) on the significance of currency undervaluation in stimulating export surges.

3 Understanding the importance of the real exchange rate

Why might an increase in the relative price of tradables and the associated expansion of tradable economic activities have a causal impact on economic growth, as my results suggest they do? There is no generally accepted theory that would explain these regularities in the data.⁹ Any such theory would have to explain why tradables are "special" from the standpoint of growth. That is the sense in which my results open an important window on the mechanisms behind the growth process. If we can understand the role that tradables play in driving growth, we may be able to get a better grip on the policies that promote (and hamper) growth.

While there is potentially a very large number of stories that may account for the role of tradables, two clusters of explanations deserve attention in particular. One focuses on weaknesses in the contracting environment, and the other on market failures in modern, industrial production. Both types of explanation have been common in the growth and development literature, but in the present context we need something on top. We need to argue that tradables suffer disproportionately from these shortcomings, so that absent a compensating policy, developing economies devote too few of their resources to tradables and grow less rapidly than they should. An increase in *RER* can then act as a second-best mechanism for spurring tradables and for generating more rapid growth.

The two clusters of explanations are represented schematically in Figures 11 and 12. I discuss them in turn in the rest of this section. The mechanics of how changes in relative prices can generate growth in the presence of sectorally differentiated distortions is discussed in the following section.

3.1 Explanation 1: Bad institutions "tax" tradables more

The idea that poor institutions keep incomes low and explain—at least in part—the absence of economic convergence is by now widely accepted (North 1990, Acemoglu, Johnson, and Robinson 2001). Weak institutions create low private appropriability of returns to investment through a variety of mechanisms: contractual incompleteness, hold-up problems, corruption, lack of property rights, and poor contract enforcement.

⁹In Rodrik (1988) I presented an argument showing that manipulating the real exchange rate could play a welfare-enhancing role if this served to improve the internal terms of trade of sectors subject to dynamic learning externalities. Gala (2007) suggests undervaluation is good for growth because increasing-return activities are located in tradables rather than non-tradables.

The resulting wedge between private and social returns in turn blunts the incentives for accumulation and technological progress alike.

Now suppose that this problem is more severe in tradables than it is in non-tradables. This is a plausible supposition since production systems tend to be more “complex” and round-about in tradables, placing greater premium on contractability and reliable third-party enforcement. A barber needs to rely on little more than a few tools, a chair, and his ingenuity to sell his services. A manufacturing firm needs the cooperation of multitudes of suppliers and customers, plus financial and legal support. Lousy institutions therefore impose a higher “tax” on tradables—especially modern tradables. This results in both a static misallocation of resources that penalizes tradables, and a dynamic distortion in the form of lower-than-socially optimal investment in tradables. An increase in the relative price of tradables can improve static efficiency and enhance growth in second-best fashion by eliciting more investment in tradables at the margin (as I will show in the following section).

What about evidence? There is a fair amount of empirical work, both across countries and across industries, which presents suggestive evidence on the disproportionate cost borne by tradables—as a whole or in part—in the presence of weak institutions.

- Across countries, lower quality institutions (measured by indices of the rule of law, contract enforcement, control of corruption) are associated with smaller ratios of trade to GDP (“openness”). See for example Anderson and Mercouiller (2002), Rodrik, Subramanian, and Trebbi (2004), Rigobon and Rodrik (2005), Meon and Sekkat (2006), Berkowitz et al. (2006), and Ranjan and Lee (forthcoming).
- Across different categories of tradable goods, more “institution-intensive” tradables are prone to larger effects. Meon and Sekkat (2006) find that the relationship they identify holds for manufactured exports, but not for non-manufactured exports, while Ranjan and Lee (forthcoming) find the effect is stronger for differentiated goods than for homogenous goods.
- Institutional weakness interacts with contract-intensity of goods to play a role in determining comparative advantage. Levchenko (2006), Berkowitz et al. (2006), and Nunn (2007) find that countries with poor institutions have comparative *disadvantage* in institutions-intensive/more complex/relationship-intensive products.

To provide more direct evidence, I use unpublished data kindly provided by Nathan Nunn to compare directly the contract-intensiveness of tradables and non-

tradables. Nunn (2007) was interested to check whether the differences in institutional quality across countries helps determine patterns of comparative advantage. He reasoned that relationship-specific intermediate inputs, defined as inputs that are not sold on exchanges and/or do not have reference prices (as in Rauch 1999), are more demanding of the contractual environment. In his original paper, Nunn (2007) used measures of relationship-specificity for tradables alone, since his main concern was with comparative advantage. But he collected similar data for services as well, which is what I use to carry out the tradables/non-tradables comparison.

Panel (a) of Table 8 shows the shares of intermediates that are relationship-specific in traded and non-traded industries. (These numbers are based on U.S. input/output tables.) At first sight, these numbers seem to conflict with what my argument requires, insofar as they show that the inputs used in tradables are less relationship-specific, and hence less demanding of the institutional environment. But this is misleading because it overlooks the fact that traded goods tend to have much higher intermediate input shares in gross output. This is shown in panel (b) of the table (this time relying on input-output tables from Brazil). When we put the two pieces together, we get the results in panel (c) of Table 8, which show that on balance tradable goods rely on relationship-specific inputs to a much greater extent. The numbers for the two sets of goods differ by a factor of between 2 and 3.

Hence the evidence that institutional and contracting shortcomings, the bane of every developing society, impose a greater tax on the traded sector than it does on the non-traded sector is fairly compelling. But if this story is correct, we should also see its implications in the growth regressions. Specifically, the growth impact of undervaluation should be greater in those countries where the magnitude of the "taxation" is largest, namely the countries with the *weakest* institutions. While per-capita GDP tracks institutional quality closely, it is not a perfect proxy for it. So the question is whether we can glean the differential impact in settings with different institutional environments.

To attempt this more direct test, I have used the World Bank governance indices¹⁰ to divide countries into three subgroups based on their "adjusted" levels of institutional quality (above average, around average, and below average). The exercise was conducted as follows. I took a simple average of the Rule of Law, Government Effectiveness, Regulatory Quality, and Corruption indices over the 1996-2004 period (starting from the earliest year for which these indices are available) for each country in our sample. Then I regressed these indices against log GDP per capita, generating a predicted value based on this cross-section. Taking the difference between actual and predicted values, I ranked countries according to their "adjusted" levels

¹⁰For the latest version of these indices see Kaufmann et al. (2008).

of institutional quality. The sample was then divided into three subgroups of equal size.

Table 9 shows the results of our benchmark specification when the regression is run for each subgroup separately. They are broadly consistent with the theoretical expectation. The positive effect of undervaluation is strongest in the "below average" group while it is virtually nil in the "above average" group. In other words, undervaluation works the most potently in those countries where institutions perform the least well (taking into account that country's income level). In column (5), I interact dummies for the subgroups with *UNDERVAL* to show a very similar effect.

The analytics of how institutional weakness interacts with undervaluation to influence growth will be developed further in the next section. But first we turn to the second category of explanations.

3.2 Explanation 2: Market failures predominate in tradables

The second hypothesis about why the real exchange rate matters is that tradables are particularly prone to the market failures with which development economists have long been preoccupied. A short list of such market failures would include:

- learning externalities: valuable technological, marketing, and other information spills over to other firms and industries
- coordination externalities: getting new industries off the ground requires lumpy and coordinated investments upstream, downstream or sideways.
- credit market imperfections: entrepreneurs cannot finance worthwhile projects because of limited liability and asymmetric information.
- wage premia: monitoring, turnover, and other costs keep wages above market-clearing levels and employment remains low.

These and similar problems can plague all kinds of economic activity in developing countries, but arguably their effects are felt much more acutely in tradables. If so, output and investment levels in tradables would be suboptimal. Real exchange rate depreciations would promote capacity expansion in tradables and increase growth. Note that once again, this is a second-best argument for undervaluation. First best policy would consist of identifying distinct market failures and applying the appropriate Pigovian remedies. Undervaluation is in effect a substitute for industrial policy.

What is the evidence? By their very nature, the types of market failures that are listed above are difficult to identify. So it is practically impossible to provide direct evidence that some kinds of good are more prone to these market failures than others. But the basic hypothesis is quite plausible. A close look at the processes behind economic development yields plenty of indirect and suggestive evidence. Economic development consists of structural change, investment in new activities, and the acquisition of new productive capabilities. As countries grow, the range of tradable goods that they produce expands (Imbs and Wacziarg 2003). Rich countries are rich because not just because they produce traditional goods more productively, but also because they produce different goods (Hausmann, Hwang, and Rodrik 2007). The market failures listed above are likely to be much more severe in new lines of production—those needed to increase economy-wide productivity—than in traditional ones. New industries require "cost discovery" (Hausmann and Rodrik 2003), learning-by-doing, and complementary economic activities to get established. They are necessarily risky and lack track records. These features make them fertile ground for learning and coordination externalities. The recent findings of Freund and Pierola (2008) are particularly suggestive in this connection: currency undervaluations appear to play a very important role in inducing producers from developing countries to enter new products and new markets, and this seems to be the primary mechanism through which they generate export surges.

3.3 Discussion

Unfortunately it is not easy to distinguish empirically between the two broad hypotheses I have outlined above. In principle, if we could identify the goods that are most affected by each of these two categories of imperfections—contractual and market failures—we could run a horse race between the two hypotheses by asking which goods among them are more strongly associated with economic growth. Nunn's (2007) data are a useful beginning for ranking goods by degree of contract-intensity. Perhaps an analogous set of rankings could be developed for market failures using the commodity categorization in Hausmann and Rodrik (2003), which are loosely based on the prevalence of learning externalities. But ultimately I doubt that we could have a sufficiently fine and reliable distinction among goods to enable us to discriminate between the two stories in a credible manner.

Rich countries differ from poor countries both because they have better institutions and because they have learned how to deal with market imperfections. Producers of traded goods in developing economies suffer on both counts.

4 A simple model of real exchange rates and growth

I argued in the previous section that when tradables are affected disproportionately by pre-existing distortions, real exchange rate depreciations can be good for growth. I now develop a simple model to illustrate the mechanics behind this. I will consider an economy in which there exist "taxes" on both traded and non-traded sectors that drive a wedge between private and social marginal benefits. When the tax on tradables is larger (in ad-valorem terms) than the tax on non-tradables, the economy's resources are mis-allocated, the tradable sector is too small, and the growth rate is sub-optimal. Under these circumstances real exchange rate depreciations have a growth-promoting effect

4.1 Consumption and growth

Consumers consume a single final good, which as we shall see below is produced using a combination of traded and non-traded inputs. Their intertemporal utility function is time-separable and logarithmic, and takes the form

$$u = \int \ln c_t e^{-\rho t} dt$$

where c_t is consumption at time t and ρ is the discount rate. Maximizing this subject to an intertemporal budget constraint yields the familiar growth equation

$$\frac{\dot{c}_t}{c_t} = r_t - \rho \tag{3}$$

where r is the real interest rate (or the marginal product of capital). The economy's growth is increasing in the rate of return to capital (r), which is the feature that we will exploit in the rest of this section.

4.2 Production

I assume that the economy produces the single final good using traded and non-traded goods as the sole inputs (y_T and y_N respectively). The production function for the final good (y) is a Cobb-Douglas aggregate of these two inputs. In addition, in order to allow for endogenous growth (while maintaining perfect competition throughout), I assume that capital produces external economies in the production of the final good. With these assumptions, the production function of the representative final-good producer can be written as follows:

$$y = \bar{k}^{1-\phi} y_T^\alpha y_N^{1-\alpha} \quad (4)$$

where \bar{k} is the economy's capital stock at any point in time (treated as exogenous by each final-goods producer), and α and $1-\alpha$ are the shares of traded and non-traded goods, respectively, in the production costs of the final good ($0 < \alpha < 1$). For convenience, I choose the exponent on \bar{k} to be a parameter $(1-\phi)$ that will make aggregate output linear in capital—as we will see shortly—and which therefore considerably simplifies the comparative dynamics of the model. I also omit time subscripts for ease of notation.

Traded and non-traded goods are in turn produced using capital alone and under decreasing returns to scale. These production functions take the following simple form:

$$q_T = A_T k_T^\phi = A_T (\theta_T \bar{k})^\phi \quad (5)$$

$$q_N = A_N k_N^\phi = A_N ((1 - \theta_T) \bar{k})^\phi \quad (6)$$

where k_T and k_N denote the capital stock employed in traded and non-traded sectors, θ_T is the share of total capital employed in tradables, and $0 < \phi < 1$. To justify decreasing returns to capital in the sectoral production functions (i.e., the fact that $\phi < 1$), we could suppose that there are other, sector-specific factors of production employed in each sector which are fixed in supply.

By definition, non-traded goods that are used as inputs in the final-goods sector can only be sourced domestically. And since non-traded goods do not enter consumption directly, we have

$$q_N = y_N \quad (7)$$

With respect to traded goods, we allow the economy to receive a transfer from the rest of the world (or to make a transfer to it). Let b stand for the magnitude of the inward transfer. Then, the material-balances equation in tradables is given by

$$q_T + b = y_T$$

It will be more convenient to express b as a share (γ) of the total domestic demand for tradables. That is, $b = \gamma y_T$. The equality between demand and supply in tradables then becomes

$$\frac{1}{1 - \gamma} q_T = y_T \quad (8)$$

When the economy makes an outward transfer, γ will be negative. I will use γ as a shifter that alters the equilibrium value of the real exchange rate.

Using equations (4)-(8), the aggregate production function can be expressed as

$$y = (1 - \gamma)^{-\alpha} A_T^\alpha A_N^{1-\alpha} \theta_T^{\alpha\phi} (1 - \theta_T)^{(1-\alpha)\phi} \bar{k} \quad (9)$$

Net output, defined as \tilde{y} , differs from gross output insofar as the economy makes a payment to the rest of the world for the transfer b (or receives a payment from it if b is negative). We express this payment in general form, assuming that it is a share σ of the transfer's contribution to gross output, i.e. $\sigma \times (\partial y / \partial b) \times b = \sigma \times (\partial y / \partial y_T) \times \gamma y_T = \sigma \times (\alpha / y_T) y \times \gamma y_T = \sigma \alpha \gamma y$. Net output \tilde{y} equals $y - \sigma \alpha \gamma y = (1 - \sigma \alpha \gamma) y$. Therefore, using (9),

$$\tilde{y} = (1 - \sigma \alpha \gamma) (1 - \gamma)^{-\alpha} A_T^\alpha A_N^{1-\alpha} \theta_T^{\alpha\phi} (1 - \theta_T)^{(1-\alpha)\phi} \bar{k} \quad (10)$$

This way of expressing the payment for the transfer allows a wide variety of scenarios. The transfer's contribution to net output is maximized when $\sigma = 0$, that is when b is a pure transfer (a grant). The contribution becomes smaller as σ increases.

Note that the production function ends up being of the Ak type, i.e. linear in capital. This gives us an endogenous growth model with no transitional dynamics. The (net) marginal product of capital (r) is $\partial \tilde{y} / \partial \bar{k}$, or:

$$r = (1 - \sigma \alpha \gamma) (1 - \gamma)^{-\alpha} A_T^\alpha A_N^{1-\alpha} \theta_T^{\alpha\phi} (1 - \theta_T)^{(1-\alpha)\phi} \quad (11)$$

which is independent of the capital stock, but depends on the allocation of capital between tradables and non-tradables, θ_T (as well as on the net value of the transfer from abroad).

Since the economy's growth rate will depend on r , it is important to know how r depends precisely on θ_T . Log-differentiating this expression with respect to θ_T , we get

$$\frac{d \ln r}{d \theta_T} \propto \left[\left(\frac{\alpha}{\theta_T} \right) - \left(\frac{1 - \alpha}{1 - \theta_T} \right) \right]$$

with

$$\frac{d \ln r}{d \theta_T} = 0 \Leftrightarrow \theta_T = \alpha$$

In other words, the return to capital is maximized when the share of the capital stock that the economy allocates to tradables (θ_T) is exactly equal to the input share of tradables in final production (α). This rate of return, and ultimately the economy's

growth rate, will be suboptimal when tradables receive a lower share of capital. We will next analyze the circumstances under which such inefficiencies obtain.

4.3 Sectoral allocation of capital

The allocation of capital between traded and non-traded sectors will depend both on the relative demand for the two goods and on the relative profitability of producing them. Consider the latter first. In equilibrium, capital will be allocated such that its (private) value marginal product is equalized in the two sectors. As discussed previously, we presume that each sector faces an "appropriability" problem, arising from either institutional weaknesses or market failures or both. We model this by assuming that private producers can retain only a share $(1 - \tau_i)$ of the value of producing each good ($i = T, N$). In other words, τ_T and τ_N are the effective "tax" rates faced by producers in their respective sectors. Let the relative price of traded goods (p_T/p_N) be denoted by R . This is our index of the "real exchange rate." The equality between the value marginal product of capital in the two sectors can then be expressed as

$$(1 - \tau_T)R\phi A_T(\theta_T \bar{k})^{\phi-1} = (1 - \tau_N)\phi A_N [(1 - \theta_T)\bar{k}]^{\phi-1}$$

which simplifies to

$$\left(\frac{\theta_T}{1 - \theta_T}\right)^{\phi-1} = \left(\frac{1 - \tau_N}{1 - \tau_T}\right) \frac{1}{R} \frac{A_N}{A_T} \quad (\text{SS}) \quad (12)$$

This is a supply-side relationship which says that the share of capital that is allocated to tradables increases with the relative profitability of the traded-goods sector. This relative profitability in turn increases with R , τ_N , and A_T , and decreases with τ_T , and A_N (remember that $\phi - 1 < 0$). The SS schedule is a positively-sloped relationship between θ_T and R , as is shown in Figure 13.

Now turn to the demand side. In view of the Cobb-Douglas form of the production function for the final good, the demands for the two intermediate goods are given by

$$\begin{aligned} \alpha y &= p_T y_T = p_T \left(\frac{1}{1 - \gamma}\right) q_T = p_T \left(\frac{1}{1 - \gamma}\right) A_T (\theta_T \bar{k})^\phi \\ (1 - \alpha)y &= p_N y_N = p_N q_N = p_N A_N ((1 - \theta_T)\bar{k})^\phi \end{aligned}$$

Taking the ratios of these two expressions and rearranging terms, we get

$$\left(\frac{\theta_T}{1-\theta_T}\right)^\phi = (1-\gamma) \left(\frac{\alpha}{1-\alpha}\right) \frac{1}{R} \frac{A_N}{A_T} \quad (\text{DD}) \quad (13)$$

This is a demand-side relationship between θ_T and R , and is shown as the DD schedule in the figure. This schedule is negatively sloped since an increase in R makes traded goods more expensive and reduces the demand for capital in that sector. Note that a reduction in γ (smaller inward transfer) shifts this schedule to the right: it increases θ_T at a given R , or increases R at a given θ_T .

4.4 Equilibrium and implications

The equilibrium levels of θ_T and R are given by the point of intersection of the SS and DD schedules. We note several things about the nature of this equilibrium. To begin with, suppose that we are at an initial position where the economy does not receive a transfer from abroad ($\gamma = 0$). If there are no appropriability problems in either of the intermediate goods sectors such that $\tau_T = \tau_N = 0$, then it is relatively easy to confirm that the equilibrium is one where $\theta_T = \alpha$. This ensures that the return to capital and growth are maximized. Now suppose that τ_T and τ_N are positive, but that their magnitude is identical ($\tau_T = \tau_N > 0$). We can see from equation (11) that the equilibrium remains unaffected. As long as the distortion affects traded and non-traded goods equally, θ_T remains at its growth-maximizing level.

Things are different when $\tau_T \neq \tau_N$. Suppose that $\tau_T > \tau_N$, which is the case that I have argued previously is the more likely situation. Relative to the previous equilibrium, this entails a leftward shift in the SS schedule. In the new equilibrium, θ_T is lower (and R is higher). Because $\theta_T < \alpha$, the economy pays a growth penalty as a result of the tradable sector being too small. Note that the endogenous depreciation of the real exchange rate (R) plays a compensatory role, but it does so only partially.

Starting from this new equilibrium (where $\tau_T > \tau_N$ and $\theta_T < \alpha$), it is entirely possible that a negative transfer would improve the economy's growth. That is because a reduction in γ leads to an increase in the equilibrium level of the real exchange rate, and moves θ_T closer to α . In terms of the figure, a fall in γ shifts the DD schedule to the right, and causes both R and θ_T to rise. Whether growth also increases ultimately remains uncertain because the reduction in γ also has a direct negative effect on growth (see equation 11). But for σ sufficiently high, we can always generate cases where this is on balance growth promoting. In such cases, the real exchange rate depreciation generated by the negative external transfer becomes

a second-best instrument to offset the growth costs of the differential distortion on tradables.

5 Policy implications

The main point of this paper can be stated succinctly. Tradable economic activities are "special" in developing countries. These activities suffer disproportionately from the institutional and market failures that keep countries poor. Sustained real exchange rate depreciations increase the relative profitability of investing in tradables, and act in second-best fashion to alleviate the economic cost of these distortions. They speed up structural change in the direction that promotes growth. That is why episodes of undervaluation are strongly associated with higher economic growth.

Are my quantitative estimates of the growth effects of undervaluation plausible? For developing countries our estimates for δ range from 0.063 (albeit in a highly reduced sample in Table 4, column 2) to 0.012 (Table 3, column 8), and cluster around 0.020. Taking the last number as our central estimate, the implication is that an undervaluation of, say, 20% produces a growth boost of 0.4 percentage points. Can the channel I have focused on deliver effects of this magnitude? Remember that the mechanism that generates growth here is structural change. So the answer obviously depends on the size of the gaps between social marginal products in tradable (especially industrial) and non-tradable sectors. I have already given some reasons in the discussion above as to why these gaps can be quite large. There is a long tradition of thought on economic dualism in developing countries which takes the persistence of large differentials between marginal products in the advanced, "formal" parts of the economy (such as industry) and marginal products elsewhere as the very essence of underdevelopment. Detailed industry studies carried out recently by the McKinsey Global Institute (e.g., 2001, 2003) provide some striking, if indirect, evidence on the magnitude of these gaps. They find that productivity levels in the most advanced firms and sectors of developing countries are not too distant from the frontier in the rich economies. Since average productivity levels in these economies are a fraction of those prevailing in rich countries, the implied inter-sectoral differences *within* developing countries are quite large. This paper's distinction between tradable and non-tradable sectors maps directly onto this dualistic structure, since most (non-agricultural) tradable activities in a typical developing country are formal while most non-traded activities (except for public services) are informal.¹¹

¹¹A simple finger exercise can be helpful here. Let us denote the productivity premium in industry by ψ and the share of employment in industry by λ_I . Some straightforward algebra can

There is an obvious parallel between the argument I have developed here and the results presented in the recent paper by Prasad, Rajan, and Subramanian (2007). These authors note that fast-growing developing countries have tended to run current account surpluses rather than deficits. This runs counter to the view that developing countries are constrained by external finance and with the presumption that capital inflows supplement domestic saving and enable more rapid growth (Rodrik and Subramanian 2008). One of the explanations Prasad et al. (2007) advance is that capital inflows appreciate the real exchange rate and hurt growth through reduced investment incentives in manufactures. They also provide some evidence on this particular channel. Even though Prasad et al. (2007) focus on the costs of overvaluation rather than the benefits of undervaluation, their concern with the real exchange rate renders their paper complementary to this one.

A maintained hypothesis in the paper up to this point has been that the real exchange rate is a policy variable. Strictly speaking, this is not true as the real exchange rate is a relative price and is determined in general equilibrium along with all other relative prices. But governments have a variety of instruments at their disposal to influence the level of the real exchange rate, and the evidence is that they use them. Maintaining a more depreciated real exchange rate requires higher saving relative to investment, or lower expenditures relative to income. This can be achieved via fiscal policy (a large structural surplus), incomes policy (redistribution of income to high savers through real wage compression), saving policy (compulsory saving schemes and pension reform), capital-account management (taxation of capital account inflows, liberalization of capital outflows), or currency intervention (building up foreign exchange reserves). Experience in East Asia as well as elsewhere (e.g. Tunisia) shows that countries that target real exchange rates ("competitiveness") can have a fair amount of success.

Some systematic evidence on how policy choices feed into the real exchange rate and undervaluation is presented in Table 10. The table shows the results when

establish that the growth effect of reallocating labor to industry in the amount $d\lambda_I$ is given by

$$growth\ impact = \frac{\psi}{1 + \psi\lambda_I} d\lambda_I.$$

A reasonable assumption on the industrial premium (at the margin) would be that $\psi = 50\%$, while a typical industrial share of labor is $\lambda_I = 0.20$. Note from Table 7 (column 2) that a 20 percent undervaluation would be associated with an increase of 0.84 percentage points in industry's share of total employment (i.e., $d\lambda_I = 0.042 \times 20\% = 0.84$). Applying the formula, an increase in the industrial labor share of 0.84 percentage points would be expected to generate additional growth equal to 0.38 percentage points, which is virtually identical to the result we get by using the coefficient estimates from the growth regressions (0.4 percentage points).

we regress *UNDERVAL* on a series of independent variables in a panel with fixed effects. The baseline specification (column 1) employs the following regressors: the terms of trade, government consumption (as a percent of GDP), an index of capital account liberalization (*KAOPEN*), and a set of dummy variables capturing the exchange rate regime in force. *KAOPEN* comes from Chinn and Ito (2006) and is a continuous variable designed to capture the extensiveness and intensity of capital controls. It increases as a country's capital-account regime becomes more liberal. The exchange rate regime indicators come from Ilzetzi, Reinhart, and Rogoff (2008) and are entered as separate dummy variables identifying distinct regimes. So for example the "crawl/managed" dummy is a variable that takes the value of 1 whenever the country in question is classified as having a currency regime with a pre-announced crawl, de-facto crawl, or managed float, and is zero otherwise. The excluded category is the set of observations with a rigid exchange rate (a peg, currency board, or currency union).¹² Subsequent columns in the table augment the baseline specification by adding domestic saving, inflation, and FDI inflows as regressors. Among the variables considered, government consumption, capital-account openness, the exchange-rate regime, and inflation can be considered direct policy variables, while domestic saving and FDI inflows are less directly so. The terms of trade is exogenous for most countries, but we would expect it to have a determinate effect on the real exchange rate.

The results in Table 10 are quite strong. As expected, positive terms-of-trade shocks are bad for undervaluation. More importantly for the present discussion, fiscal policies, capital-account policies, and the choice of exchange-rate regimes all have quite significant effects on undervaluation. Increases in government consumption tend to appreciate the real exchange rate, as do policies that liberalize the capital account. The coefficient on *KAOPEN* implies that going from the Chinese level of capital-account restrictions in 2006 (*KAOPEN* = -1.13) to the Mexican level (*KAOPEN* = 1.19) is associated with a decrease in *UNDERVAL* of around 7 percent. (Note that these effects are identified in these regressions from the variation within countries, not across countries, and they are therefore more credible.) The operative channel, presumably, is that opening up the capital account invites inflows which in turn appreciate the real exchange rate. The results on the exchange-rate regime dummies are also quite interesting. The coefficients on these dummies tell us the effects of each one of the regimes *relative to fixed-rate regimes*, since the latter is the excluded category. The central finding here is that regimes in which the exchange rate are actively managed—crawling pegs or managed floats—produce currencies that

¹²"Crawl/managed" corresponds to categories 2 and 3 in Ilzetzi et al.'s (2008) "coarse" classification, while "rigid" corresponds to category 1.

are more undervalued than fixed-rate regimes, with a difference of around 7 percent. Unsurprisingly, periods in which the currency is in a "free fall" (as defined by Ilzetki et al. [2008]) are also good for undervaluation.¹³ A pure float, by contrast, does not seem to generate significantly different levels of undervaluation. The results in Table 10 also show that high saving is good for undervaluation while FDI inflows are bad. Both of these are in line with theoretical expectations. Finally, the level of inflation does not have a strong association with undervaluation, indicating that undervaluation does not need to come at the cost of inflation. In short, policy choices, particularly on the fiscal and external fronts, matter and they do so in the manner suggested by straightforward economic logic.

It is worth emphasizing once again that real-exchange rate policy is only second-best in the context of the economic distortions I have discussed in this paper. One of the side effects of maintaining high real exchange rates is a surplus on the current account (or a smaller deficit). This obviously has effects on other countries. Were all developing countries to follow this strategy, advanced countries would have to accept living with the corresponding deficits. This is a major issue of contention in U.S.-China economic relations at present. Moreover, when some developing countries follow this strategy while others do not (as in Asians versus the rest), the growth penalty incurred by the latter becomes larger as their traded sector shrinks even further under the weight of Asian competition.

Conceptually, the first-best strategy is clear, if fraught with practical difficulties. Eliminating the institutional and market failures in question would do away with the policy dilemmas—but recommending this strategy amounts to telling developing countries that the way to get rich is to get rich. A more practical approach is to subsidize tradables production directly, rather than indirectly through the real exchange rate. Note that a depreciated real exchange rate is equivalent to a production subsidy *plus* a consumption tax on tradables. The direct strategy of subsidizing production of tradables achieves the first without the second. Hence it avoids the spillovers to other countries. A production subsidy on tradables boosts exports and imports simultaneously (provided the exchange rate and/or wages are allowed to adjust to equilibrate the current account balance) and therefore need not come with a trade surplus.

However, it goes without saying that production subsidies have their own problems. Fine-tuning them to where the perceived distortions are would amount to a

¹³It is worth noting that the growth effects of undervaluation, as detailed earlier in the paper, do not seem to depend on the type of exchange-rate regime the country happens to be at the time. In particular, the results remain unchanged when the countries whose currencies are in a "free fall" are excluded from the sample.

highly intricate form of industrial policy, with all the attendant informational and rent-seeking difficulties. Even if that were not a problem, the strategy would come into conflict with existing WTO rules that prohibit export subsidies. There is, it appears, no easy alternative to exchange-rate policy.

6 References

Acemoglu, Daron, Simon Johnson, and James A. Robinson, "The Colonial Origins of Comparative Development: An Empirical Investigation," *American Economic Review*, Vol. 91 (December), 2001, pp. 1369–1401.

Aguirre, Alvaro, and Cesar Calderon, "Real Exchange Rate Misalignments and Economic Performance," Central Bank of Chile, Economic Research Division, April 2005.

Anderson, James E., and Douglas Mercouiller, "Trade, Insecurity and Home Bias", *Review of Economics and Statistics*, 84 (2), 2002, 345-52

Arellano, M., and S. Bond, "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations," *Review of Economic Studies* 58, 1991, 277–97.

Barro, Robert J. and Jong-Wha Lee, "International Data on Educational Attainment: Updates and Implications," Center for International Development Working Paper No. 42, Harvard University, April 2000.

Berkowitz, Daniel, Johannes Moenius, and Katharina Pistor, "Trade, Law, and Product Complexity," *The Review of Economics and Statistics*, vol. 88(2), 2006, 363-373.

Bhalla, Surjit S.. *Second Among Equals: The Middle Class Kingdoms of India and China*, Peterson Institute of International Economics, Washington, DC, forthcoming (May 21, 2007 draft).

Blomberg, S. Brock, Jeffrey Frieden, and Ernesto Stein, "Sustaining Fixed Rates: The Political Economy of Currency Rates in Latin America," *Journal of Applied Economics*. Vol VIII, No. 2, November 2005, 203-225

Blundell, R., and S. Bond, "Initial conditions and moment restrictions in dynamic panel data models," *Journal of Econometrics* 87, 1998, 11–143.

Chinn, Menzie, and Hiro Ito, "What Matters for Financial Development? Capital Controls, Institutions, and Interactions," *Journal of Development Economics* 61(1), October 2006, 163-192.

Dollar, David, "Outward-oriented developing economies really do grow more rapidly: Evidence from 95 LDCs, 1976–1985," *Economic Development and Cultural Change* 40 (3), 1992, 523–544.

Easterly, William, "National policies and economic growth" in Philippe Aghion and Steven Durlauf, editors, *Handbook of Economic Growth*, Elsevier, 2005.

Elbadawi, Ibrahim, "Estimating Long-Run Equilibrium Real Exchange Rates," in *Estimating Equilibrium Exchange Rates*, ed. by J. Williamson (Washington: Institute for International Economics, 1994).

Fischer, Stanley, "The role of macroeconomic factors in growth," *Journal of Monetary Economics* 32,1993, 485–512.

Freund, Caroline, and Martha Denisse Pierola, "Export Surges: The Power of a Competitive Currency," World Bank, August, 2008.

Gala, Paulo, "Real Exchange Rate Levels and Economic Development: Theoretical Analysis and Empirical Evidence," Sao Paulo Business Administration School, Getulio Vargas Foundation, 2007.

Galvarriato, Aurora Gómez, and Jeffrey G. Williamson, "Was It Prices, Productivity or Policy? The Timing and Pace of Latin American Industrialization after 1870," NBER Working Paper No. 13990, May 2008.

Gluzmann, Pablo, Eduardo Levy-Yeyati, and Federico Sturzenegger, "Exchange Rate Undervaluation and Economic Growth: Díaz Alejandro (1965) Revisited," unpublished paper, John F. Kennedy School of Government, Harvard University 2007.

Hausmann, Ricardo, "Economic Growth: Shared Beliefs, Shared Disappointments?" Speech at the G-20 Seminar on Economic Growth in Pretoria, South Africa, 4-5 August 2005, published as CID Working Paper No. 125, June 2006.

Hausmann, Ricardo, and Dani Rodrik, "Economic Development as Self-Discovery," *Journal of Development Economics*, vol. 72, December 2003.

Hausmann, Ricardo, Lant Pritchett, and Dani Rodrik, "Growth Accelerations," *Journal of Economic Growth*, 10, 303-329, 2005.

Hausmann, Ricardo, Jason Hwang, and Dani Rodrik, "What You Export Matters," *Journal of Economic Growth*, Volume 12, Issue 1, 2007, 1-25.

Heston, Alan, Robert Summers, and Bettina Aten, *Penn World Table Version 6.2*, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006 (http://pwt.econ.upenn.edu/php_site/pwt_index.php).

Ilzetzki, Ethan O., Carmen M. Reinhart, and Kenneth Rogoff, "Exchange Rate Arrangements into the 21st Century: Will the Anchor Currency Hold?" Department of Economics, Harvard University, 2008. Data available at http://www.economics.harvard.edu/faculty/rogooff/files/ERA_Background_Material.htm.

Imbs, Jean, and Romain Wacziarg, "Stages of Diversification," *American Economic Review*, vol. 93, no. 1, March 2003, pp. 63-86.

International Comparison Program, *2005 International Comparison Program Preliminary Results*, The World Bank, Washington, DC, 17 December 2007.

Johnson, Simon H., Jonathan Ostry, and Arvind Subramanian, "The Prospects

for Sustained Growth in Africa: Benchmarking the Constraints" (March 2007). IMF Working Paper No. 07/52.

Kaufmann, Daniel, Aart Kraay, and Massimo Mastruzzi, "Governance Matters VII: Aggregate and Individual Governance Indicators, 1996-2007," World Bank Policy Research Working Paper No. 4654, June 24, 2008.

Levchenko, Andrei, "Institutional Quality and International Trade," IMF Working Paper WP/04/231, International Monetary Fund, 2004.

Levy-Yeyati, Eduardo, and Federico Sturzenegger, "Fear of Floating in Reverse: Exchange Rate Policy in the 2000s," unpublished paper, 2007.

Méon, Pierre-Guillaume, and Khalid Sekkat, "Institutional quality and trade: which institutions? which trade?," Working Papers DULBEA 06-06.RS, Université libre de Bruxelles, Department of Applied Economics (DULBEA), 2006.

McKinsey Global Institute, *India: The Growth Imperative*, McKinsey & Co, San Francisco, 2001.

McKinsey Global Institute, *Turkey: Making the Growth and Productivity Breakthrough*, McKinsey & Co, Istanbul, Turkey, 2003.

North, Douglas C., *Institutions, Institutional Change and Economic Performance*, New York, Cambridge University Press, 1990.

Nunn, Nathan, "Relationship-Specificity, Incomplete Contracts and the Pattern of Trade," *Quarterly Journal of Economics*, Vol. 122, No. 2, May 2007, pp. 569-600.

Prasad, Eswar, Raghuram G. Rajan, and Arvind Subramanian, "Foreign Capital and Economic Growth," *Brookings Papers on Economic Activity*, Vol. 1, March 2007.

Rajan, Raghuram G., and Arvind Subramanian, "Aid, Dutch Disease, and Manufacturing Growth," unpublished paper, International Monetary Fund, August 2007.

Ranjan, Priya, and Jae Young Lee, "Contract Enforcement and the Volume of International Trade in Different Types of Goods," Mimeograph, U.C. Irvine, 2004.

Rauch, James E., "Networks versus Markets in International Trade," *Journal of International Economics*, XLVIII, 1999, 7-35.

Razin, Ofair, and Susan . Collins, "Real Exchange Rate Misalignments and Growth," Georgetown University, 1997.

Rodriguez, Francisco, and Dani Rodrik, "Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence," *Macroeconomics Annual 2000*, eds. Ben Bernanke and Kenneth S. Rogoff, MIT Press for NBER, Cambridge, MA, 2001.

Rodrik, Dani, "'Disequilibrium' Exchange Rates as Industrialization Policy," *Journal of Development Economics*, 23(1), September 1986.

Rodrik, Dani, "Why we learn nothing from regressing economic growth on policies," unpublished paper, March 2005

(<http://ksghome.harvard.edu/~drodrik/policy%20regressions.pdf>).

Rodrik, Dani, and Roberto Rigobon, "Rule of Law, Democracy, Openness and Income: Estimating the Interrelationships." *Economics of Transition* 13:3, July 2005, 533-564.

Rodrik, Dani, and Arvind Subramanian, "Why Did Financial Globalization Disappoint?" Harvard University, July 2008 (forthcoming, *International Monetary Fund Staff Papers*).

Rodrik, Dani, Arvind Subramanian, and Francesco Trebbi, "Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development," *Journal of Economic Growth*, Volume 9, Number 2, June 2004, pp. 131-165.

Roodman, David, "xtabond2: Stata module to extend xtabond dynamic panel data estimator," Center for Global Development, Washington, DC, 2005 (<http://econpapers.repec.org/software/bocbocode/s435901.htm>).

Roodman, David, "How to Do xtabond2: an Introduction to "Difference" and "System" Gmm in Stata" (December 2006). Available at SSRN: <http://ssrn.com/abstract=982943>

Sachs, Jeffrey, and Andrew Warner, "Economic reform and the process of global integration," *Brookings Papers on Economic Activity* 1, 1995, 1-95.

Table 1: Panel evidence on the growth effects of undervaluation

	(1)	(2)	(3)	(4)	(5)	(6)
	All countries	Developed countries	Developing countries	All countries	Developing countries RGDPCH < \$6000	Developing countries RGDPCH < \$6000
		RGDPCH > \$6000	RGDPCH < \$6000		1950-1979	1980-2004
In <i>initial income</i>	-0.031** (-6.67)	-0.055** (-6.91)	-0.039** (-5.30)	-0.032** (-7.09)	-0.062** (-3.90)	-0.065** (-4.64)
In <i>UNDERVAL</i>	0.017** (5.21)	0.003 (0.49)	0.026** (5.84)	0.086** (4.05)	0.029** (4.20)	0.024** (3.23)
In <i>initial income</i> x In <i>UNDERVAL</i>				-0.0087** (-3.39)		
Time dummies	yes	yes	yes	yes	yes	yes
Country dummies	yes	yes	yes	yes	yes	yes
Observations	1303	513	790	1303	321	469

Notes: Robust t-statistics in parentheses. Three countries with extreme observations for *UNDERVAL* have been excluded from the sample (Iraq, Laos, and People's Republic of Korea).

** Significant at 1% level

* Significant at 5% level

Table 2: Testing for outliers and asymmetries

	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	<i>UNDERVAL</i> greater than negative 150%	<i>UNDERVAL</i> greater than negative 100%	<i>UNDERVAL</i> greater than negative 50%	<i>UNDERVAL</i> greater than negative 25%	<i>UNDERVAL</i> between negative 50% and positive 50%
coefficient on ln <i>UNDERVAL</i>	0.026** (5.84)	0.029** (6.31)	0.034** (7.28)	0.034** (5.46)	0.028** (4.32)	0.030** (3.72)
Observations	790	786	773	726	653	619

Notes: Same as Table 1

** Significant at 1% level

* Significant at 5% level

Table 3: Panel evidence with alternative indices of real exchange rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ln <i>RER_PWT</i>		ln <i>REER_IMF</i>		ln <i>RER_WPI</i>		ln <i>RER_CPI</i>	
	All countries	Developing countries (RGDPCH < \$6000)	All countries	Developing countries (RGDPCH < \$6000)	All countries	Developing countries (RGDPCH < \$6000)	All countries	Developing countries (RGDPCH < \$6000)
ln <i>initial income</i>	-0.029** (-6.02)	-0.033** (-4.43)	-0.041** (-3.63)	-0.049* (-2.51)	-0.041** (-5.32)	-0.031 (-1.63)	-0.033** (-7.37)	-0.033** (-4.81)
ln <i>UNDERVAL</i>	0.006* (1.97)	0.016** (3.74)	0.005 (0.94)	0.015† (1.92)	0.003 (1.54)	0.029** (2.95)	0.003† (1.72)	0.012** (2.83)
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes
Country dummies	yes	yes	yes	yes	yes	yes	yes	yes
Observations	1293	790	476	206	440	162	987	557

Notes: Robust t-statistics in parentheses. Countries with extreme observations have been excluded from the sample (Iraq, Laos, and People's Republic of Korea in columns 1-2 and Nicaragua in columns 3-4). The U.S. is excluded in regressions in columns 1, 5, and 7 as the U.S. is the base country with an invariant real exchange rate index.

** Significant at 1% level

* Significant at 5% level

† Significant at 10% level

Table 4: Additional covariates in panel regressions (developing countries sample)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	baseline						
<i>ln initial income</i>	-0.039** (-5.30)	-0.015** (-6.40)	-0.037** (-5.17)	-0.033** (-4.51)	-0.036** (-5.06)	-0.045** (-6.65)	-0.046** (-4.33)
<i>ln UNDERVAL</i>	0.026** (5.84)	0.063** (3.33)	0.025** (4.51)	0.021** (4.01)	0.018** (3.66)	0.019** (4.06)	0.016** (2.87)
<i>rule of law</i>		0.007 (0.010)					
<i>government consumption (share of GDP)</i>			-0.076* (-2.00)	-0.042 (-1.32)			
<i>ln terms of trade</i>				0.013† (1.93)	0.005 (0.71)		
<i>ln (1 + inflation)</i>					-0.030** (-3.23)	-0.027** (-3.34)	-0.023** (-3.16)
<i>gross domestic saving (share of GDP)</i>						0.099** (4.34)	0.124** (4.40)
<i>average years of education (x100)</i>							0.030 (0.87)
Time dummies	yes	yes	yes	yes	yes	yes	yes
Country dummies	yes	yes	yes	yes	yes	yes	yes
Observations	790	191	626	546	478	529	335

Notes: Same as Table 1

** Significant at 1% level

* Significant at 5% level

† Significant at 10% level

Table 5: Cross-section growth regressions (1980-2004)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>ln initial income</i>	-0.014** (-4.20)	-0.013** (-3.59)	-0.013** (-3.51)	-0.016** (-6.18)	-0.018** (-6.00)	-0.017** (-7.74)	-0.013** (-6.80)
<i>ln UNDERVAL</i>	0.022** (5.95)	0.021** (4.45)	0.020** (4.32)	0.022** (5.31)	0.021** (4.93)	0.020** (5.12)	0.019** (5.32)
<i>average years of education</i> (x100)	0.250* (2.06)	0.210† (1.67)	0.224† (1.75)	0.143 (1.57)	0.114 (1.18)		
<i>rule of law</i>	0.019** (8.19)	0.021** (8.09)	0.020** (6.40)	0.020** (8.28)	0.020** (6.91)	0.020** (7.34)	0.021** (7.90)
<i>government consumption</i> (share of GDP)		-0.060† (-1.82)	-0.063† (-1.89)				
<i>ln (1 + inflation)</i>			-0.008 (-0.92)				
<i>gross domestic saving</i> (share of GDP)				0.072** (3.52)	0.070** (3.12)	0.053** (3.93)	
<i>Africa</i>					-0.004 (-0.87)	-0.014** (-3.28)	-0.009* (-2.08)
<i>Latin America</i>					0.002 (0.35)	-0.006 (-0.16)	-0.002 (-0.43)
<i>Asia</i>					0.000 (0.06)	-0.009* (-2.22)	-0.001 (0.16)
<i>R²</i>	0.57	0.56	0.57	0.68	0.69	0.55	0.48
<i>Observations</i>	104	102	102	102	104	147	155

Notes: Robust t-statistics in parentheses.

** Significant at 1% level

* Significant at 5% level

† Significant at 10% level

Table 6: Dynamic panel estimation of the growth effects of undervaluation

	full sample		developed economies		developing economies	
	(1) Two Step Difference GMM	(2) Two Step System GMM	(3) Two Step Difference GMM	(4) Two Step System GMM	(5) Two Step Difference GMM	(6) Two Step System GMM
<i>lagged growth</i>	0.187** (4.39)	0.308** (5.45)	0.273** (5.34)	0.271** (4.48)	0.200** (3.95)	0.293** (4.55)
<i>ln initial income</i>	-0.038** (-4.86)	0.001 (1.17)	-0.043** (-5.21)	-0.016** (-4.11)	-0.037** (-4.72)	-0.006* (-2.34)
<i>ln UNDERVAL</i>	0.011 (1.74)	0.011* (2.14)	0.017 (1.55)	0.005 (0.60)	0.014* (2.28)	0.013* (2.26)
Time dummies	yes	yes	yes	yes	yes	yes
No. of countries	156	179	79	89	112	125
Avg obs per country	6.04	6.27	6.22	5.18	6.07	5.29
Hansen test of overid. restrictions prob > chisquared	0.067	0.101	0.893	0.762	0.332	0.253

Notes: Robust t statistics in parentheses. Three countries with extreme observations for *UNDERVAL* have been excluded from the sample (Iraq, Laos, and People's Republic of Korea). Results generated using the `xtabond2` command in Stata, with small sample adjustment for s.e., forward orthogonal deviations, and assuming exogeneity of initial income and time dummies (see Roodman 2005),

** Significant at 1% level

* Significant at 5% level

Table 7: Evidence on the tradable sector channel impact of devaluation

	Dependent Variable					
	(1)	(2)	(3)	(4)	(5)	(6)
	Industry share in GDP	Industry share in employment	Agriculture share in GDP	Agriculture share in employment	Growth - TSLs	Growth - TSLs
<i>ln current income</i>	0.079** (9.99)	0.025 (1.51)	-0.110** (-12.50)	-0.128** (-4.94)		
<i>ln initial income</i>					-0.134** (-8.33)	-0.071** (-4.39)
<i>ln UNDERVAL</i>	0.024** (3.62)	0.042** (4.87)	-0.016* (-2.25)	-0.010 (-0.48)		
<i>Share of Industry in GDP</i>					1.716** (7.59)	
<i>Share of Industry in employment</i>						1.076** (6.15)
Time dummies	yes	yes	yes	yes	yes	yes
Country dummies	yes	yes	yes	yes	yes	yes
Observations	985	469	985	469	938	459

Notes: Industry and agriculture shares in GDP are in constant local currency units. In columns (5) and (6), industry shares are regressed on *ln UNDERVAL*, *ln income*, and lagged *ln income in the first stage*.

** Significant at 1% level

* Significant at 5% level

Table 8: Illustrative calculations on the relationship-specificity of tradables

(a) Tradables use intermediates that tend to be less relationship-specific...

	Traded	Non-traded
share of intermediates not sold on exchange and not reference-priced (unweighted average)	49.6%	75.1%
share of intermediates not sold on exchange (unweighted average)	87.3%	96.4%

(b) but tradables rely more on intermediate inputs ...

	Traded	Non-traded
Inputs: share of intermediates in total output	64.3%	35.1%
Outputs: share of inter-industry sales in total output	58.4%	29.4%

(c) so on balance relationship-specific intermediates account for a much larger share of output in tradables

	Traded	Non-traded
share in gross output of intermediates not sold on exchange and not reference-priced (unweighted average)	17.9%	7.5%
share in gross output of intermediates not sold on exchange (unweighted average)	31.5%	9.7%

Sources: Panel (a) is calculated from data provided by Nathan Nunn, based on Nunn (2006). Panel (b) is based on Brazil's input-output table for 1996. Panel (c) combines the information in the other two panels using U.S. value added shares.

Table 9: Quality of institutions and the growth effects of undervaluation

	(1)	(2)	(3)	(4)	(5)
	Baseline	Country groups based on levels of adjusted indexes of institutional quality:			Interactions with group dummies
	All countries	above average	around average	below average	All countries
In <i>initial income</i>	-0.030** (-6.61)	-0.036** (-5.59)	-0.017* (-2.32)	-0.060** (-4.73)	-0.031** (-6.90)
In <i>UNDERVAL</i>	0.016** (5.18)	0.004 (1.17)	0.022** (3.98)	0.028** (4.42)	0.005 (1.45)
In <i>UNDERVAL</i> x around average institutions					0.019** (2.86)
In <i>UNDERVAL</i> x below average institutions					0.019* (2.36)
Observations	1303	513	434	356	1303

Notes: Same as Table 1

** Significant at 1% level

* Significant at 5% level

Table 10: Policy and other determinants of *UNDERVAL* (full sample)

	(1)	(2)	(3)	(4)
	dependent variable: \ln <i>UNDERVAL</i>			
<i>In terms of trade</i>	-0.139** (-3.52)	-0.164** (-4.14)	-0.167** (-4.09)	-0.115** (-2.86)
<i>government consumption</i> <i>(share of GDP)</i>	-0.793** (-4.35)	-0.680** (-3.53)	-0.519** (-2.61)	-0.045 (-0.23)
<i>capital-account openness (KAOPEN)</i>	-0.031** (-5.70)	-0.029** (-5.39)	-0.026** (-4.56)	-0.031** (-5.98)
<u>Exchange-rate regime:</u>				
<i>crawl/managed float</i>	0.068** (4.86)	0.065** (4.64)	0.065** (4.47)	0.071** (4.87)
<i>float</i>	0.027 (0.85)	0.028 (0.89)	0.058† (1.83)	0.026 (0.82)
<i>free fall</i>	0.161** (4.97)	0.158** (4.86)	0.172** (5.21)	0.162** (4.80)
<i>dual market with missing parallel</i> <i>market data</i>	0.065 (1.12)	0.067 (1.19)	0.063 (1.17)	0.021 (0.39)
<i>gross domestic saving</i> <i>(share of GDP)</i>		0.310** (3.55)	0.355** (3.80)	0.492** (5.10)
<i>FDI inflows (share of GDP)</i>			-0.376** (-3.11)	-0.382** (-3.04)
\ln (1 + <i>inflation</i>)				0.039 (1.10)
Year dummies	yes	yes	yes	yes
Country dummies	yes	yes	yes	yes
Observations	3153	3147	2994	2757

Note: Annual data, excluding outliers noted in Table 1. Robust t-statistics in parentheses. See text for sources of *KAOPEN* and exchange-rate regime classification.

** Significant at 1% level

* Significant at 5% level

† Significant at 10% level

Figure 1: China: Undervaluation and economic growth

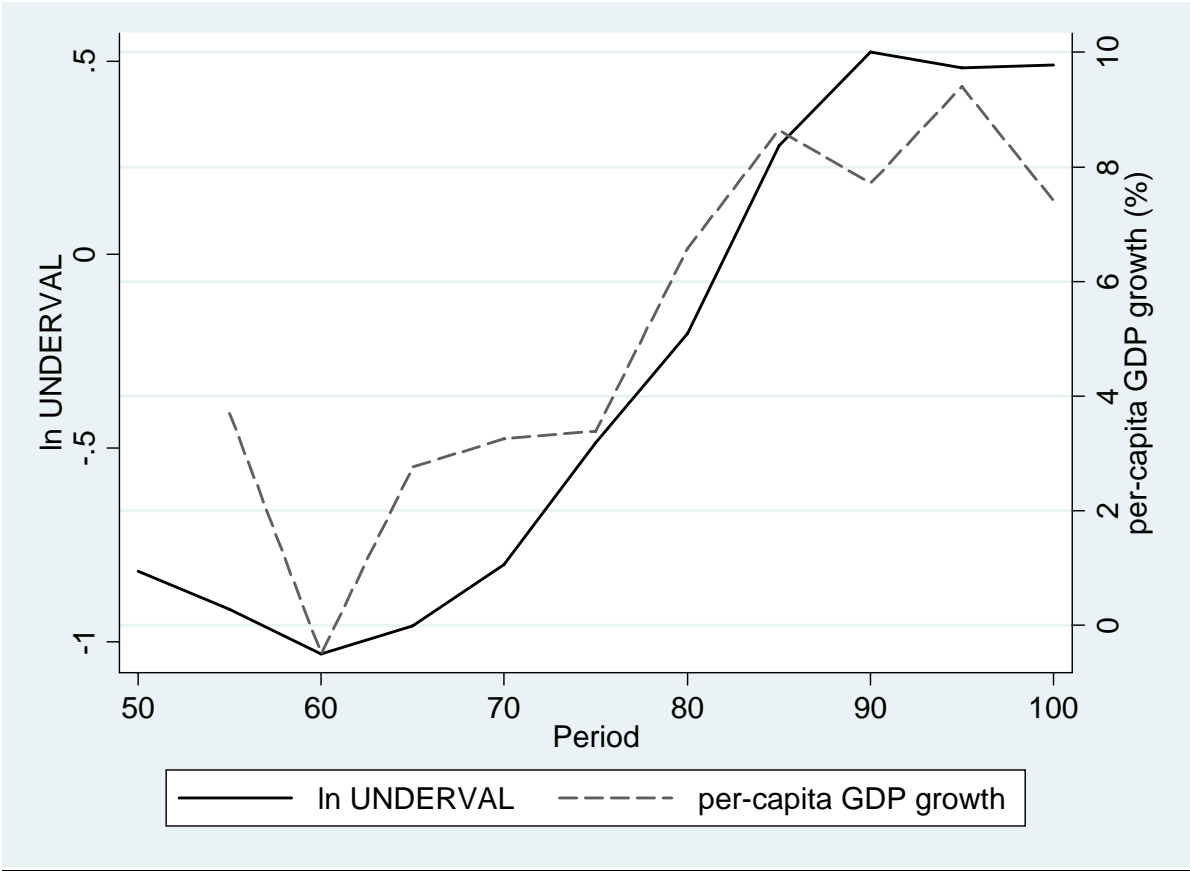


Figure 2: India: Undervaluation and economic growth

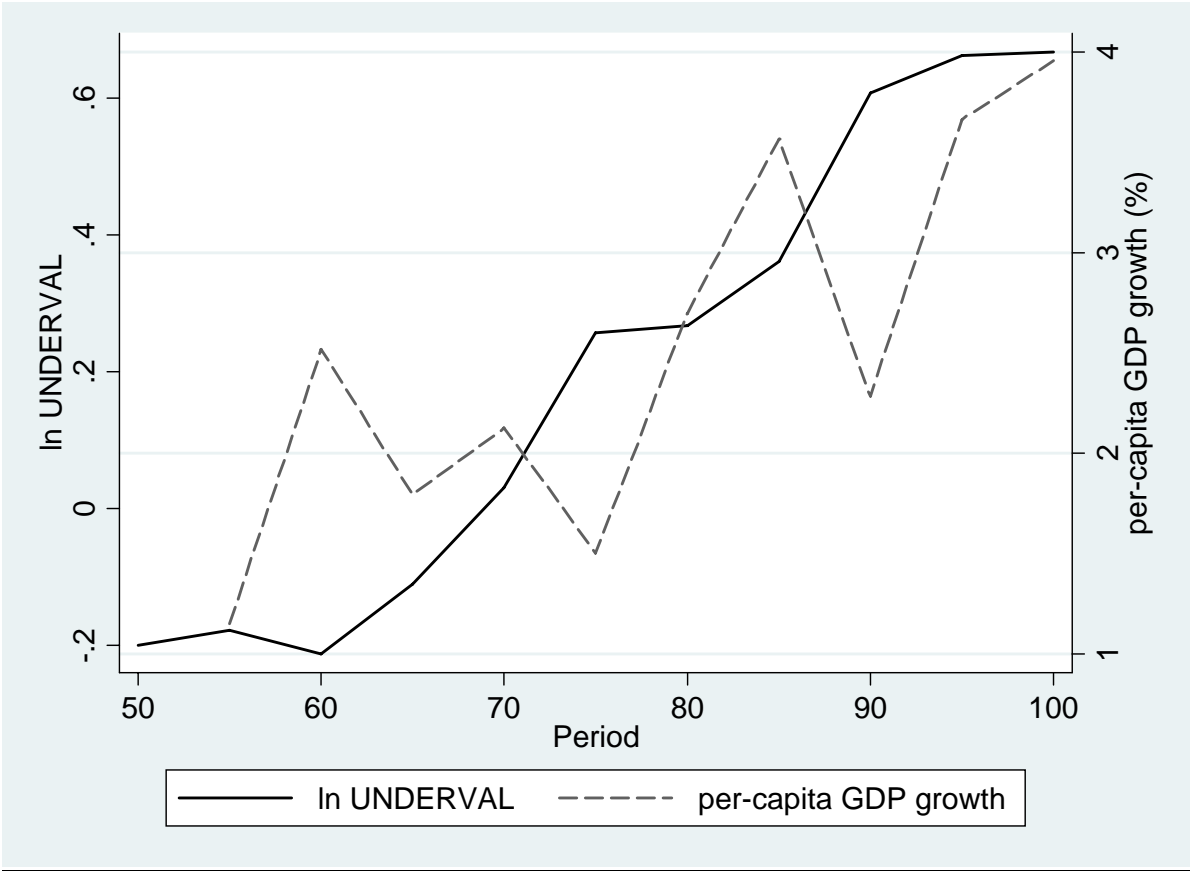


Figure 3: South Korea: Undervaluation and economic growth

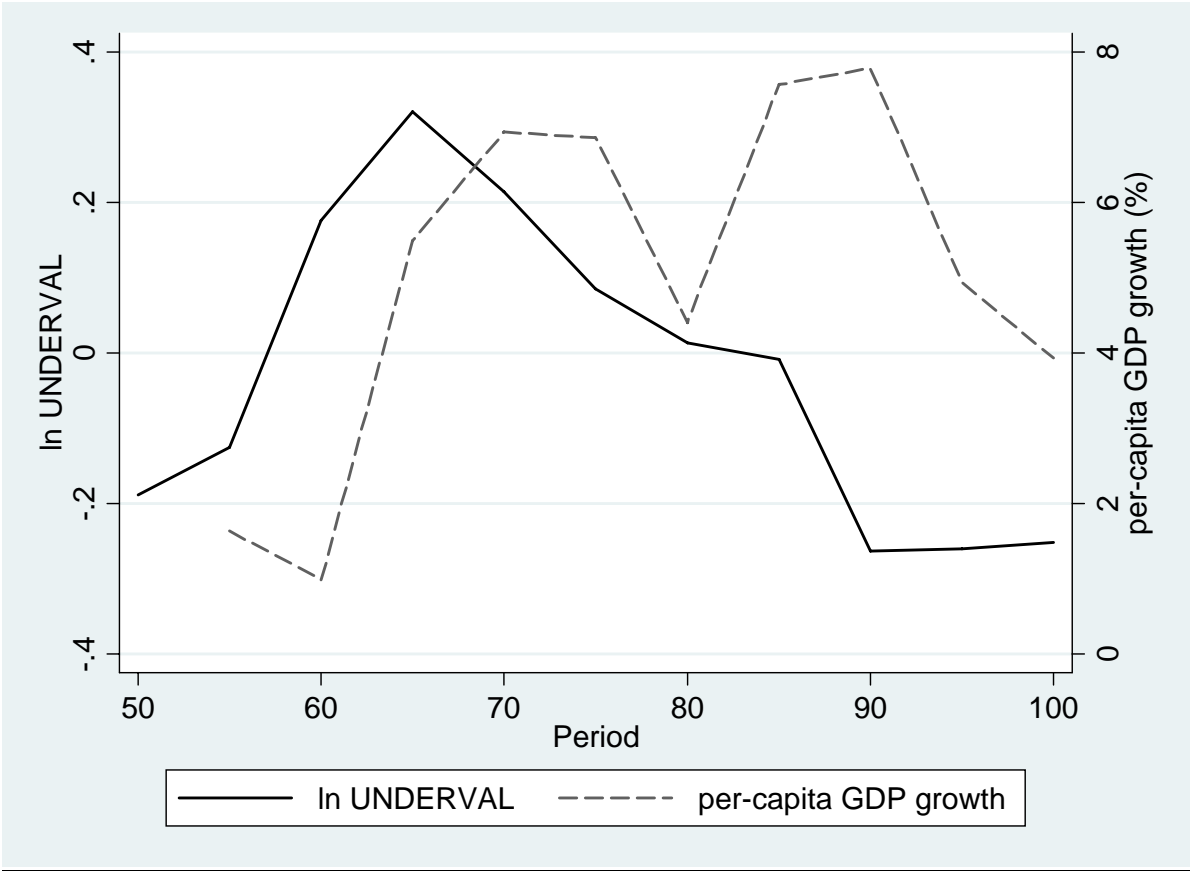


Figure 4: Taiwan: Undervaluation and economic growth

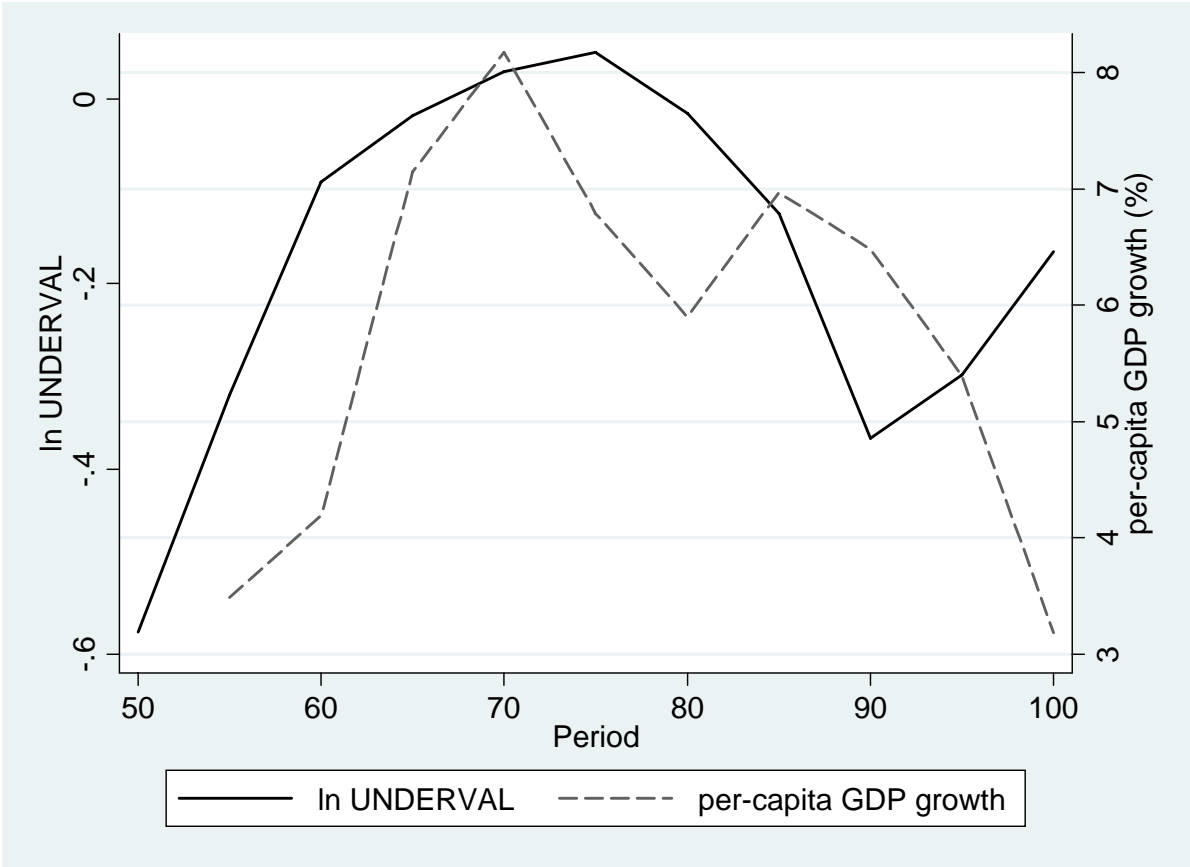


Figure 5: Uganda: Undervaluation and economic growth

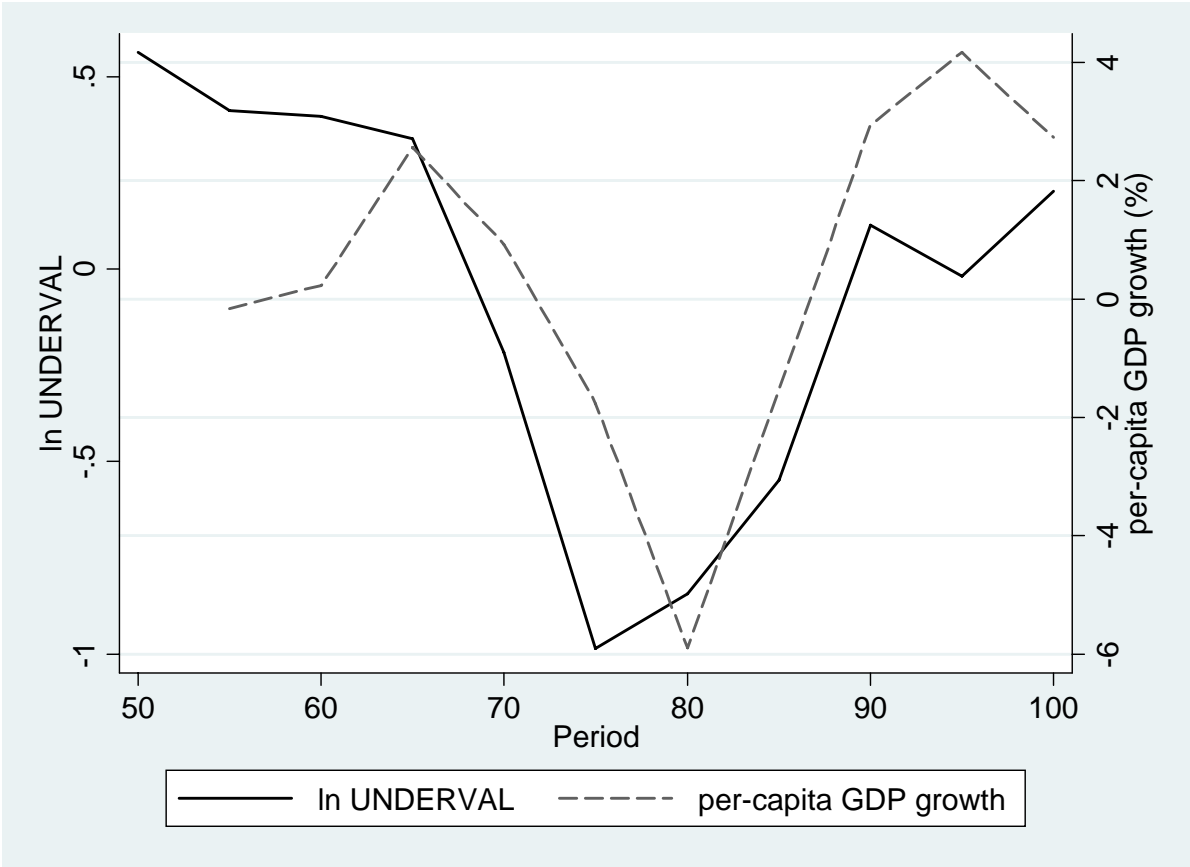


Figure 6: Tanzania: Undervaluation and economic growth

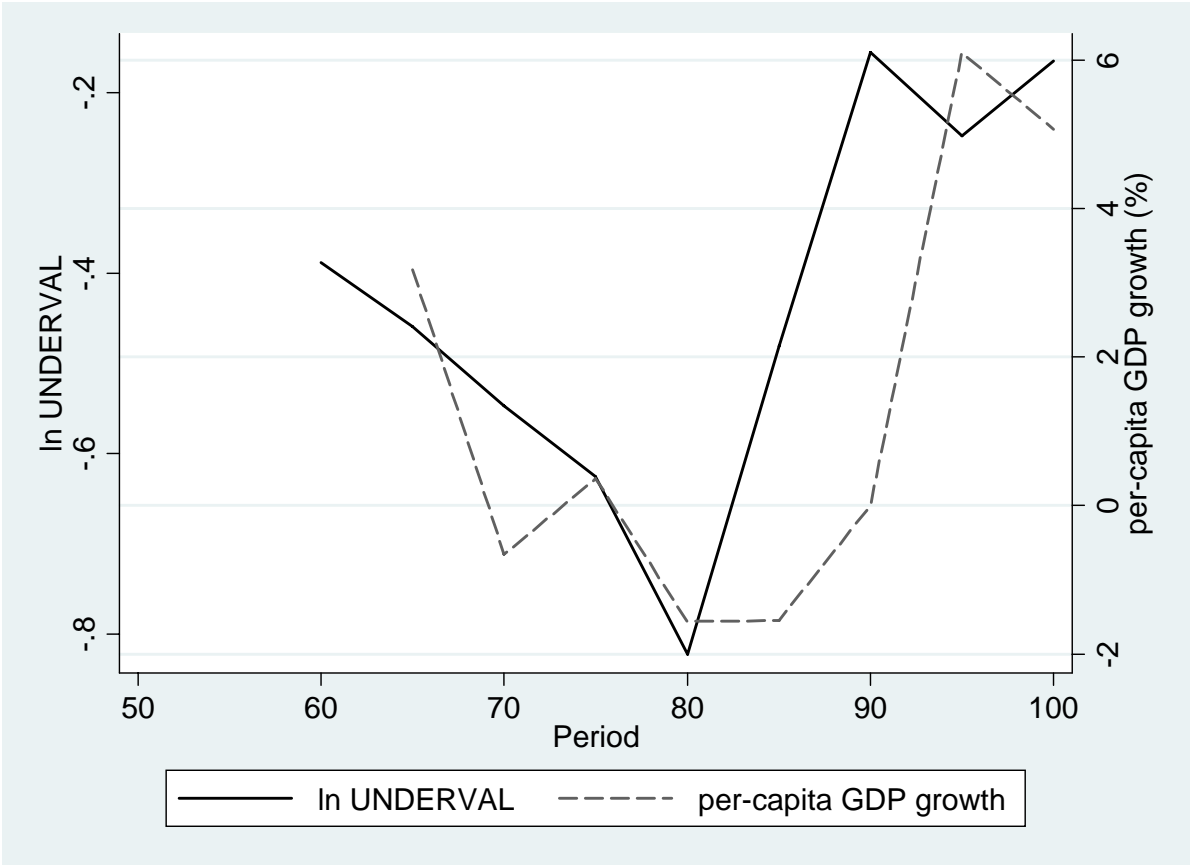


Figure 7: Mexico: Undervaluation and economic growth

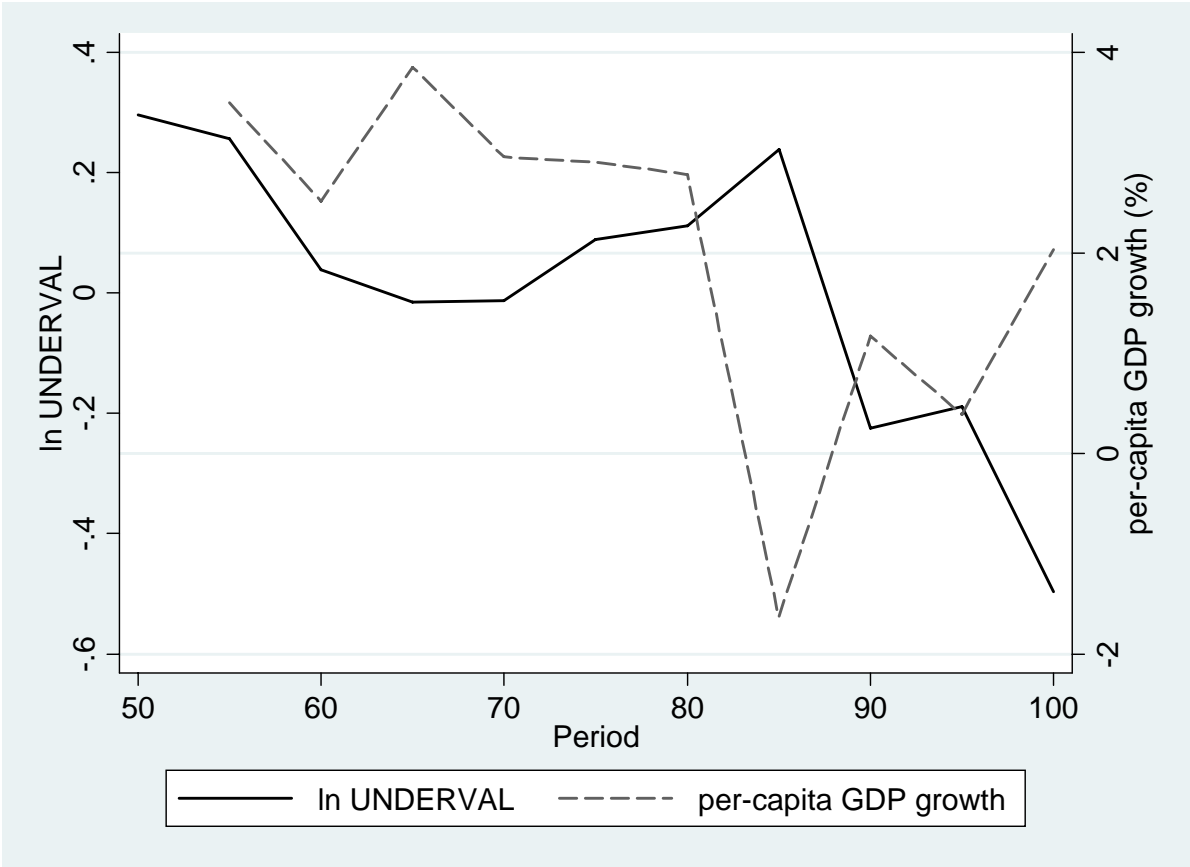


Figure 8: Distribution of $\ln \text{UNDERVAL}$

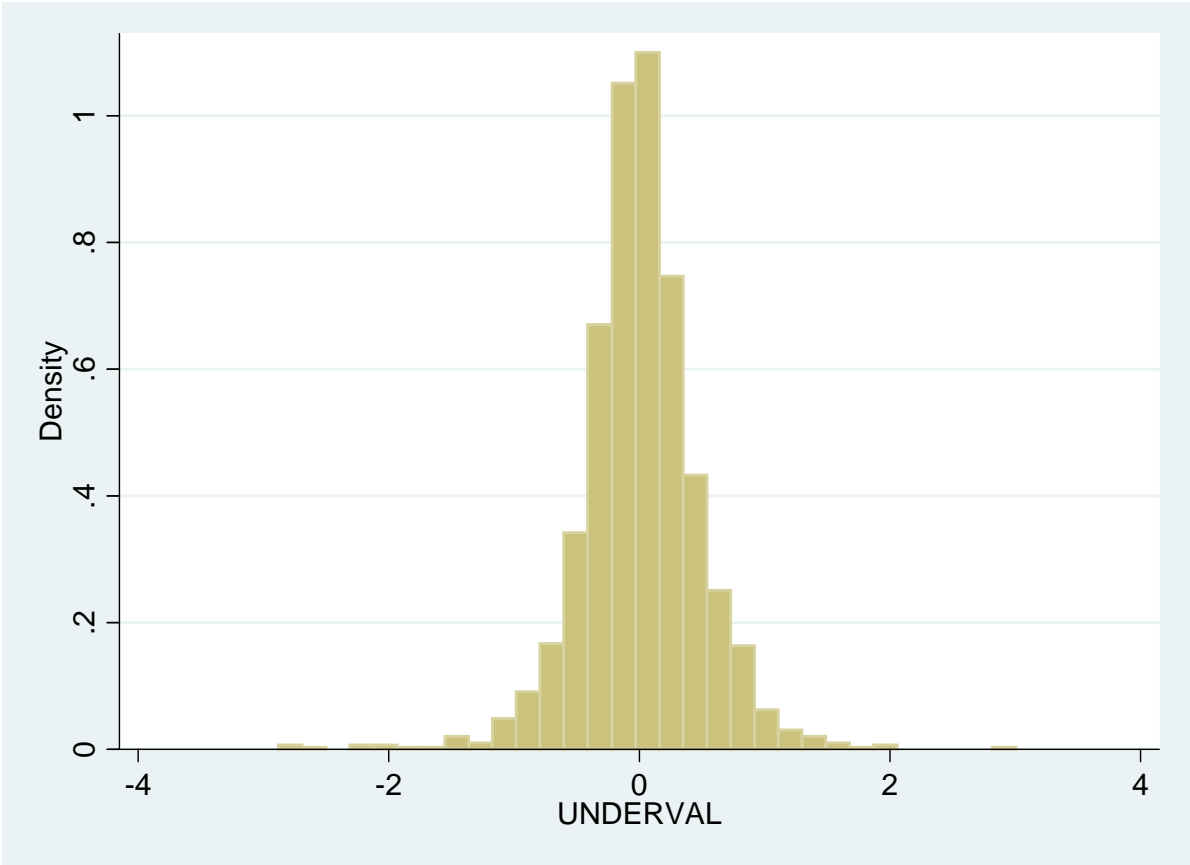


Figure 10: Growth accelerations and *UNDERVAL*

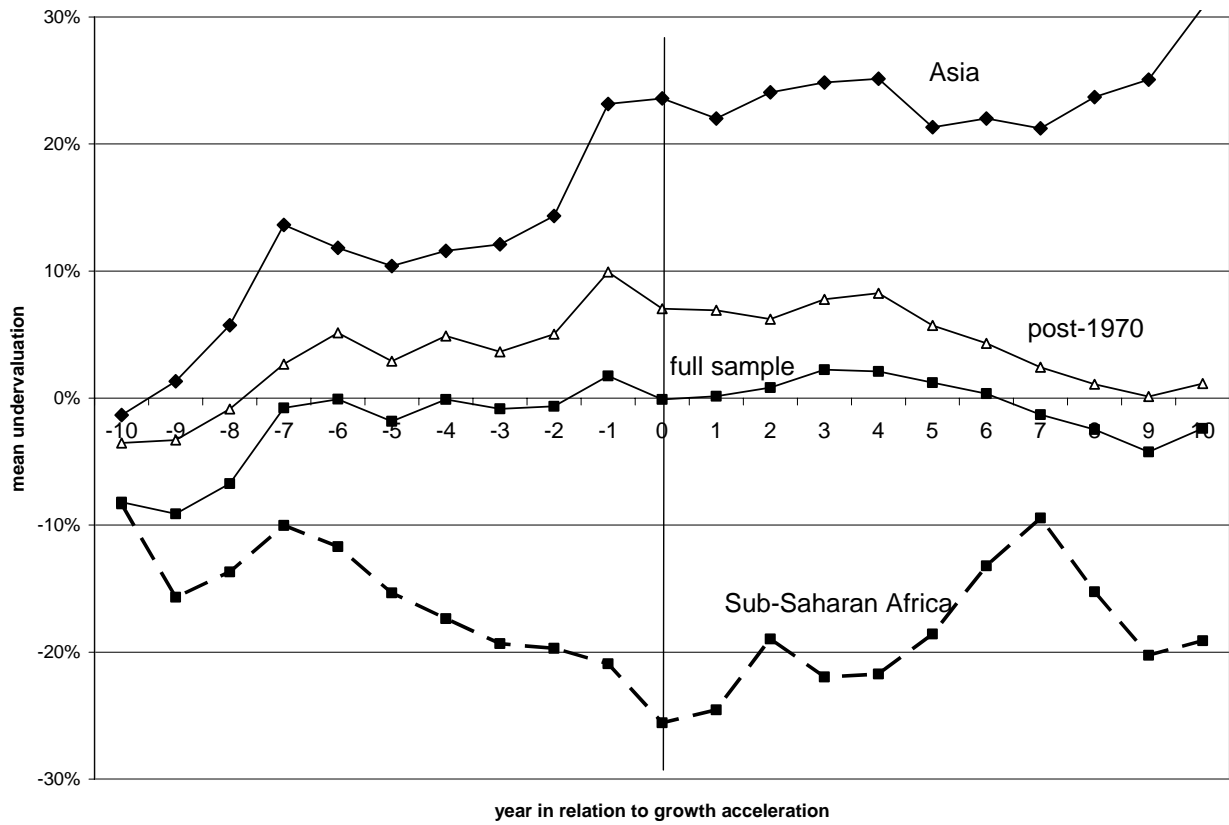


Figure 11: Undervaluation as a second-best mechanism for alleviating institutional weakness

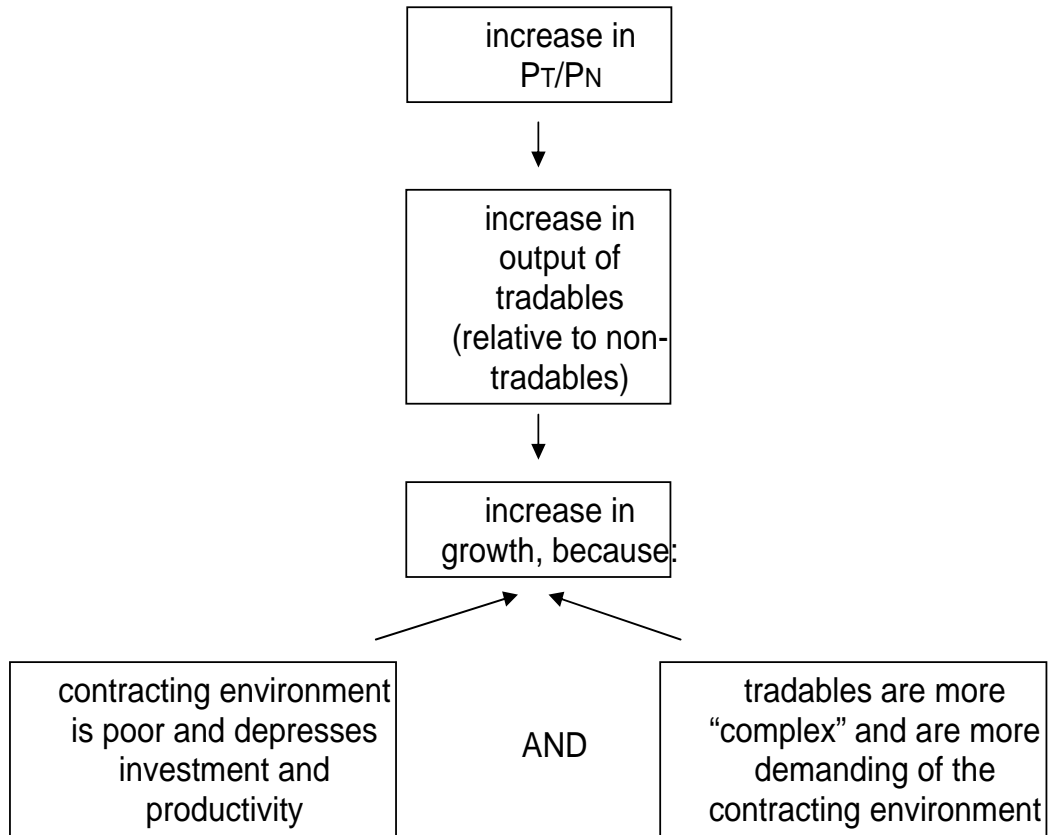


Figure 12: Undervaluation as a second-best mechanism for alleviating market failures

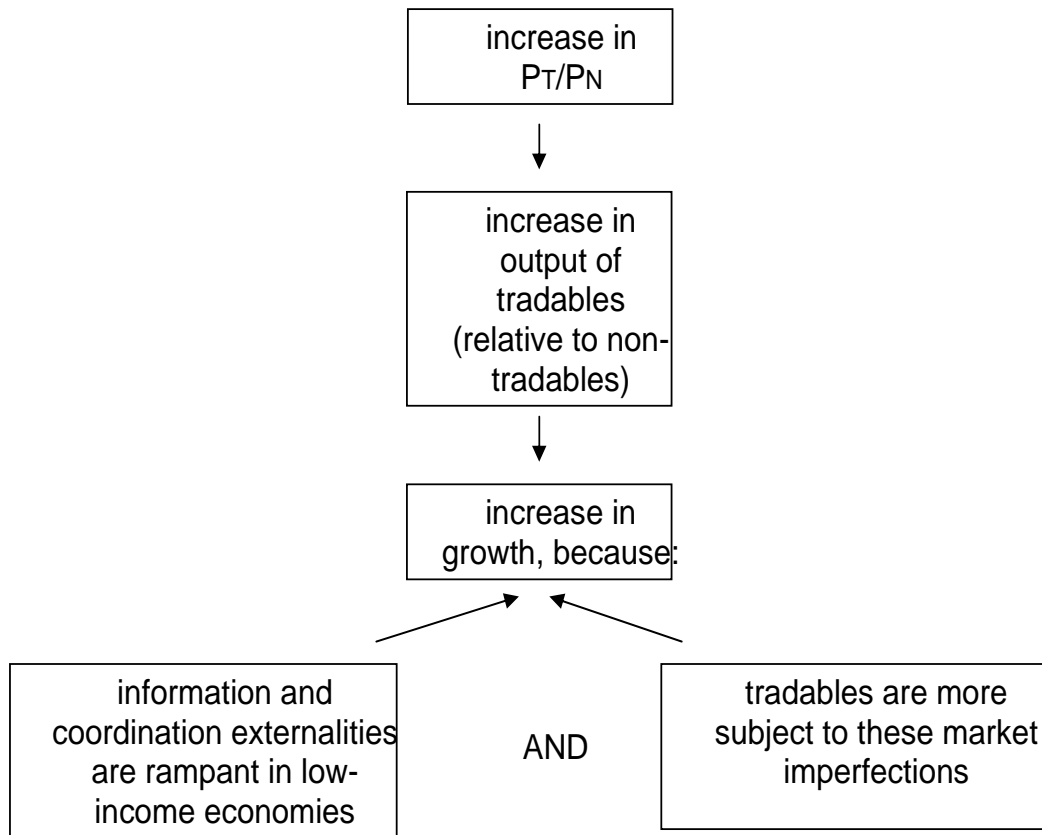


Figure 13: The equilibrium

