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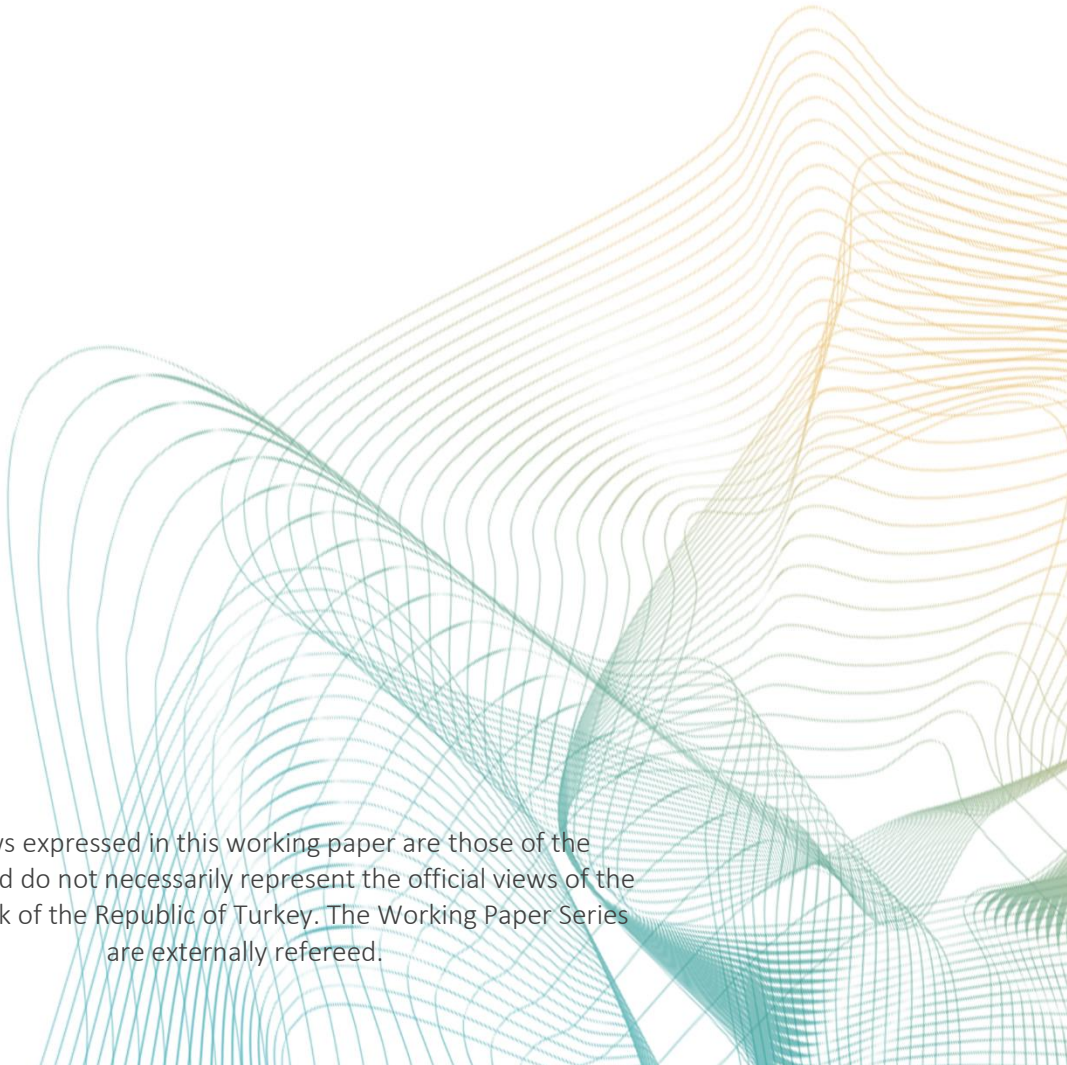

Real Exchange Rate Misalignment and Economic Growth: An Update

Bülent Ulaşan[†]

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Abstract

This paper empirically examines the relationship between real exchange rate misalignment and economic growth by using an updated data set over the sample period 1990-2014 for a large number of countries. Our findings indicate that the measure of real exchange rate misalignment is positively associated with economic growth for the low and middle-income countries whereas no significant relationship between these two for richer countries, implying the more overvalued the currency is over the long run, the lower the long-run growth rate of per capita income in developing countries. A plausible interpretation of this finding is that following the financial liberalization, large capital inflows and lending boom lead to appreciation of real exchange rates in the majority of developing countries. Prolonged real appreciation may result in lower long-run growth because of two channels: first, by changing resource allocation in favour of nontraded-goods sector it may reduce the long-term growth prospects; and second, by promoting private debt denominated in foreign currency it makes economy more vulnerable to external shocks, that is due to contractionary balance-sheet effects, a sudden and sharp real depreciation, which often happens in the boost cycle, may have a negative effect on output and growth.

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Key words: Economic Growth, Real Exchange Rate, Cross-Country Growth Regression.

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Non-technical Summary

The deviations of the real exchange rate from its equilibrium values have been an important issue in international macroeconomics, especially in the context of economic growth. This issue drew renewed interest recently due to long-standing weak economic growth and currency wars in the aftermath of the Global Financial Crisis. The objective of this study is to contribute this literature by using an updated data set over the sample period 1990-2014 for 150 countries. To do so, we construct a measure of real exchange rate misalignment as the deviation of real exchange rate from Purchasing Power Parity and adjust this variable for per capita income to take into account the Balassa-Samuelson effect.

Our findings indicate that the measure of real exchange rate misalignment is positively associated with economic growth for the low and middle-income countries whereas no significant relationship between these two for richer countries, implying that prolonged real overvaluation of national currency has a detrimental effect on long-run economic growth in developing countries. Our results are broadly in line with previous empirical studies on the topic and shows that maintenance of a competitive real exchange rate promotes economic growth in the long run.

In the literature, it is theoretically accepted that a competitive real exchange rate promotes economic growth by expanding tradable goods sector and making export more competitive in an open developing country. The key point is that determining relative price of tradables with respect to nontradables, real exchange rate is crucial for industrialization and thus for capital accumulation and productivity improvement in an economy, especially in the long run. In this manner it is possible to say that the exchange rate acts as a type of industrial policy. Our main policy recommendation therefore for developing countries is to avoid periods of prolonged and substantial real appreciation and to keep their real exchange rates at a competitive level.

Although our findings highlight the importance of a competitive real exchange rate for economic growth and development in the long run, this does not necessarily imply that a competitive real exchange rate by itself boost economic growth. Rather, it is a necessary but not sufficient condition for industrialization, exports and hence economic growth in developing countries, that is a competitive real exchange rate policy calls other complementary policies. From this perspective, a plausible policy recommendation is that the initial reforms aiming at an appropriate investment climate are crucially important.

1 Introduction

The relationship between real exchange rate and economic growth has been always an important issue in international macroeconomics since the days of mercantilism. However, theoretical works on the topic have received considerable attention only since the end of 1990s. By addressing the relation of real exchange rate directly with investment and growth, several theoretical models have been suggested and the claim that a stable and competitive real exchange rate is crucial to promote economic growth in developing countries has received considerable attention in this period. For instance, a competitive exchange rate policy is one of the original ten guidelines of the Washington Consensus. At the same time, many empirical cross-country studies, mainly focused on 1970-2000 period, provide evidence supporting this claim. The importance of a competitive real exchange rate for economic growth has become especially more apparent in recent years due to the longstanding weak economic growth performance, currency wars across countries and the tendency towards inward-oriented protectionist trade policies in the world economy in the aftermath of the Global Financial Crisis between 2007 and 2009.

The objective of this study is to contribute this literature by using an updated data set over the sample period 1990-2014 for 150 countries. We prefer this period because of three reasons: first, this period coincides with capital account liberalization in the majority of developing countries; second, due to the data availability, our empirical analysis is based on a large sample of countries with respect to the previous empirical studies on the topic; and third, our sample period includes the Global Financial Crisis.

In our empirical analysis, we follow the conventional approach in the literature and construct a measure of real exchange rate misalignment as the deviation of real exchange rate from Purchasing Power Parity and adjust this variable for per capita income to take into account the Balassa-Samuelson effect. Then, we evaluate the link between real exchange rate misalignment and economic growth in the framework of augmented Solow growth model relying on three-factor Cobb-Douglas production function. We also check whether our results are driven by outlying countries and carry out our empirical investigation by employing robust estimators as well as ordinary least squares.

The empirical findings indicate that the measure of real exchange rate misalignment is positively and significantly correlated with economic growth in low and middle-income sample, that is real overvaluation of national currency has a detrimental effect on economic growth in developing countries during the sample period. We further evaluate this result across two sub-

periods, namely 1990-2004 period and 2005-2014 period. In the period 1990-2004, the first phase of financial liberalization across developing countries, we find that our measure of real exchange rate misalignment is negatively and significantly associated with growth for all countries. This finding is stronger and more robust in the sample of low and middle-income countries. However, the coefficient estimate of real exchange rate misalignment turns positive again for all countries in the 2005-2014 period, showing that growth promoting effect of overvalued currency is temporary. The last finding also implies that the contractionary effect of the recent Global Financial Crisis is higher and recovery after the slump is slower in countries with the overvalued currencies.

Our main finding has long been recognized in the literature,[1] and can be explained as follows: After the financial liberalisation capital inflows and lending boom in developing countries cause real appreciation of their currencies which in turn leads to misallocation of resources and financial vulnerability.[2] Misallocation of resources arises from the profit squeeze in tradable sector as the real exchange rate is the relative prices of tradables in terms of nontradables. Put differently, a real exchange rate appreciation may render competitiveness in traded-goods sectors, particularly in manufacturing and nontraded-goods sectors become more profitable for production and capital accumulation.[3] A real exchange rate appreciation results in lower growth in the long-run as manufacturing is more successful in terms of productivity growth, human capital accumulation and exporting.[4]

Financial vulnerability may arise from the presence of unhedged-foreign-currency-denominated debt in private sector during the lending boom. Since an overvalued currency encourages nontraded-goods sector as mentioned above, this sector grows faster than traded-goods sector and accumulates higher level of debt stock denominated in foreign currency.[5] The currency mismatch in private-sector balance sheet is magnified as foreign-currency- denominated earnings is more limited in nontradable sector with respect to traded sector.[6] In short, a prolonged-overvalued currency may increase financial vulnerability by promoting foreign-currency-denominated borrowing in private sector,

[1]The studies by David Dollar (1992) and Dani Rodrik (2008) are prominent examples in the literature.

[2]Calvo et al. (1993), Rodrik (1998), Bresser-Pereira (2010), Ros (2015).

[3]See, for instance, Ros and Skott (1998), Razmi et al. (2012), Gala (2008), and Ros (2015).

[4]Corden and Neary (1982), Corden (1984), Matsuyama (1992), Sachs and Warner (1999) are few examples amongst others.

[5]Schneider and Tornell (2004).

[6]Chang and Velasco (2001).

especially in nontraded ones. A sudden depreciation of domestic currency as a result of an external shock deteriorates the private-sector balance sheet and thus has a negative effect on output and growth in developing countries.[7] Our main policy recommendation therefore for developing countries is to avoid periods of prolonged and substantial real appreciation and to keep their real exchange rates at a competitive level.

The paper is structured as follows. The next section, Section 2 reviews the literature on the relationship between economic growth and real exchange rate. Section 3 constructs a measure of real exchange rate misalignment using Penn World Table data on a large sample of countries. Section 4 illustrates the augmented Solow growth model and data for our empirical investigation. Our findings are presented and discussed in Section 5. Finally, Section 6 concludes.

2 Literature Review

2.1 What Does the Theory Tell Us?

Although the theoretical literature on real exchange rate equilibrium dates back to the 1960s, theoretical works on the effect of real exchange rate misalignment on economic growth, especially in the long-run, have emerged since the end of 1990s. We evaluate the theoretical literature under four grounds in what follows.

2.1.1 Export-led Growth

The early theoretical literature assesses the role of real exchange rate misalignment on economic growth in the framework of *Export-led Growth Strategy*. Since the beginning of the 1970s, economists have argued that exports promote the rate of economic growth by extending the market size, inducing technology and increasing productivity.[8] According to export-led growth strategy, the price of exporting goods and services should be attractive to shift resources into their production. In doing so, one condition is that exchange rate should be competitive, that is it does not vary around an equilibrium level, neither overvalued nor undervalued in a persistent way.

In this respect, discouraging exports, overvaluation of national currency is obviously harmful for economic growth. For instance, Krueger (1998) argues

[7] Eichengreen and Hausmann (1999), Frankel (2005).

[8] This argument is based on the learning-by-exporting hypothesis, such that exporters of developing countries may increase productivity as a result of contact with their foreign counterparts. See, for instance, Balassa (1989), Falvey and Yu (2005), amongst others.

that many developing countries followed fixed exchange rate regimes during their import-substitution-industrialisation period to make imports of capital goods cheaper and so to increase investments. The result was real appreciation of national currency, exchange rate control regimes and a considerable bias against exporting sectors.

Another important result emphasised by the early literature is that fixed exchange rate regimes create a high level of black-market premium acting as a tax on exports. Many studies, such as Lee (1993), Rodrik and Rodríguez (2000), Easterly (2005), and Ulaşan (2014) find that the negative association between black-market premium on exchange rate and growth is strong and statistically significant.[9]

2.1.2 Industrialization

Interest on the effect of real exchange rate on economic growth has accelerated considerably since the end of 1990s and by addressing the relation of real exchange rate directly with investment and growth, several theoretical models have been suggested in this period. These models in essence assess the real exchange rate-growth nexus in the framework of industrialisation. In other words, they seek the channels through which the real exchange rate affects the industrial production, the engine of economic growth.[10]

Ros and Skott (1998) provide a formal model which investigates the dynamic implications of the shift in relative prices between tradables and nontradables by assuming constant or decreasing returns to scale in the nontraded-goods sector and increasing returns in the traded-goods sector. These authors show that in the presence of sluggish adjustment in real wages, trade liberalization leads to real overvaluation of domestic currency by reducing domestic prices of tradables. This decreases the profitability and thus capital accumulation in traded-goods sector. Consequently, after opening up to international trade, traded-goods sector contracts whereas nontraded-

[9]Rodrik and Rodríguez (2000) and Ulaşan (2014) argue that a high level of black-market premium indicates macroeconomic imbalances rather than restrictive policies on international trade.

[10]There are two important reasons why industrialization is key element for economic growth: first, it is obvious that differently from many service sectors, industrial sector is subject to international trade; second and more importantly, industrial sector, particularly manufacturing is much more subject to increasing return to scale, to learning-by-doing, and to technological spillovers generated through research and development than the traditional sectors such as commodity or agriculture (as indicated by Matsuyama (1992) and Sachs and Warner (1999)) and/or the positive externalities from traditional sectors are less than those from manufacturing (as pointed out by Corden and Neary (1982) and Corden (1984)).

goods sector expands and economy may be settled an equilibrium corresponding a lower level of living-standards. According to Ros and Skott (1998), this is a particularly serious problem in less-developed countries if the trade liberalisation is not accompanied by real exchange rate devaluation,[11] that is the contraction of traded-goods sector may be dramatic and permanent.[12]

Frenkel (2004) and Frenkel and Ros (2006) emphasise the effect of real exchange rate on the employment performance. According to these authors, one of the mechanisms by which real exchange rate affects the employment is *development channel*. This channel concentrates on the role of real exchange rate on economic growth and thus on the generation of new employment possibilities. The development channel emphasises that a competitive real exchange rate is key to promote to profitability in traded-goods sector. Put differently, a competitive real exchange rate policy plays an important role to boost the incentives for investing and expanding production and employment in traded-goods sector since this sector is more dynamic with respect to the rest of the economy in terms of increasing returns to scale and positive externalities as mentioned before.

Porcile and Lima (2010) develop a growth model based on the balance-of-payments constraint. The key assumption in this model is that all capital goods are imported from abroad, that is capital accumulation and thus economic growth are directly determined by the country's exports. Therefore, the equilibrium level of the real exchange rate influences the rate of long-run economic growth, particularly developing countries such as those in Latin America as the exports are a positive function of real exchange rate.

A similar theoretical analysis is carried out by Razmi, Rapetti and Skott (2012). These authors set up a small open economy with two sectors; a modern tradable sector and a nontradable traditional sector. Akin to Porcile and Lima (2010), all investment goods are imported and the production of the modern sector is used for either domestic consumption or exports. Since the need for trade balance puts a limit on the sustainable levels of aggregate demand, given a level of trade balance, an increase in the real exchange rate ambiguously raises economic growth because of two reasons: first, it

[11] In the right words a large or sharp real depreciation. The terms devaluation (revaluation) and depreciation (appreciation) are often used interchangeably in the literature although the former is indeed belong to the Bretton Woods system characterized by fixed exchange rates.

[12] As pointed out by Ros and Skott (1998), in the literature the effect of trade liberalisation on economic growth and development is assessed by focusing on resource allocation and the relative prices within the tradables. However, trade liberalization obviously affects the relative prices between the traded and nontraded-goods sector and the changes internal competitiveness of tradables. Therefore, by attempting to fill the existing gap on the topic, Ros and Skott (1998) is an important contribution to the literature .

shifts domestic consumption toward nontradables and thus releases a greater proportion of output in traded-goods sector for exports; and second it also raises profitability and thus investment in traded-goods sector.

According to the theoretical studies discussed above, the real overvaluation of national currency has a negative impact on the long-run economic growth by reducing profitability in traded-goods sector, especially in manufacturing. By the same token, one can claim that real undervaluation may promotes economic growth. However, these model do not provide any argument on that undervaluation boosts growth.

In this respect, by emphasizing the fact that economic growth is higher in most countries with more undervalued national currencies, Rodrik (2008) proposes a theoretical framework in favour of undervaluation to promote economic growth and development in developing countries. His theoretical analysis is based on two premises. First, institutional quality is poor in most developing countries and the adverse impact of institutional weakness on tradable sector is stronger with respect to nontradables. Second, tradable sectors suffer much more from the market failures than the nontradables in these countries. An increase the relative price of tradables to nontradables, and thus in the level of profitability in tradables eliminates their disadvantages stemming from institutional weakness and market failures. Therefore, according to Rodrik (2008), undervaluation promotes economic growth in developing countries.

A similar theoretical analysis is carried out by Gala (2008). Gala (2008) argues that exchange rate level affects investment and productivity, and thus the long-run economic growth through two channels. According to the first channel, level of exchange rate determines real wages and thus aggregate consumption, savings, investment and foreign debt.[13] In the absence of policies aiming competitive exchange rate, capital inflows lead to real appreciation of national currency and then artificailly higher levels of real wage and salary. Implications of higher real wages are twofold: first, high real wages are obviously a cost disadvantage from the perspective of export-led growth strategy; second and more importantly, by stimulating consumption, high real wages reduce aggregate savings and investment. Put differently, foreign debt finances domestic consumption and in contrast to common view, foreign savings are not replaced with domestic savings as assumed in conventional economic theory. We shall return to this issue in the next subsection.

The second channel suggested by Gala (2008) is very similar to Rodrik's (2008) analysis. Employing an investment function based on capacity uti-

[13]As indicated by Bresser-Pereira (2010) and Ros (2015) the exchange rate has a strong effect on real wages and salaries.

lization and on profit margin, Gala (2008) shows that real overvaluation of national currency decreases profitability and thus investment in tradable sector whereas undervaluation stimulates profitability and capital accumulation in this sector.

Moreover, Gala (2008) links his theoretical arguments to productivity level, the key element for the long-run economic growth. The level of real exchange rate determines the level of profitability in most manufacturing industries as the level of real exchange rate by definition reflects the relative price of tradables to nontradebles. In this setting, a developing country with the excessive overvalued currency is in danger of hindering reallocation of resources from traditional low-productivity sector to manufacturing sector and/or of shutting potentially high-productivity industries. Therefore, overvaluation leads to a decrease in the level of overall productivity in the economy. The opposite is likely true in a developing country with a competitive exchange rate or undervalued currency.

Finally, under the small open economy assumption, Ros (2015) develops an analytical framework for a typical developing country in which a single tradable good is produced and firms face a perfectly elastic demand for exports. Therefore, firms do not increase the production in response to a rise in domestic demand given a particular level of the real wage; rather they adjust demand conditions by reducing the level of exports.

In this setting, by reducing the real wage in traded-goods sector and thus raising profitability, an increase in real exchange rate shifts the economy toward a new equilibrium path with a higher growth rate and a lower real wage (hence a higher level of employment). In the absence of technological progress, this happens in the short and medium run, however. As a consequence of dynamic adjustment in real wages and employment, the economy returns to its initial position. However, a real devaluation in domestic currency with technological progress ambiguously brings the economy to a long-run equilibrium with a higher rate of economic growth and of employment. The reason is that after the real devaluation, profitability and hence capital accumulation in the traded-goods sector increase as a result of not only the decrease of real wages but also of the increase of level of productivity during the transition period. In short, in the presence of irreversible technological progress, a real devaluation has permanent effect in favour of growth and employment.

2.1.3 Allocative Efficiency: Growth with Foreign Savings

The recent literature has also emphasized the role of foreign finance in developing countries on real exchange rate and thus on economic growth. Inspiring

by the predictions of neoclassical growth theory, the *Allocative Efficiency* hypothesis asserts that capital inflows to developing countries stimulate investment and growth by reducing the cost of capital and bring these countries to higher level of material well-being.[14] According to the Allocative Efficiency approach, also known as *Growth with Foreign Savings*, developing countries should liberalize their capital account to benefit from the capital transfers of capital-rich developed countries for economic growth and development.[15]

However, this strategy is criticized on two grounds. First, some scholars, such as Calvo et al. (1993), Rodrik (1998), argue that the financial markets are fundamentally different from the markets for goods and services and thus the theoretical predictions of Allocative Efficiency view do not hold true in reality. The reason is that many market failures such as those stemming from asymmetric information and moral hazard are prevalent in financial markets. Moreover, financial markets are disposed towards panic, contagion and boom-and-bust cycles and hence international capital flows are considerably less certain and predictable than the international trade in goods and services.

The second and from the point of our discussion the more important criticism is that foreign capital inflows into developing countries goes along with the appreciation of domestic currency and hence artificially higher salaries (Bresser-Pereira and Gala (2008), Bresser-Pereira (2010)). It is therefore likely that foreign capital inflows boost domestic consumption rather than investment, especially if the borrowing countries are highly indebted and are not able to provide investment opportunities with expected profit rate higher than the basic interest rate.

From the standpoint of monetary policy in developing countries, two key observations are striking since the beginning of 1990s, the period of capital account liberalization. First, the priority of monetary policy in developing countries, especially those in Latin America has been price stability and inflation-targeting policy has been took into practice by most of them. It is possible to say that these countries have successfully and sharply reduced their high inflation in this period, yet the exchange rates were generally kept in low levels to control inflation as the nominal exchange rates act as a nominal anchor for prices (Bresser-Pereira (2010)). Therefore, capital flows

[14] One of the well-known predictions of the neoclassical growth model developed by Solow (1956) is that we should observe differences in rates of capital return across countries, that is the marginal return of capital and thus profit rates and real interest rates should be higher in developing countries as these countries has smaller stock of capital with respect to the capital-abundant developed countries. Therefore, capital should be keen to move from developed countries to developing countries in the presence of free capital mobility and liberalizing the capital account provides more efficient capital allocation across countries.

[15] See, for instance, Obstfeld (1998), Fisher (1998), and Summers (2000) amongst others.

toward developing countries stimulate domestic demand on the one hand, also help them to fight against inflation on the other hand.[16]

There is no doubt that a policy to control inflation in the short run must keep an eye on the nominal exchange rate as pointed out by Chang and Velasco (2000). However, the major caveat in this story is that keeping exchange rate in low level to reduce inflation with the help of capital inflows, may eventually leads to de-industrialization as mentioned before and equally importantly intensifies the persistence and degree of exchange rate pass-through over time, that is the economy depends heavily on foreign capital not only to promote economic growth but also to establish price stability. Moreover, it is likely that this kind of disinflation process goes along with the high real interest rate, detrimental for investment and fiscal balance to attract foreign capital in the form of foreign direct investment. It is highly likely that under the pegged exchange rate regime, controlling inflation via exchange rate channel will raise real interest rate much more than the floating exchange rate regime as the central bank sterilizes the capital inflows to reduce the quantity of currency in circulation. On the other hand, the tendency towards overvaluation under an inflation-targeting policy with a floating exchange rate regime is likely to be much stronger.

The second observation is that capital account liberalization has made monetary policy in developing countries increasingly more complex and difficult. The reason is that by facilitating the access to international capital markets and improving new financing instruments financial liberalisation has caused not only appreciation of domestic currency but also a large debt denominated in foreign currency in these countries as the ability of borrowing from abroad in their own currency is considerably limited.[17] Therefore, developing countries have become more vulnerable to adverse external shocks such as a sudden stop of capital inflows due to increasing currency mismatch between their assets and liabilities.[18]

In the presence of unhedged debt denominated in foreign currency, by deteriorating the balance sheets of financial and nonfinancial firms a real de-

[16] As argued by Svensson (1999), in an open economy, nominal exchange rate affects inflation via two channels: first, it directly affects domestic prices of imported goods and thus inflation; and second, under sticky prices determining real exchange rate and hence the relative price between domestic and foreign goods, nominal exchange rate indirectly affects both domestic and foreign demand for domestically produced goods and hence inflation.

[17] This is known as the "original sin". See, Eichengreen and Hausmann (1999).

[18] Moreover, the borrowers in financially liberalized developing countries may consider debt-denomination mismatch as an optimal behaviour since they expect systemic bailouts and this magnifies their exposure to external shocks as argued by Rancière and Tornell (2016).

preciation is likely to be contractionary. Under these circumstances a typical monetary policy avoids a real depreciation not only for reducing exchange rate pass-through but also for preventing deleterious balance-sheet effects. However, this strategy could be costly in terms of long-run economic growth as the excessive appreciation leads to de-industrialization by reducing profitability of traded sector (as we have already noted in the previous section) and/or by causing the Dutch disease (as we shall discuss in the next section). In this point, it is worth emphasising that a financially liberalised developing country with a competitive real exchange rate policy may manage to eliminate adverse balance-sheet effect as a competitive real exchange rate promotes traded-goods sector.[19]

2.1.4 The Dutch Disease

In the framework of industrialization, another important channel between real exchange rate misalignment and economic growth is the *Dutch disease*. It is well-known that Dutch disease originally refers to problem meaning that natural resource abundance or a resource boom leads to contraction of the tradable-nonresource sector, particularly industry and thus may cause a slowdown in the long-run economic growth. However, as argued by Palma (2005), the Dutch disease does not necessarily arise from the presence of natural resource abundance and in a broader sense can be applied to two more situations leading to de-industrialization: First, the development of an important service-export sector, particularly financial sector (as in Switzerland, Luxembourg, Singapore, and Hong Kong-China) and tourism sector (as in Greece, Cyprus and Malta). In other words, this phenomenon can be occurred in countries generating a significant level of trade surplus in services and thus able to cover their trade deficit in manufacturing.

Second, changes in economic policy. Some Latin American countries have been contaminated with the Dutch disease as a result of drastic changes in their economic policies since the around 1990. Brazil and Southern Cone countries (Argentina, Uruguay and Chile) were the most industrialized countries in Latin America. However, after the openness to international trade

[19]For instance, Frenkel (2004) argues that countries with higher trade/GDP or export/GDP ratios are less prone to default. In addition, a sudden stop is less contractionary and recovery is faster in the economies traded more. Schneider and Tornell (2004) point out that traded-goods and nontraded goods sector behave quite differently during the boom-bust periods, that is nontradable sectors typically grow faster than tradable sectors during the boom episode, contract more in a crisis and it takes a longer time to recover after the slump. Moreover, most bad debts go to nontradable sector. Chang and Velasco (2001) develop a model implying that most adverse balance-sheet effects arise from mainly nontraded-goods sectors.

and capital account liberalization, Brazil and Southern Cone countries have experienced a high level of de-industrialization as indicated by Ros (2015). The real exchange rate appreciation as a result of large capital inflows and emphasis on price stability led them to de-industrialization during that period. Moreover, the surge in commodity prices, especially as a result of commodity demand from fast growing countries such as China during the 1990s and early 2000s intensifies the effect of the Dutch disease in Brazil and Southern Cone and these countries have become important commodity exporters.

In summary, the adverse effects of Dutch disease on manufacturing and thus on long-run economic growth may arise from the expansion of primary or service exports. Expansion of non-manufacturing exports causes two impacts on the economy: first, it directly crowds out manufacturing in GDP (direct effect); and second, increasing the relative price of nontradables and/or causing trade surplus, it leads to a decline in real exchange rate, which in turn magnifies the degree of Dutch disease.

Therefore, a competitive real exchange rate can avert the Dutch disease, an important reason of premature de-industrialization process in many middle and high-income developing countries. For instance, Palma (2005) points out that countries such as China, India and Turkey, have liberalized their international trade regimes and financial systems and experienced a large capital inflows as in Brazil and Southern Cone since 1990, yet these countries have been able to neutralize their real exchange rate to more or less extent and managed to escape de-industrialization. In this point, it is worth reminding that the Dutch disease does not seem a serious problem during the boom period in nonmanufacturing sector. The problem starts when the boom period ends as is the case with experiences of many Latin American countries after the global financial crisis of 2007-2009 (Ros (2015)).

2.2 What Does the Evidence Tell Us?

As mentioned before, the early theoretical studies assess the role of real exchange rate misalignment in the framework of export-led growth strategy. However, in spite of this fact, the early empirical studies on export-oriented growth generally neglect the role of real exchange rate.

Since the beginning of the 1990s, empirical cross country studies directly focused on the relationship between real exchange rate and economic growth and many studies on the topic have blossomed. Almost all studies in this period conclude either negative associations between real exchange rate misalignment and growth or positive correlations between real undervaluation of the currency and growth. For instance, Cottani et al. (1990) investigate

the relationship between economic growth and real exchange rate behavior for a cross-section of developing countries over the 1960-1983 period and find a strong negative correlation between per capita GDP growth and two measures of real exchange rate, implying that economic polices stabilizing real exchange rate around a realistic level is beneficial for economic growth.

Interest for the real exchange rate in the empirical growth literature has particularly raised from the contribution by Dollar (1992). Dollar (1992) developed a measure of outward orientation of economy based on two separate indices namely real exchange rate distortion and real exchange rate variability. By using these indices, Dollar (1992) concludes that his outward orientation measure is highly correlated with per capita GDP growth in a large sample of 95 countries for the period 1976-1985 and suggests liberal trade policies for better economic performance. The following views are belong to Dollar (1992, p.540): "[T]hese results strongly imply that trade liberalisation, devaluation of the real exchange rate, and maintenance of a stable real exchange rate could dramatically improve growth performance in many poor countries."

Razin and Collins (1997) construct a new measure of real exchange rate misalignment based on both developing and developed countries and find important non-linearities in the relationship between misalignment and growth. According to their findings, only very high level of appreciation of national currency is associated with slower growth while moderate depreciation is associated with faster growth.

Polterovich and Popov (2003) find strong empirical evidence that accumulation of foreign exchange reserves leads to persistent depreciation of national currency in real terms and thus promotes export-led growth.

Hausmann, Pritchett and Rodrik (2005) investigate periods of rapid growth for a sample of 110 countries over the years between 1950 and 1997 and conclude that most growth accelerations are correlated with increases in investment and trade and with real depreciations. Similarly, Berg, Ostry and Zettelmeyer (2008) identify the rapid growth episodes for 140 countries over the period 1970-2006. Their findings indicate that growth duration is positively correlated with export orientation (with higher level of manufacturing exports, greater openness to FDI and avoiding real overvaluation of currency) as well as the degree of income equality and democratic institutions.

Emphasising the role of foreign capital on economic growth in developing countries, Prasad et al. (2007) show that there is a significantly positive association between current account surplus and economic growth. These authors also show that by leading to overvaluation of domestic currency, foreign capital has a detrimental effect on manufacturing exports and overall growth.

Rodrik (2008) investigates the relationship between real exchange misalignment and economic growth for a sample of 184 countries and conclude that undervaluation relative to PPP is positively and significantly associated with economic growth. His result is particularly strong in developing countries and robust to different estimation techniques and different measure of real exchange rate misalignment. The studies by Gala (2008) and Berg and Miao (2010) reach similar results and confirm the findings of Rodrik (2008), that is undervaluation of national currency is good for economic growth

MacDonald and Vieira (2010) investigate the link between real exchange rate misalignment and economic growth by employing panel data models (both fixed and random effects) with the different model specifications and samples over the period 1980-2004 and conclude that real exchange rate misalignment positively and significantly correlated with growth, implying that real depreciation of domestic currency stimulates growth.

McLeod and Mileva (2011) simulates a simple two sector open economy growth model derived from Matsuyama (1992) and conclude that a weaker (depreciated) national currency in real terms leads to surge in growth rate as workers move from nontraded-goods sector with slow productivity growth to traded-goods sector subject to more learning by doing. Using a panel data model for 58 countries, these authors also show that a nonlinear relationship between real exchange rate and TFP growth, that is real depreciation of national currency raises TFP and GDP growth up to a point. Mbaye (2013) carries out a similar empirical analysis and finds that real undervaluation substantially stimulates economic growth via productivity channel.

Levy-Yeyati et al. (2013) argue that there is a tendency towards intervening to depreciate the local currency over 1974-2004 period. These authors refer to this phenomenon as *fear of appreciation* and find that real undervaluation of domestic currency contributes to economic growth.

Bussière et al. (2015) asses the link between real exchange rate misalignment and growth using the annual data between 1960 and 2012 for a sample of 68 advanced and developing countries. These authors employ propensity score matching technique to address the problems of endogeneity and selection bias and conclude that real exchange rate appreciations raise economic growth only if appreciations are accompanied by productivity increases, that is without productivity gains appreciation by itself reduces growth in developing countries.

2.3 Summary and Assessment

To sum up, it is possible to highlight two important results from the existing literature. First, theoretically an overvalued currency in real terms has a

detrimental effect on long-run economic growth, particularly in developing countries. Even though this argument does not necessarily imply that real depreciation of national currency is good for economic growth, a stable and competitive real exchange rate appears to be a necessary condition for stable and sustainable economic growth. The key point is that determining relative price of tradables with respect to nontradables, real exchange rate is crucial for industrialization and thus for capital accumulation and productivity improvement in an economy, especially in the long run.

Second, empirical cross-country studies on the link between real exchange rate misalignment and growth have demonstrated that a competitive real exchange rate promotes exports and growth whereas an overvalued domestic currency is mostly associated with poor growth performance. Similarly, growth experiences of individual developing countries since the 1950s show that a fast growth period is generally accompanied by a competitive real exchange rate. For instance, South Korea, Taiwan, Singapore, Uganda, Tanzania, to a lesser extent Argentina and Turkey, and more recently China and India achieved extraordinarily high growth rates by keeping their real exchange rate at a competitive level, or even with undervalued national currency.

Despite these facts, as pointed out by Bresser-Pereira (2010), there is a structural tendency of national currencies toward overvaluation in developing countries during the last thirty years, the period of capital account liberalization. There are three important reasons for this tendency: First, several developing countries, in particular some Latin American countries, catch the Dutch disease due to the boom of natural-resource-intensive exports. Second, most developing countries rely more on capital inflows than before to boost economic growth. Third, main focus of monetary policy in the majority of developing countries, especially those implementing inflation targeting with floating exchange rate, has been controlling inflation through exchange rate channel.

3 Measuring the Real Exchange Rate Misalignment

Assessing real exchange rate misalignment is not an easy task and there is no consensus on measurement of equilibrium exchange rate and exchange rate misalignment in the literature. The most important difficulty is that the equilibrium level of real exchange rate is not observable. However, the common methodology in the literature is measuring real exchange rate mis-

alignment as the deviation from the Purchasing Power Parity (PPP) despite its limitations.[20] In this study, we follow the standard method and construct a measure based on deviation from PPP.

3.1 Methodology

The fundamental building-block of the PPP condition is the law of one price (LOOP), which states that the price of a single good should be equalized in common currency terms across countries. We can write the LOOP in its absolute version as follows:

$$P_{i,t} = S_t P^*_{i,t} \quad i = 1, 2, ..., N \tag{1}$$

where S_t is the nominal exchange rate expressed as the domestic currency price of foreign currency; $P_{i,t}$ is the price of good i in terms of the domestic currency; and $P^*_{i,t}$ is the price of good i in terms of the foreign currency at time t. It is possible to express the absolute LOOP in (natural) logarithmic form:

$$p_{i,t} = s_t + p^*_{i,t} \quad i = 1, 2, ..., N \tag{2}$$

where lower-case letters denote logarithms. Summing over all prices, we can derive the absolute PPP condition:

$$s_t = p_t - p^*_t \tag{3}$$

From equation (3), the real exchange rate can be easily defined in logarithms as follows:

$$r_t = s_t - p_t + p^*_t \tag{4}$$

Equation (4) can be viewed as a measure of the deviation from PPP. In this context, one can ask the question of does PPP hold in reality? Answering this question is obviously beyond the scope of this paper.[21] It is, however,

[20] As argued by many authors, such as Edwards and Savastano (1999), MacDonald and Vieira (2010) and Chong et al. (2012) measuring real exchange rate misalignment based on deviations from PPP is likely misleading in the short and medium time horizon. Therefore, some studies construct measures relying on deviations of real exchange rate from some other equilibrium levels, such as Behavioral Equilibrium Exchange Rate, General Equilibrium Simulation Models, Fundamental Equilibrium Exchange Rate. One obstacle for applying these alternatives in cross-country growth analysis is data availability. The reader can refer to Edwards and Savastano (1999), MacDonald and Stein (1999), and MacDonald (2007, Chapter 9) for nice surveys on the real exchange rate misalignment.

[21] There is a huge literature on the topic; see, for instance, Rogoff (1996) and Taylor and Taylor (2004) amongst others.

possible to say that absolute PPP does not need hold because of trade barriers and transportation costs.

Even if LOOP always holds, there are greater differences between the relevant price indices. More clearly, if the weights in the price indices differ across countries, absolute PPP does not hold even if LOOP holds. The International Comparison Project, commonly known as *Penn World Table* (PWT), and other projects for calculating PPP exchange rates (e.g. World Bank World Development Indicators) aim to address this problem. These projects attempt to calculate aggregate price levels by using a common basket of goods with the same price-weights across countries over time. Specifically the ICP aims to provide estimates of PPPs over a large time period (since 1950), so a great help in cross-country empirical work. It is, however, worth reminding that data are available for only a few countries for certain time periods, so extensive extrapolation is used, that is the PWT data are partially artificial.

Moreover, considerable differences in price impulses may arise across various goods and services in economy, especially between traded and nontraded-goods sectors. To show this, assume that price index is a geometric average of traded and nontraded-goods prices:

$$\begin{aligned} p_t &= \alpha p_t^N + (1-\alpha) p_t^T \\ p_t^* &= \alpha^* p_t^{N^*} + (1-\alpha^*) p_t^{T^*} \end{aligned} \tag{5}$$

where α is the share of nontraded goods in price index; the p_t^N and p_t^T denote logged values of prices of nontraded goods and traded-goods, respectively. Substituting the last expressions into (4) and re-arranging yields:[22]

$$r_t = (s_t - p_t^T + p_t^{T^*}) - \alpha[p_t^N - p_t^T] + \alpha^*[p_t^{N^*} - p_t^{T^*}] \tag{6}$$

Consider that weights are identical ($\alpha = \alpha^*$) across countries as in PWT, then:

$$r_t = (s_t - p_t^T + p_t^{T^*}) - \alpha[p_t^N - p_t^T] + \alpha[p_t^{N^*} - p_t^{T^*}] \tag{7}$$

As seen from the last expression, real exchange rate is affected not only by changes in the intercountry relative price of tradables, but also by changes in the intercountry relative price of nontradables. Therefore, even if LOOP always holds and price weights in the good basket are identical across countries, reel exchange rate can change as a result of the changes in the relative price of non-tradebles in one country. This argument is closely related

[22]This decomposition of real exchange rate is very common in the literature. See, for instance, Engel (1993), Cheung et al. (2018) amongst others.

the Balassa-Samuelson effect. Balassa (1964) and Samuelson (1964) observe that exchange rates by PPP standards tend to be overvalued in developed countries with respect to those in developing countries and argue that this situation is a result of the productivity differences between two groups, that is developed countries are relatively more productive in tradable-goods sector.[23]

Implications of the Balassa-Samuelson effect are twofold: first, the real exchange rates do not need to adjust their PPP standards in the long run as the relative productivity differences across countries persist over time; and second, a positive association between income and price levels across countries is inevitably observed. The later implication is also related to soul of Penn World Tables and other projects aiming to measure PPP exchange rates across countries. The reason is that these projects calculate aggregate price levels by using a common good basket with the same weights for a benchmark year and then extrapolate them over time according to countries' income levels as noted above. Therefore, the well-known positive cross-country correlation between relative price levels and per capita income levels is a result of not only the Balassa-Samuelson effect but also the nature of cross-country data. The second rationale is commonly referred as the *Penn effect*.

The message of this discussion for cross-country empirical works is clear: One should correct the variations in the price levels resulting from the Balassa-Samuelson and/or the Penn effects while using cross-country data on price levels.

3.2 Data

We collect price level and GDP per capita from PWT Version 9.0 (Feenstra et al. (2015)) to calculate our real exchange rate misalignment measure.[24] Data involve 182 countries over the period 1950-2014 and the share of world population covered is 98.5 percent. In PWT, a country's PPP gives the number of local currency units that are needed to buy a bundle of products worth one dollar in the USA. Dividing the nominal exchange rate (measured in local currency units per US dollar) by the PPP; then gives "the price level" of that country relative to the USA. The incorporation of new PPPs data are from the 2011 International Comparison Program (ICP) and other sources. This means that all variables are now denoted in 2011 US dollars.

[23]This effect suggested by was firstly introduced by Harrod (1933). That is why it is sometimes referred as the Harrod-Balassa-Samuelson effect.

[24]The central element of PWT has always been real GDP per capita. This measure requires two main pieces of information, namely GDP per capita in national currency and PPPs to correct for differences in prices across countries.

In this framework, the PWT reports the real exchange rate (RER), which is referred to as the "Price Level Index (PLI)" as follows:

$$RER_{it} = PLI_{it} = \frac{S_{it}P^*_{it}}{P_{it}} \tag{8}$$

where now P^* and P are actual price levels (and not indices!) for country i at time t.[25]

There are three price levels for each country relative to the USA in the PWT Version 9.0: i) PL_CON: Price level of consumption of households and government; ii) PL_DA: Price level of domestic absorption, (consumption plus investment); iii) PL_GDP^O: Price level of output-side GDP. Simple correlations amongst these prices are almost one (see Appendix 7.C).

We prefer the price level of consumption of households and government in PWT as our measure of real exchange rate. Put differently, real exchange rate is defined as the deviation of nominal exchange rate from the purchasing power parity exchange rate as follows:

$$RER_{it} = PL\_CON_{it} = S_{it}/PPP_{it} \tag{9}$$

where S_{it} is the nominal exchange rate and PPP_{it} is the purchasing power parity with respect to the USA for country i and both expressed as domestic currency units per US dollar. The value of one indicates the equilibrium level of real exchange rate. If RER is less than one, the value of national currency is higher (more appreciated) than its PPP value, implying real overvaluation of national currency. Or, if RER greater than one, the value of national currency is lower (more depreciated) than its PPP value, showing real undervaluation of national currency.

It is useful to express RER in (natural) logarithm for empirical investigation:

$$logRER_i = log(S_i/PPP_i) \tag{10}$$

that is, positive values indicate real undervaluation whereas negative values show real overvaluation of national currency.

3.3 Controlling for the Balassa-Samuelson/Penn-Effect

As mentioned earlier, we should be careful about distinction between observations based on benchmark or interpolated PPP estimates because PPP estimates based on extrapolations using information on national accounts price trends.

[25]Notice that P^* is price level in the USA.

Due to the "Balassa- Samuelson (BS) effect", which predicts that as countries get richer, the prices of nontradable goods tend to be higher, the negative relationship between the log of a country's price level (its exchange rate over its PPP) and the log level of current GDP per capita is highly likely. To take into account the BS/Penn effect, we run the following regression:

$$logRER_{it} = \beta_0 + \beta_1 y_{it} + \tau_t + \varepsilon_{it} \tag{11}$$

where $y_{i,t}$ is GDP per capita in country i at time t, τ_t are year dummies, and ε_{it} is error term.

We estimate this model by pooling OLS over the 1950-2014 period. Column 1 of Table 1 presents the resulting estimate without year dummies. In column 2, we also include year dummies to take control for time effect. We conclude that year dummies are both individually and jointly significant and thus prefer to employ this regression for our measure of real exchange rate misalignment. Moreover, coefficient variation of this regression is considerably higher. As seen, this regression implies a considerable amount of the Balassa-Samuelson effect. The regression result yields a 0.20 coefficient estimate for the price elasticity with respect GDP per capita, that is a 10 percent increase in income level implies a 2 percent decrease in real exchange rate.[26]

The residuals obtained from this regression can be used as the real exchange rate misalignment measure, that takes into account and control for the Balassa-Samuelson effect. More compactly, we can define a measure of real exchanre rate misalignment, RERM as follows:

$$RERM_{it} = logRER_{it} - log\widehat{RER}_{it} = \widehat{\varepsilon_{it}} \tag{12}$$

The sample distribution of our real exchange rate misalignment is presented in Figure 1.

4 Empirical Framework

The neo-classical growth model developed by Solow (1956) has been the workhorse for the cross-country growth empirics aiming to quantify the sources of growth differences across countries. We, therefore, employ the extended version of the Solow (1956) growth model along the lines Mankiw, Romer and Weil (1992) and Barro and Sala-i-Martin (1992) amongst others.

[26]Our estimates for the price elasticity is found to be very close to those estimated by other studies, such as Rodrik (2008), Chong et al. (2012) and Cheung et al. (2018)

Table 1: Estimation of the Balassa-Samuelson/Penn-Effect

	(1)	(2)
log of GDP per capita	-0.312***	-0.195***
	(0.006)	(0.005)
Constant	3.975***	4.040***
	(0.056)	(0.074)
Time dummies	No	Yes
$F-value^a$	-	200.7
Number of observations	9,439	9,439
Adjusted R^2	0.25	0.67

Notes: Pooled time-series cross-section OLS regression for more than 180 countries over the 1950-2014 period. Dependent variable is the log of a country's price level (its exchange rate over its PPP) based on consumption of households and government. Heteroscedastic-consistent (White-robust) standard errors are in parentheses.
* Indicates significant at 10 % level; ** indicates significant at 5% level; *** indicates at 1% level.

[a] Test for joint significance of time dummies.

4.1 Model Specification

We consider three-factor Cobb-Douglas production function such that production at time t in country i is given by

$$Y_i(t) = K_i(t)^{\alpha} H_i(t)^{\beta} (A_i(t)L_i(t))^{1-\alpha-\beta} \tag{13}$$

where the notation here is standard such that Y is output, K is physical capital, H is the stock of human capital, L is labour, and A is level of labour-augmenting technology. Assuming that production function exhibits constant returns to scale and labour and technology grow exogenously at rates n and g such that $L(t) = L(0)e^{nt}$ and $A(t) = A(0)e^{gt}$, output per unit of labour; $y(t) = Y(t)/L(t)$ and output per unit of effective labour; $\tilde{y}(t) = Y(t)/A(t)L(t)$ are defined.

The production function in equation (13) can be written in its intensive form. More clearly, it can be expressed in terms of per unit of effective labour as it shows constant returns to scale property.

$$\tilde{y}(t) = \tilde{k}(t)^{\alpha} \tilde{h}(t)^{\beta} \tag{14}$$

where $\tilde{k}$ and $\tilde{h}$ denote the physical capital stock per unit of effective labour and the stock of human capital per unit of effective labour, respectively.

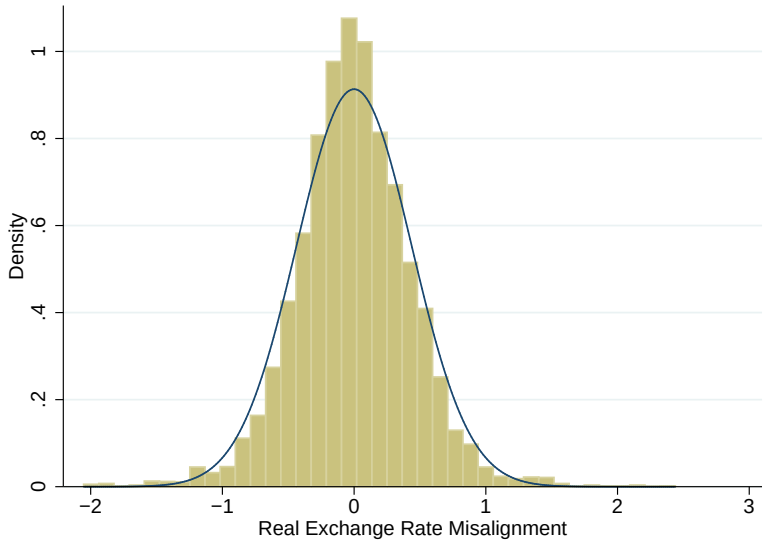


Figure 1: Distribution of RERM: Annual data over 1950-2014

The model assumes that a constant fraction of output is invested in both physical and human capital such that s_K is the fraction of income invested in physical capital and s_H is the fraction of income invested in human capital. Defining δ as the depreciation rate of both physical and human capital, the first-order Taylor approximation of $\log \tilde{k}(t)$ and $\log \tilde{h}$ around the their steady-state levels, yields the following cross-country growth regression:[27]

$$\begin{aligned} \log y_{i,t} - \log y_{i,t-1} = \beta_0 + \beta_1 \log y_{i,t-1} + \beta_2 \log(n_{i,t} + g + \delta) + \\ \beta_3 \log s_{i,t,K} + \beta_4 \log s_{i,t,H} + \varepsilon_{i,t} \end{aligned} \tag{15}$$

As can be seen from the last equation, it is assumed that rates of technological progress and of depreciation are constant across countries. The critical assumption is that initial technological differences, represented in error term $\varepsilon_{i,t}$ are distributed independently from the any regressors and thus the cross-country growth regression in equation (15) can be estimated by ordinary least squares (OLS).[28]

[27] The detailed derivation of the cross-country growth regression can be found in Mankiw et al. (1992), Durlauf et al. (2005) and Ulaşan (2012).

[28] In the context of cross-country growth regression, it is very difficult to accept the validity of this assumption. As seen easily in equations (14) and (15), cross-country growth regression is dynamic in its nature as the initial income level, $logy_{i,t-1}$, is included as an explanatory variable. Therefore, by definition the country-specific fixed effect must be correlated with other other explanatory variables. One solution to this problem is to

We follow the standard practice in the cross-country growth literature and extend the model specification in equation (15) through adding our real exchange misalignment measure:

$$\begin{aligned}\log y_{i,t} - \log y_{i,t-1} = \beta_0 + \beta_1 \log y_{i,t-1} + \beta_2 \log(n_{i,t} + g + \delta) + \\ \beta_3 \log s_{i,t,K} + \beta_4 \log s_{i,t,H} + \beta_5 RERM_{i,t} + \mu_{i,t}\end{aligned} \tag{16}$$

It is worth reminding that the initial level of income, population growth and saving rates for physical and human capital are proximate determinants of economic growth. Therefore, coefficient estimate of β_5 in equation (16) reveals the impact of real exchange rate misalignment on growth through the productivity channel.

4.2 Data

Data are compiled from standard sources. GDP, employment level, total population and investment rate are taken from the PWT Version 9.0 (Feenstra et al. (2015)). Dividing the expenditure-side real GDP by level of employment, we calculate the per worker GDP. We measure $s_{i,K}$ by the share of gross capital formation in current GDP and $s_{i,H}$ by the secondary school gross enrolment rate. The gross secondary school enrolment rates come from the World Bank World Development Indicators (2017). Akin to Mankiw et al. (1992), we assume that the sum of rates of depreciation and technological progress is constant across countries and equal to 0.05. The variables and their sources and summary statistics are given in the Appendix.

5 Estimation Results

In this section, we present and discuss the findings of our empirical investigation over the sample period 1990-2014. To do so, we estimate the following

employ dynamic panel data models with fixed effect. The system generalized method of moments (GMM) is particularly useful in this respect as this estimator mitigates the endogeneity bias stemming not only from time-invariant omitted variable but also from simultaneity and measurement error. However, the panel data approaches to growth regressions bring their own problems. The most important problem is that panel data growth models employ the growth information in the short run and are clearly prone to business cycle effects. This is more serious problem for the present paper as our sample period covers 25 year-time interval between 1990 and 2014. Therefore, we stick with the single cross-country regression to reflect the long-run growth dynamics.

cross-country growth regression:

$$\begin{aligned} logy_{i,2014} - logy_{i,1990} = \beta_0 &+ \beta_1 logy_{i,1990} + \beta_2 log(n_i + g + \delta) \\ &+ \beta_3 log(Investment\ rate_i) \\ &+ \beta_4 log(School\ enrolment\ rate_i) \\ &+ \beta_5 log(Real\ Exchange\ Rate\ Misalingment_i) + \mu_i \end{aligned} \tag{17}$$

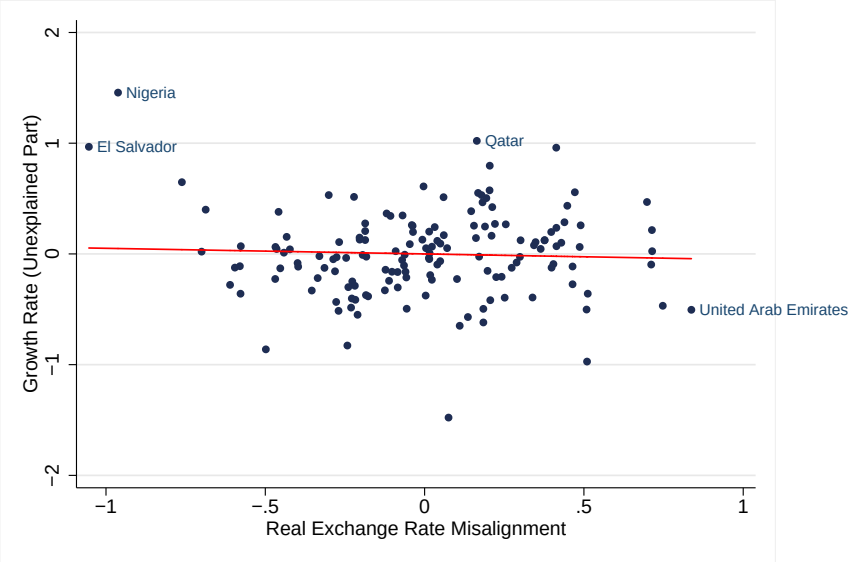
All of these variables are averaged over the sample period except the initial level of income and school enrolment rate. In order to minimize endogeneity problem between growth and education, we employ the level of school enrolment rate at beginning of sample period.

Before evaluating the regression results, we want to emphasise an important, but often neglected point about the standard errors of coefficient estimates. The common practice in the cross-country growth literature for dealing heteroscedasticity is reporting regression results with the heteroscedasticity consistent (White-robust) standard errors since they work well regardless of heteroscedasticity in the actual errors. It is, however, worth reminding that our measure of real exchange rate misalignment is predicted residuals obtained from the auxiliary model in Equation (11), not actual error terms. In other words, our empirical strategy is in essence a two-step/generated-regressor substitution procedure. As pointed out by Murphy and Topel (1985), this approach produces consistent parameter estimates in the second step, but standard errors and related test statistics are not correct. Murphy and Topel (1985) suggest a method for correction for the second-step standard errors. However, the Murphy and Topel (1985) estimator is not applicable in our empirical investigation as this method requires the same sample of observations in both step. Therefore, we report the bootstrap estimates of the heteroscedasticity consistent standard errors as a more pragmatic and better alternative to correct the second-stage estimated errors since our sample and time period in the first stage is larger.

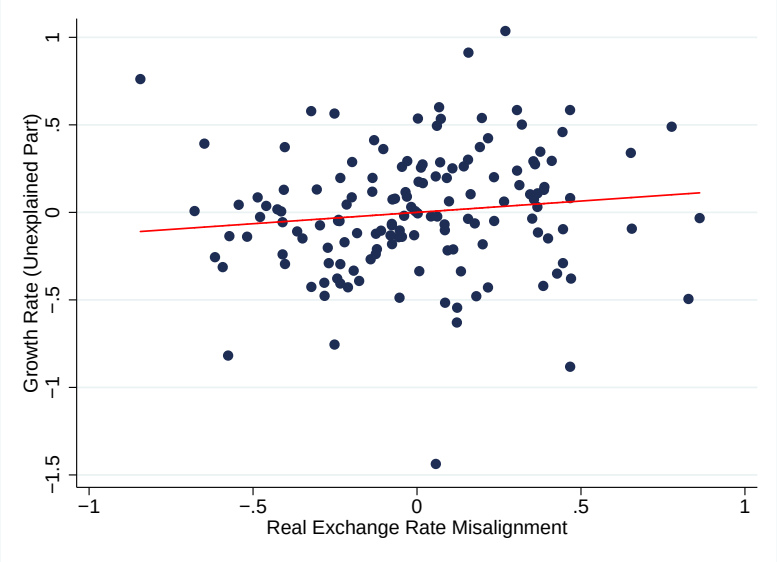
5.1 The Long-run Estimates: 1990-2014 period

Table 1 provides the estimation results. In column 1, the model is estimated by OLS for a sample of 150 countries whose data are available over the 1990-2014 period. The coefficient estimate of real exchange rate misalignment is found to be negative, but not statistically significant. Put differently, we could not establish a statistically significant association between growth and real exchange rate misalignment when the sample includes all countries.

The graphical visualization of partial association between growth and real exchange rate misalignment is presented in Figure 2a.



(a) The sample includes all countries.



(b) The sample excludes four outlying countries.

Figure 2: Partial Associations between Growth Rate and Real Exchange Rate Misalignment

An important concern related to the cross-country growth works is that results may be partly driven by outlying countries since the cross-country growth regressions are based on small samples.[29] Therefore, we investigate outlying countries by employing diagnostic plot in Figure 3. This figure plots leverages against the normalised residual squared of our cross-country growth regression based on the full sample. As can be easily seen United Arab Emirates is the most influential country with the highest leverage in our sample. In addition to this country, Tajikistan, Qatar, Uzbekistan, Gunea-Bissau, El-Salvador, Nigeria, Djibouti and Tanzania have moderately high level of leverages. Figure 3 also shows that Zimbabwe and Nigeria are the countries with highest residual. The leverage value of Zimbabwe is less than to the sample mean, that is Zimbabwe is not an influential observation in spite of its very high residual. It is, however, highly likely that Nigeria is an influential country as its leverage is relatively high. Therefore, graphical inspection indicates that United Arab Emirates and Nigeria are highly likely are outlying countries. Among the countries with moderately high leverages, Qatar and El-Salvador are of concern due to their high level of residuals.

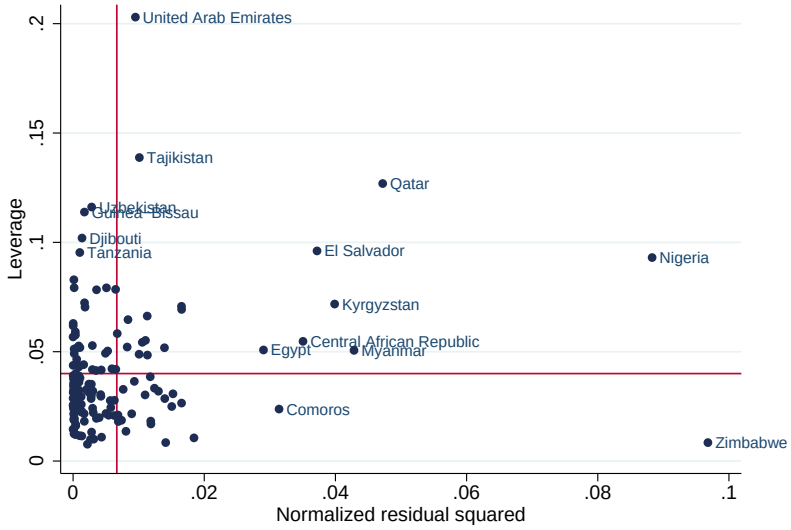


Figure 3: Leverage versus Residual Plot

In addition to graphical inspection, we apply a more compact statistical method on our data set to highlight outliers. The diagnostic measure pro-

[29] As Temple (2000) rightly points out, we should make sure that our results reflet the tendencies of a majority of data, not those of a minority of observations if we want to reach useful generalizations about economic growth.

posed by Hadi (1992) is a more efficient method, especially when the sample includes more the one outliers. Employing Hadi measure, we conclude United Arab Emirates, Nigeria, Qatar and El-Salvador as the potential outlying countries, that is Hadi measure confirms our findings from graphical inspection.

The most common approach for dealing with outlier problem is dropping these observations from the sample. In column 2 of Table 2, we omit these four outlying countries and conclude that the coefficient estimate of real exchange misalignment measure is positive, but not significant. The graphical visualization of partial association between growth and real exchange rate misalignment is presented in Figure 2b. As seen, the partial relation between growth and misalignment turns positive once the four outlying countries are dropped.

Instead of dropping these countries, an alternative and better way is to carry out the regression analysis by employing weighted least squares, more robust estimation technique to outliers. In column 3 of Table 2, we estimate our cross-country growth regression by Iteratively Reweighted Least Squares (IRLS).[30] However, the result is unchanged, that is coefficient of real exchange rate misalignment is to be found positive, but insignificant.

In summary, our cross-country empirical investigation indicates that there is no statistically association between growth and real exchange rate misalignment when the sample includes all countries.

So far, we assume that countries are homogenous in terms of regression parameters. It is, however, clear that parameter homogeneity assumption is not realistic. At a very simple level, it is very likely that the effect of real exchange rate misalignment is different between low and middle-income and high-income countries. Therefore, we divide the full sample into two sub-samples according to the initial level of GDP per capita. We employ the 50th percentile (median) of the per capita GDP in 1990 as a threshold level and classify the countries with the initial income above the the threshold level as high-income countries while those with initial income belove the threshold level as low and middle-income countries.

The estimation results based on two sub-samples are reported in Table 3. As in the case of full sample, we identify the outliers for each sample

[30]IRLS is based on iterative computation of case weights obtained from the residuals. However, the most important shortcoming of IRLS is that it is not robust to high leverage data points. Therefore, if one can identify and drop the observations with the high leverage value and then estimate the sample of remaining observations by IRLS, estimation results will be more robust. Hence, before applying IRLS, we firstly highlight high leverage countries in each data set. For this, following Huber (1981) we determine the countries as risky whose leverage values is greater than 0.2.

Table 2: Economic Growth and Real Exchange Rate Misalignment: The Long-run Estimates

	(1)	(2)	(3)
	OLS	OLS	IRWL
log of GDP per worker in 1990	-0.410***	-0.327***	-0.295***
	(0.058)	(0.051)	(0.062)
log of $(n_i + g + \delta)$	-0.259	-0.357*	-0.193
	(0.245)	(0.194)	(0.265)
log of Investment rate	0.735***	0.814***	0.838***
	(0.125)	(0.112)	(0.152)
log of School enrolment rate	0.358***	0.251***	0.239***
	(0.084)	(0.073)	(0.084)
log of RER Misalignment	-0.051	0.130	0.194
	(0.126)	(0.099)	(0.132)
Constant	5.207***	4.165***	4.343***
	(0.977)	(0.763)	(0.854)
Number of countries	150	146	149
Adjusted R^2	0.35	0.39	0.40
Implied λ^a	0.0220	0.0165	0.0146

Notes: Dependent variable is the log difference of GDP per worker between 1990 and 2014. Heteroscedastic-consistent (White-Robust) standard errors obtained from the bootstrap estimates with 1000 replications are in parentheses.
* Indicates significant at 10% level; ** indicates significant at 5% level; *** indicates at 1% level.

[a] The implied convergence rate in the vicinity of the steady state.

applying Hadi methodology. More clearly, the OLS estimates in Table 3 do not involve outlying countries. Similarly, countries with high leverages are dropped in the IRWL estimates.

In columns 1 and 2 of Table 3, both OLS and IRWL estimates based on the low and middle-income countries are presented, respectively. In each case, real exchange rate misalignment is found to be positively correlated with economic growth at the 5 percent statistically significance level. In columns 3 and 4, we carry out the same regression analysis for the sample of high-income countries and conclude that coefficient estimate of real exchange rate misalignment is negative, but not significant.

As a result, our empirical investigation indicates that the statistically significant association between economic growth and real exchange rate misalignment is established only for the low and middle-income countries. Re-

Table 3: Economic Growth and Real Exchange Rate Misalignment: The Long-run Estimates

	Low & Middle-income Sample		High-income Sample	
	OLS	IRWL	OLS	IRWL
log of GDP per worker in 1990	-0.306***	-0.248***	-0.515***	-0.543***
	(0.077)	(0.076)	(0.119)	(0.152)
log of $(n_i + g + \delta)$	-0.152	-0.057	-0.047	-0.125
	(0.338)	(0.346)	(0.266)	(0.440)
log of Investment rate	0.771***	0.840***	0.502**	0.513
	(0.130)	(0.184)	(0.199)	(0.316)
log of School enrolment rate	0.240***	0.185**	0.335**	0.322
	(0.087)	(0.094)	(0.166)	(0.238)
log of RER Misalignment	0.424**	0.534**	-0.106	-0.151
	(0.204)	(0.249)	(0.136)	(0.158)
Constant	4.417***	4.200***	6.594***	6.663***
	(1.181)	(1.177)	(1.488)	(1.949)
Number of countries	76	76	67	68
Adjusted R^2	0.41	0.48	0.28	0.27
Implied λ^a	0.0152	0.0119	0.0302	0.0326

Notes: Dependent variable is the log difference of GDP per worker between 1990 and 2014. Heteroscedastic-consistent (White-robust) standard errors obtained from the bootstrap estimates with 1000 replications are in parentheses.
* Indicates significant at 10% level; ** indicates significant at 5% level; *** indicates at 1% level.

[a] The implied convergence rate in the vicinity of the steady state.

gression results imply that depreciation of domestic currency is beneficial for the long-run economic growth in these countries.

Concerning the other growth variables, in each sample all variables have the expected signs and are found to be strongly significant except the population growth. We find strong evidence in each regression for the hypothesis of conditional convergence, that is an economy with a lower initial value of GDP per worker tends to generate higher growth rate of GDP per worker when other growth determinants are controlled for. Moreover, we also report estimated convergence rates in the vicinity of steady state, (λ) in the last row of the Tables 2 and 3. For instance, predicted convergence rate from the cross-country growth regression depicted in column 1 of Table 1 is found to be 0.022. This implies that on average 2.2 percent of the gap a country's steady state and its current income level is eliminated each year and the

halfway to convergence takes approximately 30 years in the absence of any other shock.

Second, our findings show that investment rates of both physical and human capital significantly contribute to the growth rates of countries in the long run. As seen in Tables 2 and 3, coefficient estimates of physical investment rate are found to be considerably higher those of school enrolment rate. This finding implies that accumulation of physical capital is more important than the accumulation of human capital for the long-run economic growth, particularly in developing countries.

5.2 The Short-run Estimates

In this section, we estimate our baseline model over the periods 1990-2004 and 2005-2014 for the same sample of countries. Notice that time interval which growth and all right-hand-side variables averaged over is not sufficiently long. Therefore, it is highly likely that estimation results with 10-year or 15-year averages reveal the impact of real exchange rate misalignment on economic growth in the short run and/or medium term.

5.2.1 1990-2004 Period

The regression results are given Table 4. We again determine outlying countries by Hadi methodology. Therefore, the OLS estimates excludes outliers and IRWL estimates do not cover high leverage data points.

In columns 1 and 2, our model is estimated for all countries. Both OLS and IRWL estimates indicate that real exchange rate misalignment measure is negatively and significantly correlated with economic growth. In column 3, we run the cross-country growth regression for low and middle-income countries and find that coefficient estimate of real exchange rate misalignment is negative and significant. Notice that low and middle-income sample do not include any outliers and thus we do need to IRWL estimate. Estimation results obtained from high-income sample are reported in columns 4 and 5. We conclude that the relationship between our measure of real exchange rate misalignment an economic growth is negative and statistically significant when the sample excludes one outlying country. However, this finding is not very robust as the significance of coefficient estimate disappears when we employ IRWL estimator.

In sum, differently from the long-run estimation results, the cross-country growth regressions over the period 1990-2004 find a negative and statistically significant correlation between real exchange misalignment and growth for all countries. This finding is stronger and more robust for the sample of

low and middle-income countries and clearly implies that appreciation of domestic currencies in real terms has a positive effect on economic growth in developing countries during the 1990-2004 period in spite of currency crises and hence growth collapses in this period.[31]

One explanation is that the 1990s witnessed a surge in capital flows into developing countries and as pointed out by Frenkel and Rapetti (2010) the majority of developing countries received a considerable amount of net capital flows from developed countries. Therefore, the allocative efficiency hypothesis could hold true in this period, that is capital inflows could stimulate investment as well as consumption and thus promote economic growth in developing countries.

Another explanation is that commodity prices increased in this period, especially in the late 1990s and the early 2000s as a result of high world demand for raw materials. In particular, the demand from China, the fastest growing country in this period, created a favourable environment for resource-rich developing countries. Therefore, most of these countries enjoyed from the high commodity prices and recorded faster growth rates.

5.2.2 2005-2014 Period

Table 5 reports the cross-country growth regression results over the 2005-2014 period for three different samples. Outliers and high leverage data points are excluded from the samples as before.

When the sample includes all countries the OLS and IRWL regressions yield a positive coefficient estimate of real exchange rate misalignment measure with the 10 percent significance level. This implies that differently from 1990-2004 period, real depreciation of national currency is on average positively associated with economic growth for the period 2005-2014. Column 3 presents the estimated result for the sample of low and middle-income countries. The coefficient estimate of misalignment measure is again positive, but now it is higher and highly significant. Regression results obtained from high-income sample are depicted in the last two column of the table. The OLS estimate of misalignment measure is found to be positive and highly significant; yet this finding is not robust as the coefficient estimate of misalignment measure based on IRWL estimator is not statistically significant, albeit its positive sign.

In our view, implications of these findings are threefold: First, growth promoting effect of allocative efficiency appeared in 1990-2004 period is not permanent. Moreover, it is likely that positive effect of allocative efficiency

[31]Examples are Turkey in 1994, Mexico and Argentina in 1995, the five countries in East Asia in 1997-98, Russia and Brazil in 1998-99 and Turkey and Argentina in 2001.

on growth in that period stems from the expansion of domestic consumption rather than productivity gains. Gourinchas and Jeanne (2013) show that allocation of net capital inflows across developing countries is negatively or uncorrelated with productivity level over the 1980-2000 period, that is international capital tend to flow more towards developing countries with lower productivity growth. Second, on average, the destructive effect of Global Financial Crisis on economic growth is much stronger and the economic recovery aftermath the crisis is much slower in the countries with overvalued currencies. Third, the adverse effect of the Dutch disease on growth is quite evident in this period.

Table 4: Economic Growth and Real Exchange Rate Misalignment: The Short-run Estimates

Dependent Variable: Log Difference real GDP per worker over the 1990-2004 period

	Full Sample		Low & Middle-income Sample	High-income Sample	
	(1)	(2)	(3)	(4)	(5)
	OLS	IRWL	OLS	OLS	IRWL
log of GDP per worker in 1990	-0.173***	-0.180***	-0.209***	-0.294**	-0.338*
	(0.045)	(0.047)	(0.064)	(0.122)	(0.186)
log of $(n_i + g + \delta)$	-0.181	-0.241	-0.427	0.493	-0.017
	(0.223)	(0.235)	(0.352)	(0.400)	(0.521)
log of Investment rate	0.383***	0.354***	0.354***	0.184*	0.284*
	(0.088)	(0.091)	(0.091)	(0.111)	(0.147)
log School enrol. rate in 1990	0.143**	0.144*	0.169**	0.247	0.156
	(0.069)	(0.074)	(0.075)	(0.204)	(0.343)
log of RER Misalignment	-0.350***	-0.291***	-0.304**	-0.285**	-0.311
	(0.079)	(0.103)	(0.123)	(0.117)	(0.207)
Constant	2.141***	2.006**	1.775	5.104***	4.229
	(0.794)	(0.811)	(1.201)	(1.771)	(2.894)
Number of countries	149	149	78	67	68
Adjusted R^2	0.28	0.27	0.23	0.19	0.18

Note: Heteroscedastic-consistent (White-robust) standard errors obtained from the bootstrap estimates with 1000 replications are in parentheses. * Indicates significant at 10% level; ** indicates significant at 5% level; *** indicates at 1% level.

Table 5: Economic Growth and Real Exchange Rate Misalignment: The Short-run Estimates

Dependent Variable: Log Difference real GDP per worker over the 2005-2014 period

	Full Sample		Low & Middle-income Sample	High-income Sample	
	OLS	IRWL	OLS	OLS	IRWL
log of GDP per worker in 1990	-0.130***	-0.165***	-0.104*	-0.161***	-0.162*
	(0.039)	(0.033)	(0.058)	(0.058)	(0.088)
log of $(n_i + g + \delta)$	-0.300***	-0.432***	-0.046	-0.387***	-0.408***
	(0.116)	(0.090)	(0.286)	(0.108)	(0.154)
log of Investment rate	0.152**	0.156**	0.234***	-0.018	-0.005
	(0.060)	(0.070)	(0.078)	(0.084)	(0.107)
log School enrol. rate in 2005	0.129	0.179***	0.117	0.151	0.268
	(0.084)	(0.064)	(0.093)	(0.145)	(0.212)
log of RER Misalignment	0.251***	0.193***	0.262**	0.141*	0.149
	(0.069)	(0.071)	(0.125)	(0.084)	(0.114)
Constant	1.021*	1.021**	1.586	0.851	0.832
	(0.568)	(0.520)	(1.037)	(0.834)	(1.223)
Number of countries	155	155	79	72	72
Adjusted R^2	0.27	0.41	0.16	0.50	0.54

Note: Heteroscedastic-consistent (White-robust) standard errors obtained from the bootstrap estimates with 1000 replications are in parentheses. * Indicates significant at 10% level; ** indicates significant at 5% level; *** indicates at 1% level.

6 Conclusion

This paper empirically examines the role of real exchange rate misalignment on economic growth over the period 1990-2014. Using a cross-country growth regression framework, we find that real undervaluation of currency is positively associated with long-run economic growth in developing countries. Our findings are broadly in line with previous empirical studies on the topic and imply that real overvaluation of national currency over a long period is harmful for long-run economic growth. One should be very careful while interpreting our findings for policy implications, however. We want to emphasise three points in this context:

First, it is theoretically accepted that a competitive real exchange rate promotes economic growth by expanding tradable goods sector, particularly manufacturing, and making export more competitive in an open developing country. In this manner it is possible to say that the exchange rate acts as a type of industrial policy. However, it has been argued that there has been a tendency in developing countries towards overvaluation of real exchange rate since the beginning of 1990s. An important reason is that following financial liberalisation capital inflows to developing countries appreciate their real exchange rates. Another reason is that the priority of economic policy in the majority of developing countries is fighting against inflation and the exchange rate channel may be used as a key tool for controlling inflation. However, exchange rate is a very important price and keeping it at a level under its equilibrium value leads to inefficient resource allocation, especially in an open economy. Moreover, it is likely that this kind of disinflation process goes along with the high real interest, detrimental for investment and fiscal balance to attract foreign capital in the form of foreign direct investment. More to the point, an overvalued national currency in the name of fighting against inflation may intensify the persistence and degree of exchange rate pass-through over time as real appreciation of domestic currency discourage investment incentives in manufacturing. *Therefore, policy makers should not follow exchange rate policies based purely on inflation-control objective.*

Second, although our findings highlight the importance of a competitive real exchange rate for economic growth and development in the long run, this does not necessarily imply that a competitive real exchange rate by itself boost economic growth. Rather, it is a *necessary but not sufficient* condition for industrialization, exports and hence economic growth in developing countries, that is a competitive real exchange rate policy calls other complementary policies. From this perspective, a plausible policy recommendation is that the initial reforms aiming at an appropriate *investment climate* are crucially important.

Third, our findings do not imply that a real devaluation is good for economic growth, and hence one should not conclude that a real devaluation has a beneficial effect on economic growth. Saying that maintaining a competitive (or even undervalued) real exchange rate policy is good for economic growth is conceptually different from the statement that a real devaluation is helpful for growth. As we have already noted, the consequences of a competitive real exchange on growth are quantitatively and qualitatively positive. However, in contrast to traditional view based on the Marshall-Lerner condition and aggregate demand-aggregate supply model, economic theory does not conclude that real devaluation of national currency is unambiguously expansionary.[32] In particular, after the financial liberalization, a real devaluation is likely to be contractionary due to detrimental balance-sheet effects stemming from unhedged foreign currency denominated debts. It is, however, possible to draw a conclusion from the existing literature on the topic that a competitive real exchange rate policy may also considerably reduce adverse balance-sheet effects due to its boosting effect on tradable sectors.

[32]See, Kim and Ying (2007) for a nice summary on the effects of a real devaluation on growth.

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7 Appendix

7.A Descriptions and Sources of Variables used in Cross-Sectional Growth Regression Analysis

7.A.1 Basic Variables

Expenditure-side Real GDP (RGDP^E) : 2011 international prices in millions US dollar, chain series. **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

Population (TP) : Total population in millions. **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

Employment (EMP) : Number of persons engaged to labour force defined as the total population between ages 15 and 64 (in millions). **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

Real GDP per worker (PWGDP) : 2011 international prices in US dollar, chain series. The exact calculation is $RDPE/EMP$.

(g+δ) : The sum of exogenous rates of technological process and depreciation. It is assumed to be constant across countries and equal to 0.05.

Investment Rate (CSHI) : Share of gross capital formation at current PPPs. **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

Secondary school enrolment rate (SCH) : Total (both sexes) enrollment in secondary education, regardless of age, expressed as a percentage of the population of official secondary education age. Gross enrolment rate can exceed 100 % due to the inclusion of over-aged and under-aged students because of early or late school entrance and grade repetition. **Source**: The World Bank World Development Indicators (2017), which draws on UNESCO Institute for Statistics.

PL_CON : Price level of CCON, equal to the PPP (ratio of nominal CON to CCON) divided by the nominal exchange rate, where CCON is real consumption of households and government, using prices that are constant across countries. USA value of PL_CON=1 in 2011. **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

PL_DA : Price level of CDA and CGDP^e , equal to the PPP (ratio of nominal DA to CDA) divided by the nominal exchange rate, where CDA is real domestic absorption, computed as real consumption (CCON)

plus real investment and CGDP^e is expenditure-side real GDP, using prices for final goods that are constant across countries. USA value of PL_DA=1 in 2011. **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

PL_GDP^o : Price level of CGDP^o, equal to the PPP (ratio of nominal GDP to CGDP^o) divided by the nominal exchange rate, where CGDP^o is output-side real GDP, using prices for final goods, exports, and imports that are constant across countries. USA value of PL_GDP^o = 1 in 2011. **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

XR : Nominal exchange rate, national currency/US Dollar, (market plus estimated). **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

Real Exchange Rate Misalignment (RERM) : The Balassa-Samuelson effect adjusted measure of real exchange rate misalignment. The measure is expressed in logarithms and the value zero indicates equilibrium real exchange rate with respect to the PPP. If $RERM < 0$, the value of national currency is higher (more appreciated) than its PPP value, implying real overvaluation of national currency. if $RERM > 0$, the value of national currency is lower (more depreciated) than its PPP value, implying real undervaluation of national currency. **Source:** Author's calculation.

7.A.2 1990-2014 period

Growth1990-2014 : The average growth rate of real GDP per worker over the 1990-2014 period. The exact calculation is $log(PWGDP2014/PWGDP1990)$, where PWGDP2014 and PWGDP1990 is the real GDP per worker in 2014 and 1990, respectively. **Source:** Author's calculation.

Initial income (PWGDP1990) : Logarithm of real GDP per worker in 1990.

Population Growth (n) : Average rate of population growth between 1990 and 2014. The exact calculation is (1/24)*log(TP2014/TP1990), where TP1990 and TP2014 are the levels of total population in 1990 and 2014, respectively. **Source:** Author's calculation.

(g+δ) : Sum of exogenous rates of technological process and depreciation over the 1990-214 period and assumed to be equal to 0.05.

Investment Rate (CSHI) : Average share of gross capital formation at current PPPs over the 1990-2014 period. **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

(n+g+δ) : Sum of rates of population growth, technical process and depreciation over the 1990-2014 period.

School enrolment rate (SCH1990) : The gross rate of secondary school enrolment in 1990. **Source**: The World Bank World Development Indicators (2017).

Real Exchange Rate Misalignment (RERM) : Average value of real exchange rate misalignment measure over the period 1990-2014. **Source:** Author's calculation.

7.A.3 1990-2004 period

Growth1990-2004 : The average growth rate of real GDP per worker over the 1990-2004 period. The exact calculation is $log(PWGDP2004/PWGDP1990)$, where $PWGDP2004$ and $PWGDP1990$ is the real GDP per worker in 2004 and 1990, respectively. **Source:** Author's calculation.

Initial Income (PWGDP1990) : Logarithm of real GDP per worker in 1990.

Population Growth (n) : Average rate of population growth between 1990 and 2004. The exact calculation is $(1/14)*log(TP2004/TP1990)$, where TP1990 and TP2004 are the levels of total population in 1990 and 2004, respectively. **Source:** Author's calculation.

Investment Rate (CSHI) : Average share of gross capital formation at current PPPs over the 1990-2004 period. **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

School enrolment rate (SCH1990) : The gross rate of secondary school enrolment in 1990. **Source**: The World Bank World Development Indicators (2017).

Real Exchange Rate Misalignment (RERM) : Average value of real exchange rate misalignment measure over the period 1990-2004. **Source:** Author's calculation.

7.A.4 2005-2014 period

Growth2005-2014 : The average growth rate of real GDP per worker over the 2005-2014 period. The exact calculation is $log(PWGDP2014/PWGDP2005)$, where PWGDP2014 and PWGDP2005 is the real GDP per worker in 2014 and 2005, respectively. **Source:** Author's calculation.

Initial Income (PWGDP2005) : Logarithm of real GDP per worker in 2005.

Population Growth (n) : Average rate of population growth between 2005 and 2014. The exact calculation is $(1/9) * log(TP2014/TP2005)$, where TP2005 and TP2014 are the levels of total population in 2005 and 2014, respectively. **Source:** Author's calculation.

Investment Rate (CSHI) : Average share of gross capital formation at current PPPs over the 2005-2014 period. **Source**: Penn World Tables, version 9.0 (Feenstra et al. (2015)).

School enrolment rate (SCH2005) : The gross rate of secondary school enrolment in 2005. **Source**: The World Bank World Development Indicators (2017).

Real Exchange Rate Misalignment (RERM) : Average value of real exchange rate misalignment measure over the period 2005-2014. **Source:** Author's calculation.

7.B Summary Statistics

7.B.1 Basic Variables

	♯ of Obs.	Mean	Std. Dev.	Min.	Max.
$RGDP^E$	9439	253090.8	997328.1	18.54156	1.71E+07
TP	9439	30.09057	111.4891	0.004377	1369.436
EMP	8244	14.21886	56.50001	0.00118	798.3678
PWGDP	9439	11305.73	16723.19	142.3923	245077.8
CSHI	9439	0.217898	0.207474	-2.03451	14.57077
PL_CON	9439	0.362726	0.274585	0.019942	1.796395
PL_DA	9439	0.363976	0.262261	0.016961	1.651684
PL_GDP^o	9439	0.385848	0.820992	-18.6291	47.8145
XR	9439	244.1417	1289.601	7.89E-15	25941.66
RERM	9439	2.53E-11	0.436807	-2.0534	2.438417

7.B.2 1990-2014 Period

Variable	Obs	Mean	Std. Dev.	Min	Max
Growth1990-2014	166	0.556552	0.577042	-0.9845	4.456126
PWGDP1990	170	9.604684	1.105185	6.933603	12.26794
(n+g+δ)	180	0.065201	0.013216	0.018944	0.117192
CSHI	180	0.226051	0.114451	0.063483	1.150058
SCH1990	156	0.602855	0.326974	0.045578	1.336099
RERM	180	6.17E-05	0.374761	-0.83361	1.081303

7.B.3 1990-2004 Period

Variable	Obs	Mean	Std. Dev.	Min	Max
Growth1990-2004	167	0.229641	0.479762	-1.23437	3.364256
PWGDP1990	170	9.604684	1.105185	6.933603	12.26794
(n+g+δ)	180	0.065142	0.013805	-0.00983	0.106152
CSHI	180	0.21363	0.128492	0.047053	1.372233
SCH1990	156	0.602855	0.326974	0.045578	1.336099
RERM	180	2.70E-09	0.436141	-1.19806	1.131195

7.B.4 2005-2014 Period

Variable	Obs	Mean	Std. Dev.	Min	Max
Growth2005-2014	169	0.285117	0.27462	-0.41236	1.203249
PWGDP2005	173	9.905961	1.187022	7.150883	12.03992
(n+g+δ)	182	0.065255	0.014802	0.034838	0.155967
CSH	182	0.24482	0.11496	0.053863	1.233081
SCH2005	162	0.745891	0.299341	0.099082	1.483661
RERM	182	8.43E-10	0.341755	-0.75029	1.19242

7.C Price Levels in PWT Version 9.0: Pairwise Correlations

	PL_CON	PL_DA	PL_GDP^o
PL_CON	1.00		
PL_DA	0.98	1.00	
PL_GDP^o	0.95	0.97	1.00

7.D List of Countries in the Regression Analysis

Albania	Czech Republic*	Lao People's DR	Russian Federation*
Algeria*	D.R. of the Congo	Latvia*	Rwanda
Angola	Denmark*	Lebanon	Saint Lucia*
Argentina	Djibouti	Lesotho	Sao Tome and Principe
Armenia	Ecuador	Lithuania*	Senegal
Australia*	Egypt	Luxembourg*	Sierra Leone
Austria*	El Salvador	Madagascar	Slovakia*
Azerbaijan*	Estonia*	Malawi	Slovenia*
Bahamas*	Ethiopia	Malaysia*	South Africa*
Bahrain*	Fiji	Mali	Spain*
Bangladesh	Finland*	Malta*	Sri Lanka
Barbados*	France*	Mauritania	St. Vincent & the Grenadines
Belarus*	Gabon*	Mauritius*	Suriname*
Belgium*	Gambia	Mexico*	Swaziland
Belize	Georgia*	Mongolia	Sweden*
Benin	Germany*	Morocco	Switzerland*
Botswana*	Ghana	Mozambique	Syrian Arab Republic
Brazil	Greece*	Myanmar	Tajikistan*
Brunei Darussalam*	Guatemala	Namibia	TFYR of Macedonia*
Bulgaria*	Guinea	Nepal	Thailand
Burkina Faso	Guinea-Bissau	Netherlands*	Togo
Burundi	Honduras	New Zealand*	Trinidad and Tobago*
Cabo Verde	Hungary*	Nicaragua	Tunisia
Cambodia	Iceland*	Niger	Turkey*
Cameroon	India	Nigeria	U.R. of Tanzania: Mainland
Canada*	Indonesia	Norway*	Uganda
Central African Republic	Iran	Oman*	Ukraine*
Chad	Iraq	Pakistan	United Arab Emirates*
Chile*	Ireland*	Panama	United Kingdom*
China	Israel*	Paraguay	United States*
China, Hong Kong SAR*	Italy*	Peru	Uruguay*
Colombia*	Jamaica	Philippines	Uzbekistan
Comoros	Japan*	Poland*	Venezuela*
Congo	Jordan	Portugal*	Viet Nam
Costa Rica*	Kazakhstan*	Qatar*	Zambia
Côte d'Ivoire	Kenya	Republic of Korea*	Zimbabwe
Croatia*	Kuwait*	Republic of Moldova	
Cyprus*	Kyrgyzstan*	Romania*	

Note: Countries with asterisk are the high-income countries according to the median of real GDP per capita in 1990.

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