# The Mechanics of Real Undervaluation and Growth

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**Abstract**

The media and policy makers often mention that China manipulates its real exchange rate (RER) in order to improve its exports and boost growth. This view, however, is not supported by the most prominent economic models, which do not predict a positive relationship between real undervaluation and economic growth. I propose a 3-sector model with labor market frictions that explains how a policy aimed at increasing domestic savings and depreciating the RER can, at the same time, generate real growth through a reallocation of workers from a low-productivity traditional sector into a high-productivity manufacturing sector. The policy is particularly effective in countries with relative abundance of labor, scarcity of agricultural resources, and high barriers for the entry of workers into the manufacturing sector. Empirically, I verify that higher real undervaluation (measured as deviations from PPP) is positively associated with GDP and manufacturing growth in countries with lower per capita agricultural land and higher rural population. The relationship vanishes and even becomes negative in the opposite cases. Finally, I propose a simple methodology for the identification of real depreciations exogenously induced (i.e. that are not related to changes in productivities or in terms of trade). I find that, during the last 20 years, such episodes have been mainly observed in East Asian developing countries.

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*Is it true that a competitive exchange rate is behind China's success?* Over the past two decades, China has experienced one of the most remarkable economic transformations of modern economic history. Millions of workers have migrated from the traditional economy into rapidly expanding industrial areas, manufacturing production and exports have dramatically increased, and per capita income has grown at almost double-digit rates during the last 20 years. Such an outstanding performance is explained, according to many media analysts and policy makers, by a direct manipulation of the exchange rate by the Chinese government, aimed, they say, at keeping the *real* exchange rate (RER) undervalued and thus fostering exports and growth[1]. This view, however, is not supported by the most prominent economic models, which do not predict a positive relationship between an undervalued RER and growth. According to them, either changes in the nominal exchange rate should be accompanied by changes in prices that would virtually leave the RER unchanged, or, if the pressure for appreciation is somehow "controlled" through a containment of the domestic demand, the induced real depreciation would introduce a distortion and lead to a misallocation of resources and an eventual *fall* in real output.

In this paper, I combine A. Lewis' idea of *unlimited supply of labor* (Lewis (1954)) with Corden and Neary's notion of *Dutch disease* (Corden & Neary (1982)) to explain how a policy aimed at depreciating the RER can generate real growth and facilitate the transition from a traditional to a modern economy in countries with relative abundance of labor and scarcity of natural resources. The model's predictions are consistent not only with the main features of the Chinese experience but also with those of most Asian "miracles" and other developing countries in Latin America and South Saharan Africa. The key elements in the proposed mechanism are frictions in the labor market and reallocation of labor across sectors. In the model, high rates of growth are sustained by reallocating labor from a low-productivity traditional sector (agriculture and nontradables) to a high-productivity manufacturing one. With diminishing returns in agriculture, a policy aimed at lowering wages induces migration to manufacturing by increasing the wage differential across sectors, thereby generating a real depreciation and growth, and moving the economy to a new steady state with higher per capita income. Interestingly, the effect of such a policy is potentially stronger in economies with relatively low endowments of natural resources, which is precisely the case of most Asian countries.

This paper is related to at least three bodies of literature. First, it is part of the new literature on the effect of a *persistent* real exchange rate depreciation on growth. Most of this literature is empirical and has been devoted to document the relationship between RER and growth and other macroeconomic variables (see, for example, Razin & Collins (1997), Hausmann *et al.* (2005), Prasad *et al.* (2006), Eichengreen (2007), Rodrik (2008), Berg & Miao (2010), Jeong *et al.* (2010), Aflouk & Mazier (2011), and Rapetti *et al.* (2012) among others). As Montiel & Servn (2008) mention, there are basically two proposed theoretical channels to explain a possible positive relationship between RER depreciation and growth: the "TFP" channel, which assumes that increasing the production of tradables has a positive effect on TFP growth; and the "capital accumulation" channel, which relies on a link between real depreciation, domestic savings, and capital accumulation (see Levy-Yeyati & Sturzenegger (2007) and Montiel & Servn (2008)). Despite the fact that the mechanism proposed in this paper shares some elements with the "capital accumulation" view, it is nonetheless a radically different channel, whose key element is the intersectoral reallocation of labor motivated by the depreciation. This key feature of the mechanism makes the paper, at the same time, part of a recent literature focused on micro-level resource misallocation to explain low levels of aggregate TFP. In one of the most recent and influential papers in this field, Song *et al.* (2011) explain the high rates of growth and savings of China with a mechanism that emphasizes the role of financial frictions and reallocation of resources between firms in the manufacturing sector. In contrast, this work focuses on labor frictions and intersectoral reallocations which, besides explaining the high rates of growth and savings recently observed in many Asian economies, provide also a rationale for the undervalued currencies, the high rates of urbanization, and the decline in the size of traditional sectors experienced by them. The paper is related in this field with, for example, the work of Banerjee & New-

[1] See, for example, Wiemer (2009), Davis (2012), Lee (2012).

man (1998) and Banerjee & Duflo (2007), and with the recent empirical evidence on productivity and income gaps presented in Bosworth & Collins (2008), McMillan & Rodrik (2011), Gollin *et al.* (2011), and de Vries *et al.* (2012)[2]. Finally, this paper is related to the literature on structural transformation. Specifically, the model explains how the speed of the transition from an agricultural/traditional to an industrial economy can be affected by interventions aimed at lowering real wages, particularly in countries with scarce natural resources.

In the proposed model, workers that migrate from the traditional economy to the manufacturing sector face a loss of utility (i.e. an entry cost), which reduces the *minimum* wage that they are willing to accept in the traditional economy before migrating, and *can* potentially create a wedge between the wages (and productivities) in both sectors. In this context, a policy that lowers the real wage in the traditional sector can eventually trigger (or accelerate) the migration of workers to manufacturing, and generate growth through a better allocation of labor. Once the intervention (aimed at depreciating the RER) ceases, the economy behaves as in a standard neoclassical model where growth depends on TFP growth. These predictions are consistent with the experience of most East Asian countries (and with the recent experience of China, in particular), that have sustained high rates of growth for long periods of time by mobilizing employment from an initially overpopulated traditional economy to the industrial sector[3], a fact that was already documented by Alwyn Young in his celebrated paper *The Tyranny of Numbers* (Young (1995)) in Hong Kong, Singapore, South Korea and Taiwan.

A particular feature of the theory proposed in this paper is that the potential effects of a government-induced real undervaluation depend on the size and productivity of the agricultural sector. Specifically, a more productive agricultural sector and a higher endowment of agricultural land imply either a higher wage in the sector or higher land's rents (or both), which tends to increase the difference between the actual and the minimum wage workers in the traditional economy are willing to accept before migrating. In this context, inducing migration to manufacturing requires a larger real depreciation (i.e. a larger fall in wage) and, given the higher initial productivity in agriculture, has a smaller final effect on growth. This prediction of the model is consistent with the fact that, as shown in Section 1 of the paper, the use of (policy-induced) undervalued RER's seem to be more extended and effective in Asian countries, where the relative endowment of land suitable for agriculture is lower (see Table 2). These empirical regularities predicted by the model are also consistent with the empirical analysis performed in Section 3, which shows that the East Asian countries have been more prone to experience policy-induced real undervaluations in the last two decades. Finally, and also in line with the predictions of the model, the empirical analysis verifies that the positive relationship between real undervaluation and both, growth of per capita GDP and manufacturing production, is stronger in countries with lower endowments of agricultural resources, higher ethnolinguistic fractionalization, and higher initial rural population.

The paper is organized as follows: Section 1 describes the empirical evidence from Asia, Latin America and S.S. Africa that motivates the main assumptions of the model. Section 2 introduces the model, characterizes the equilibrium, and analyzes possible government interventions aimed at depreciating the RER and their potential effects on growth. Section 3 verifies additional empirical regularities predicted by the model using a panel of countries between 1970 and 2010. Section 4 concludes.

# 1 Empirical Regularities

In this Section I present some empirical evidence on the relationships between real undervaluation, growth, manufacturing production and employment, and gross savings, across different countries and regions. I provide the intuition of the mechanism that explains the links between these variables and identify the conditions that make them potentially stronger. I finish the Section providing empirical

[2] In a broader sense, the paper is also part of an extensive literature on the causes and consequences of rural-urban labor migration that follows, among others, the work of Harris & Todaro (1970).

[3] The mobilization of labor has been accompanied by the corresponding expansion of the stock of capital in that sector.

evidence that such conditions are mainly observed in Asia, and in China in particular.

### 1.1 Real Exchange Rate Undervaluation and Growth

In an influential (and no less controversial) paper, Rodrik (2008) argues that undervaluation of the currency (i.e. a real exchange rate depreciation) stimulates economic growth, and that the effect is particularly strong in developing countries. Using a Balassa-Samuelson-adjusted PPP method to measure undervaluation, Rodrik presents evidence suggesting that the link between RER undervaluation and growth is through the expansion of the industrial sector. In an extension of Rodrik's work, Berg & Miao (2010) find similar results. Among other papers that, using different measures of RER misalignment, document similar regularities are Aguirre & Caldern (2005), Polterovich & Popov (2005), Sallenave (2010), Aflouk & Mazier (2011), and Breau *et al.* (2012)[4]. In addition, many of these works and others like Sachs & Williamson (1985), Edwards (1988), Ghura & Grennes (1993), Loayza *et al.* (2004), and Rajan & Subramanian (2011) find evidence of the *negative* effects of RER *overvaluation* on growth.

[Figure 1 here]

The recent experience of China provides a good example of the positive relationship between undervaluation and growth. Figure 1 presents data on per capita GDP growth (PPP) and an index of RER undervaluation[5] for China, India, and two groups with the main non oil-exporting economies of Latin America and South Saharan Africa, respectively. Based on the figures, three main observations can be made regarding the relationship between undervaluation and GDP growth. First, the relationship is not necessarily positive in the short run, particularly for the Latin American countries where the frequent recessions are usually accompanied by real depreciations[6]. Second, the relationship holds in the long run, but is not monotonic: the Asian countries were on average both, the most undervalued (China 27% and India 52%) and the ones that experienced the highest growth (8.5% and 3.0% respectively), in comparison to the Latin American and African countries that were relatively *overvalued*[7] during the period (with an index of undervaluation of -5% and -11% respectively) and experienced the lowest growth (1.9% and 0.7% respectively). And, third, the relationship is not equally strong and in the same direction in all countries: it seems to be positive in India, the African countries, and China in particular, while in Latin America the relation is either null or negative.

Similar conclusions can be verified when considering a larger sample of countries and a longer period. Table 1 presents several economic indicators for developing countries[8] of Asia, Latin America and Caribbean, and South Saharan Africa. Columns (2) and (3) show that, besides China and India, other Asian economies also maintained relatively high levels of undervaluation (21% in average) and experienced high rates of growth (3.2% annual per capita in average over the entire period). The most relevant examples in this group are South Korea, Singapore, Hong Kong, Indonesia, Malaysia, Thailand and, more recently, Vietnam and the Philippines. Their performance is in sharp contrast with that of the African economies, which maintained high levels of *overvaluation* (-22% of undervaluation) and experienced very low rates of growth (0.5%). Finally, the link between real undervaluation and growth is, again, weaker in the Latin American countries, which experienced very modest growth (1.6% annual) and remained relatively undervalued during most of the period (11% in average).

[Table 1 here]

[4]See Eichengreen (2007) and Aflouk & Mazier (2011) for an extensive review of the theoretical and empirical literarure on real exchange rate missalignment and growth.

[5]The same measure used in Rodrik (2008). All the details regarding the estimation of this measure are discussed in Section 3.

[6]In Latin America the hyperinflations of the early 1990's, the Mexican crises of 1995, the Brazilian devaluation of 1999, and the Argentine crisis of 2002 are all associated with both, recessions and large real depreciations.

[7]Overvaluation is simply understood as negative undervaluation.

[8]Countries with per capita GDP (PPP 2005 USD) lower than 10,000 in 1970. The only countries in these regions that were excluded are Australia, New Zealand, Japan, Barbados and Trinidad & Tobago.

## 1.2 Savings

Column (5) of Table 1 presents information about savings in these economies. The most striking case is China that, besides maintaining an extraordinary high average saving rate of 38.6% of GDP for more than 40 years, has systematically increased the rate surpassing 50% of its GDP in the late 2000's. This increase of the saving rate (and particularly the accumulation of foreign assets during the last decade) combined with an acceleration of GDP growth in China is consistent with the evidence presented in Song *et al.* (2011). But Column (5) shows that savings have also increased in other Asian countries. In fact, with the exception of Bangladesh, Pakistan and the Philippines, the saving rate in all these economies has increased and remained high (above 30% of GDP) during the last 20 years. As Prasad (2011) documents, a common feature across Asian countries during the last decade is the increase in corporate savings, a phenomenon that seems to accompany the high rates of growth and relative undervaluation of the economies of the region. These facts are consistent with the findings of Montiel & Servn (2008), who document a negative relationship between savings and real exchange rate for the fast-growing East Asian economies. These authors point out that, since both the real exchange rate and savings are endogenous variables, we should not, *a priori*, expect a systematic correlation between them, except for the countries that adopt the real exchange rate as a tool of development policy, which seems to be the case of many Asian economies[9]. The case of S.S. Africa is, again, on the other extreme. Gross savings, that were already low in the early 1970s, further declined over in the following decades to reach an average of 10.5% of GDP in the late 2000's. The real exchange rate, at the same time, remained very overvalued during the entire period, which seems to be related with the large aid inflows experienced by the region[10], as evidenced by Rajan & Subramanian (2011).

The Latin American countries maintained a relatively stable but low saving rate through the period[11]. The region registered its lowest saving rate (17.9% of GDP in average) between 1991 and 2003, a period of large capital inflows, relatively high overvaluation, and high but volatile growth.

## 1.3 The Manufacturing Sector

Columns (5) and (6) of Table 1 provide information about the size of the manufacturing sector relative to, both, GDP and to total production of tradable goods[12]. Between 1970 and 2010, manufacturing production in Asia grew faster than total GDP and, in particular, considerably more than the production of other tradable goods (namely, agriculture, mining and forestry). This is is consistent with the evidence presented by Rodrik (2008), who argues that, in low income countries, the positive effect of undervaluation on growth takes place through an expansion of the industrial sector. In sharp contrast, the manufacturing sector in S.S. Africa (that was already small in 1970/74, accounting for 11.3% of GDP) shrank during the same period , and the production of tradable goods further concentrated on commodities based on natural resources. This is consistent with the literature that highlights the potential adverse effects of overvaluation on the manufacturing sector. These facts are also in line with the evidence presented by Rajan & Subramanian (2011), who suggest that the poor performance of the manufacturing sector Africa is related to the appreciation of the RER caused by aid inflows. Finally, the manufacturing sector in Latin America also shrank (relative to GDP) during the period, and slightly reduced its share in the production of tradable goods.

[9]Montiel & Servn (2008), p.10.

[10]In average, between 1985 and 2010 the amount of Net Official Development Assistance received by the region accounted for more than 5% of GNI (source: WDI).

[11]See Edwards (1996).

[12]Total production of tradable goods is estimated as the sum of industrial production (which includes manufacturing and mining) and agricultural production. Specifically, it corresponds to categories A through E of ISIC Rev.3. This measure is a good approximation of total tradable production, but is not exact since it includes electricity, gas and water supply (category F), most of which is non tradable, and does not consider production of exportable services, whose relative importance remains low but has increased in the last years.

[Figure 2 here]

Figure 2 presents data on the share of employment in manufacturing and, again, the index of undervaluation between 1990 and 2005 (2007 for China)[13]. From simple inspection it can be seen that, besides the differences in levels of each of the variables across countries and regions, employment in manufacturing and the index of real undervaluation follow similar patterns in all of them. The only exception is Latin America in the years between 2000 and 2005, where employment in manufacturing continues its declining trend despite the fact that the RER began to depreciate.

### 1.4 Some Questions

It follows from the analysis of Tables 1 and 1 and Figures 2 and 1 that the relationships between real undervaluation, manufacturing production and employment, and GDP growth appear to be stronger in China, particularly after the reforms of 1992 and the devaluation of 1994, where the three indicators first move downward in the aftermath of the Asian crisis (with a slowdown of GDP growth, a fall in manufacturing employment and an real appreciation of the Renminbi), and then move up together uninterruptedly from 2001 to 2007. In India and S.S. Africa, undervaluation and manufacturing employment follow relatively similar trends, but, in both cases, real GDP is less sensitive to changes in both variables than it is in China. Finally, as it was already mentioned, the link between real undervaluation and manufacturing production and employment and with GDP growth appears to be much weaker in Latin America.

At least four important questions arise from the previous analysis. First, what is the mechanism, if any, that links real undervaluation with production and employment in the manufacturing sector? Second, how do changes in manufactures translate into higher rates of GDP growth? Third, why do these links seem to be particularly strong in China and other Asian countries, but weaker in S.S. Africa and practically inexistent in Latin America? And, finally, what is the role that savings play in instrumenting a policy that effectively undervalue the RER, and (eventually) triggers an expansion of the manufacturing sector and boosts growth? I sketch some answers to the first three questions before jumping into the model where all of them are addressed in depth.

**Undervaluation and the Value of Manufacturing Production (% GDP).** If the law of one price holds for tradable goods (or if at least it holds relatively more for tradables than for nontradables), then changes in the real exchange rate should be mainly associated with changes in the relative price of nontradables. How can a fall in the relative price of nontradables (i.e. a real undervaluation) be associated with an increase in the share of manufacturing production in GDP? In an economy that is a net exporter of manufactures (which is the case of most Asian countries), the link between a real undervaluation that endogenously responds to changes in fundamentals (e.g. a fall in terms of trades of in the productivity of the manufacturing sector), and the value of manufacturing production relative to GDP is expected to be negative: the fall in the terms of trade or in the productivity of the exportable sector, which reduces the value of manufacturing production (and of exports) relative to GDP, inducing a contraction in aggregate demand and a (relative) fall in the price of nontradables. In order to obtain a positive relationship between real undervaluation and manufacturing production[14], it is necessary that the fall in the price

[13] Unfortunately there is no data on sectoral employment before 1990 for China and several other countries. The data used here is mainly from Timmer & de Vries (2009) and McMillan & Rodrik (2011).

[14] The other possible explanation for the positive link between undervaluation and the share of manufacturing production in GDP requires the economy to be a net *importer* of manufactures (and therefore a net exporter of commodities or services), which is not the case of the Asian countries. In this case, the real depreciation could be induced by either a fall in the terms of trade or in the productivity of the exportable sector, which affects reduces the value of the exportable production and, with it, aggregate demand and the demand for nontradables. Since neither the productivity nor the price of manufactures change, the shares of manufacturing production in both, GDP and total tradable production, increase. This case, however, does not seem to correspond with the conditions of the Asian countries, which are net exporters of manufactures an importers of commodities.

of nontradables responds to an "exogenous" contraction of aggregate demand (that is, one that is not endogenously caused by a fall in terms of trade or in the productivity in the exportable sector), which impacts negatively on the price (and, probably, the quantity produced) of nontradables, but does not affect the value of the production of tradables (among them, the manufactures), whose productivities and prices remain unchanged[15].

**Undervaluation and Employment in Manufacturing.** Everything else constant, a real depreciation implies that the relative price of tradables (not only manufactures, but also commodities and, in particular, agricultural) increases, so that the demand for labor and capital in those sectors also increase. Employment in manufacturing increases if the real wage in that sector increases relatively more than the real wage other tradable sectors, which is expected to happen if, as usual, labor productivity in agriculture (and in the production of other commodities) diminishes with the addition of workers due to the fact that the stock of land is fixed.

**Employment in Manufacturing and GDP Growth.** The link between growth in employment in manufacturing and real GDP growth is not trivial. Indeed, in a frictionless economy, the reallocation of labor toward manufactures induced by an "exogenous" real undervaluation would actually cause a loss of efficiency and hurt GDP growth. This is the reason why some authors appeal to the existence of (*indirect*) positive TFP effects associated with the expansion of the manufacturing sector (or, more generally, the exportable sector) in order to explain the positive link between real undervaluation, manufacturing production, and growth[16]. I take a different stand here. My hypothesis is that the positive effect on growth from the reallocation of labor to the manufacturing sector is actually *direct,* and would come from the fact that labor productivity in the manufacturing sector is higher than in the nontradable and the agricultural sector (which constitute the "traditional" sectors of these economies). In this case, the real depreciation would induce migration of (low-cost) workers from an initially low-productivity tradicional economy to a high-productivity manufacturing sector, implying an improvement in the allocation of labor. This is precisely the environment described by Lewis (1954), in which an *unlimited* (large) supply of labor is available at *zero* (very low) cost. Clearly, the larger the productivity gap between sectors, the larger the effects on growth from the reallocation of workers.

The question now is where that initial labor productivity gap (between manufacturing and the traditional sectors) comes from. One possibility (that is explored in detail below) is the existence of entry costs for workers that want to enter the manufacturing sector.

**Why in Asia?** With some light about the elements that link an induced undervaluation with employment in manufacturing, and this with real growth, we can outline an answer to the question about the reasons why this mechanism seems to work in China and other Asian economies, but not so much in South Saharan Africa and Latin America. My hypothesis is that, as shown in the next section, the conditions described above (high entry costs for workers in manufacturing, high productivity gap between sectors, and large shares of employment in the low-productivity sector) are more likely to hold in Asia, and in particular in China, than in S.S. Africa or Latin America.

### 1.5 Labor Productivity in Manufactures and Agriculture

[Figure 3 here]

[15] I use this outcome in Section 3 to identify the "exogenous" undervaluations (that is, those that are not related to changes in fundamentals).

[16] See, for example, Eichengreen (2007).

Figure 3 presents the ratio of average labor productivities in manufacturing and agriculture, between 1990 and 2005, for China, India, and the main non oil-exporting economies of Latin America and S.S. Africa[17]. The figure confirms, first, that there exist opportunities for growth in all these regions by reallocating workers to the manufacturing sector, and, second, that such growth opportunities are particularly relevant in China where, in 2003, the average worker in manufacturing was almost 10 times more productive than the average worker in agriculture. The persistence (and even widening) of the productivity gaps is evidence of the existence of labor market frictions or entry costs in the manufacturing sector. The productivity gap has increased in China (since the reforms in the early 1990s), and in India (since 2001). On the other hand, the gap has declined in S.S. Africa (during the entire period), and in Latin America (since the middle 1990s).

The regularities presented in Figure 3 are consistent with the evidence presented in an IMF Report of 2006 (Jaumotte & Spatafora (2006)) that highlights that despite the fact that the agricultural sector throughout developing Asia (and China, in particular) is characterized by a relatively low level of labor productivity, it accounts for a very large share of employment. In this line, Bosworth & Collins (2008) estimate that the productivity gap (i.e. ratio) between workers in the industrial sector and those in agriculture was in 2004 of 7 in China, and 4 in India. McMillan & Rodrik (2011) document that the average manufactures-agriculture productivity gap is 2.3 in S.S. Africa, 2.8 in Latin America, and 3.9 in Asia, and emphasize the role of labor reallocation as a contributor of growth in Asia. Using a more disaggregated database, de Vries *et al.* (2012) confirm these results. In a recent work, Gollin *et al.* (2011) use micro data from households surveys to document that the gap between agriculture and the rest of the economy persists across regions even after controlling by hours worked and level of human capital. Using their data, we can verify, again, that while the productivity gap in China is higher than in most developing countries, in Latin America it is particularly low. What lies behind the differences in productivity gaps across countries and regions? Figure 4 shows the average labor productivity in manufacturing and agriculture, both expressed in constant PPP USD of 2000. The graphs show that, despite the extraordinary growth in manufacturing productivity in China after the reforms in the early 1990s, average labor productivity in that sector is still lower, in 2005, than in Latin America (which is, at the same time, low relative to the industrialized countries). It follows, then, that the key behind the extraordinary high productivity gap in China is not a particularly high level of productivity in manufacturing but, instead, a strikingly low productivity in the agricultural sector. Indeed, except for 2005, China had the lowest labor productivity in agriculture during the entire period (the same applies for India, whose agricultural productivity in 2005 remained close to China's, well below the level of S.S. Africa and Latin America). Analogously, the reason behind the relatively low productivity gap in Latin America has mainly to do with the high (and increasing) labor productivity in agriculture in the region.

[Figure 4 here]

### 1.6 The Role of Natural Resources

A question that follows from the previous analysis is why is agricultural productivity so different in Asia and Latin America. Part of the answer is given in column 3 of Table 2 , which displays the endowment of agricultural (arable and cultivable) land per inhabitant of the different regions in 1990. The Asian countries have the lowest endowment of agricultural land relative to the size of their population and, among them, China ranks worst. Latin America and Africa, on the other hand, have the highest ratios, with per capita endowments 3 times larger that of China. The numbers become even more contrasting when we consider the share of rural population in each of the regions (column 5). More than 70% of the population in the Asian and African countries lived in rural areas by 1990, compared with 29% in Latin America. Indeed, the endowment of agricultural land *per rural inhabitant* in 1990 was about 7.5

[17]Labor productivity is estimated as the ratio between value added and employment in each sector.

times higher in Latin America than in Asia, a number that is in line with the relative labor productivity in agriculture in both regions in the same year.

It is not only the availability of agricultural land (relative to the size of the population) that is higher in Latin America. The pattern persists when considering mineral resources. Column 3 of Table 2 presents per capita oil reserves for the different regions in 2002 (before the most recent discoveries of oil in Latin America). Again, the East and South Asian countries rank worst. Per capita oil reserves in the Latin American countries were, in average, 9 times higher than in China in that year[18]. The pattern is confirmed when comparing the amount of rents from natural resources, which are displayed in columns 1 and 2 of the table. Between 1990 and 2010, per capita rents from natural resources were about 6 times higher in Latin America than in China, and almost 14 times higher than in India.

[Table 2 here]

The evidence suggests that differences in endowments of natural resources lay behind the observed disparity of sectoral productivity gaps. The simultaneous observation of such gaps in productivities, on the one hand, and of high shares of rural population, on the other, strongly suggest the existence of frictions in the labor market that prevent an efficient allocation of labor. This situation is evident in the Asian countries, and in China in particular, where the differences in sectoral productivities as well as the fraction of population in the low-productivity sectors are larger[19]. It is precisely in such countries where policy-induced real depreciacions seem to play an important role facilitating the movility of workers, the expansion of the manufacturing sector, and, eventually, economic growth. In the following section I develop a model that incorporates and these elements and provides an explanation for the observed empirical regularities.

## 2 Model

Consider a static, small open economy with three sectors: agriculture, nontradables, and manufactures (with prices $p_A$, $p_N$, and $p_M$ respectively). Agricultural goods and manufactures are tradable, and their prices are given internationally. The economy is populated by a continuous mass ($L = 1$) of individuals that supply inelastically $1$ unit of labor and consume a basket (based on utility maximization) of agricultural, nontradable, and manufacturing goods whose price is $p = \tilde{p}\left(p_A, p_N, p_M\right)$.

There is one competitive firm in each sector. Agricultural goods are produced combining labor ($L_A$) and land ($F$). The supply of land, $F$, is exogenously given, so that the production function of agricultural goods, $Y_A = A_A G(F, L_A)$, exhibits diminishing returns in labor. The production of nontradables and manufactures requires only labor, and their production functions, $Y_N = A_N L_N$ and $Y_M = A_M L_M$ respectively, exhibit constant returns[20].

For simplicity, assume that land rents are distributed uniformly across individuals, so that each individual receives an amount $t \equiv r_L F$, where $r_L$ the rental price of land[21].

[18]The number is still above 3 if Venezuela is excluded. Recent discoveries of oil in the region, elevated the ratio of per capita oil in Latin America to China to more than 50 in 2011, and more than 8 if excluding Venezuela.

[19]Kuijs & Wang (2006) document the existence of barriers to labor mobility in China, and argue that its reduction would result in a sustantial reduction in the income gap between rural and urban workers.

[20]For simplicity and in order to highlight the key role of the labor market, the model only considers labor as a production factor (other than land). Capital can be included as an additional factor in the three sectors WLOG. If, for example, capital consists of manufactures and is mobile across sectors (this would be the case in which capital is mainly composed of machinery and equipment) the ratio $K/L$ in the manufacturing sector will be determined by $p_M$. On the other hand, if capital consists of a mix of tradable and nontradable goods (this would be the case in which capital combines equipment and infrastructure), a policy that depresses the nontradable sector and generates migration to manufacturing, will probably be accompanied by an increase in investment that will affect the demand for nontradables, partially offsetting the initial effect.

[21]This assumption is modified later, when the effects of different distributions of rents are analyzed.

## 2.1 Labor Market

The key assumption in the model is the existence of an *entry cost* for workers that enter the manufacturing sector. Specifically, individuals that migrate from either nontradables or agriculture to the manufacturing sector face a *loss of utility* $E_M \geq 0$[22]. There is no cost for workers that enter either agriculture or nontradables, which ensures that the wage is equalized between the two sectors. I refer to the combination of the agricultural and nontradable sectors as the *traditional* economy (or $T$-sector), whose wage is $w_T$ and total employment $L_T = L_A + L_N$. I use the subindex $M$ to refer to the manufacturing sector ($M$-sector), whose wage is $w_M$ and total employment $L_M$.

The first order condition of the problem of the firm in the manufacturing sector implies that $w_M$ is completely determined by the international price, $p_M$, and the productivity of the firm, $A_M$, and is equal to $w_M = p_M A_M$. Also, from the first order condition of the firm that produces nontradables, the price in the sector is $p_N = \frac{w_T}{A_N}$. Therefore, given the prices $p_A$ and $p_M$ and the technology $A_N$, the price of the consumption basket, $p$, can be expressed as a function only of $w_T$:

$$\begin{aligned} p &= \tilde{p}\left(p_A, p_N, p_M\right) \\ &= \tilde{p}\left(p_A, \frac{w_T}{A_N}, p_M\right) \\ &= p(w_T) \end{aligned}$$

## 2.2 Problem of the Individuals

The problem of an individual that is initially in sector $S \in \{T, M\}$ consists in choosing the sector $S' \in \{T, M\}$ and the basket of goods $\{c_A, c_M, c_N\}$ that maximize his utility (net of migration costs) subject to its budget constraint. The problem can be formalized as:

$$V(S) = \max_{\{c_A, c_M, c_N, S'\}} \left\{U(c\left(c_A, c_N, c_M\right)) - I(S' = M|S = T)E_M\right\}$$
$$\text{s.t. } p_A c_A + p_N c_N + p_M c_M \leq w_{S'} + t$$

where $S \in \{T, M\}$ is the sector where the individual is initially located, $S' \in \{T, M\}$ is the sector where the individual works (and whose wage is $w_{S'}$), $c\left(c_A, c_N, c_M\right)$ is an aggregator of final consumption, $t$ is the rent from land received by the individual, and $I(S' = M|S = L)$ is an indicator that takes value $1$ if the individual is initially in sector $T$ and decides to migrate to sector $M$, and $0$ in all other cases.

The problem can be solved in two stages. The first stage consists in solving for $\{c_A, c_M, c_N\}$ that maximize $c\left(c_A, c_N, c_M\right)$ for a given income $w_S + t$ and prices $\{p_A, p_N, p_M\}$. The price index $p = p\left(p_A, p_N, p_M\right)$ that results from this maximization allows to express the optimal final consumption as $c_S = \frac{w_S + t}{p}$, $S = T, M$. The second stage consists in choosing the sector $S' \in \{T, M\}$ that maximizes utility net of migration costs.

**An individual in the $T$-sector.** The decision of an individual that is initially in the $T$-sector can be formalized as:

$$V(T) = \max\left\{U(c_T), U(c_M) - E_M\right\}$$

where $U(c_T)$ is the value of *staying* in the $T$-sector, and $U(c_T) - E_M$ is the value of *migrating* to manufacturing.

[22] This loss of utility could be associated, for example, with the cost of search, acquisition of new specific skills, moving, the distance to relatives and friends, or the cost of adaptation to an environment with different culture and lifestyle.

Two important observations can be made here. First, assuming that $\lim_{L_A \to 0} G_L(F, L_A) = \infty$ (i.e. the marginal product of labor in agriculture approaches infinity as $L_A$ approaches zero) and that $\lim_{c_N \to 0} \frac{\partial U(c)}{\partial c_N} = \infty$ (i.e., the marginal utility of nontradable goods increases to infinity as $c_N$ approaches zero) ensures that agricultural and nontradable goods will always be produced. Therefore, the value of migrating to manufacturing, $U(c_M) - E_M$, will be, in equilibrium, no greater than the value of staying in the $T$-sector, $U(c_T)$ (otherwise, there would be complete migration to manufactures and no production of agricultural and nontradable goods). And, second, if reaching the equilibrium implies migration to manufactures (in the sense that the equilibrium's labor share in manufacturing is strictly higher than the initial one), then, once the equilibrium is reached, the value of staying in the $T$-sector is equalized to the value of migrating. In this case, $U(c_T) = U(c_M) - E_M \implies U(c_T) < U(c_M) \implies c_T < c_M \iff w_T < w_M$. That is, the existence of a positive entry cost $E_M > 0$, implies that the wage in the traditional sector is strictly lower than the wage in manufacturing *when there is migration*. In fact, the "migration condition" $U(c_T) = U(c_M) - E_M$ implicitly defines the *minimum observable wage in the $T$-sector*, $\underline{w}_T$, which satisfy: $U\left(\frac{\underline{w}_T + t}{p(\underline{w}_T)}\right) = U\left(\frac{w_M + t}{p(\underline{w}_T)}\right) - E_M$.

**An individual in the $M$-sector.** The decision of an individual that is initially in the $M$-sector can be formalized as:

$$V(M) = \max\{U(c_M), U(c_T)\}$$

where $U(c_M)$ is the value of *staying* in manufacturing, and $U(c_T)$ is the value of *migrating* to the $T$-sector. In this case, since there is no cost associated with entering the $T$-sector, migration to the traditional sector implies that $U(c_M) \leq U(c_T) \iff w_M \leq w_T$. Eventually, if the equilibrium is such that $w_M < w_T$, there is complete migration to the traditional sector and no production of manufactures.

### 2.3 Equilibrium

An important feature of the model is that, given set of parameters $\{A_A, A_N, A_M, p_A, p_M, F, E_M\}$, the equilibrium depends on the initial distribution of employment. Specifically, defining $L_{M0} \in [0, 1]$ as the *initial* share of labor in the manufacturing sector, there exist a minimum $\underline{L}_M$ and a maximum $\overline{L}_M$, with $0 \leq \underline{L}_M \leq \overline{L}_M$[23], such that, in equilibrium, $L_M$ and $w_T$ are:

| Equilibrium $L_M$ and $w_T$: | | Initial Empl. in Manuf. | Case |
|---|---|---|---|
| $L_M = \underline{L}_M$ and $w_T = \underline{w}_T$ | if | $L_{M0} \leq \underline{L}_M$ | [1] |
| $L_M = L_{M0}$ and $\underline{w}_T < w_T < w_M$ | if | $\underline{L}_M < L_{M0} < \overline{L}_M$ | [2] |
| $L_M = \overline{L}_M$ and $w_M \leq w_T$ | if | $\overline{L}_M \leq L_{M0}$ | [3] |
| (in this case, $w_M < w_T \iff \overline{L}_M = 0$) | | | |

In other words, for a given set of parameters, the equilibrium level of employment in manufacturing, $L_M$, and wage in the traditional sector, $w_T$, are in the ranges $[\underline{L}_M, \overline{L}_M]$ and $[\underline{w}_T, w_M]$ respectively (unless $\overline{L}_M = 0$ and $\underline{w}_T > w_M$, which is an extreme case with no production of manufactures), but the actual levels within those ranges depend exclusively on the initial employment distribution ($L_{M0}$ and $L_{T0} = 1 - L_{M0}$). Interestingly, there is reallocation of labor between from the traditional to the manufacturing sector only if $w_T = \underline{w}_T$ (the minimum observable), and from manufactures to the traditional sector if $w_T = w_M$ (the maximum). On the other hand, employment in manufactures does not change if $\underline{w}_T < w_T < w_M$, which is the case when $\underline{L}_M < L_{M0} < \overline{L}_M$. The three cases are summarized in Figure 5 and are described below.

[23]The minimum is $\underline{L}_M = 1 - \underline{L}_A + \underline{L}_N$, where $\underline{L}_A$ is such that $\underline{w}_T = p_A G_L(F, \underline{L}_A)$ and $\underline{L}_N$ is such that the market of nontradables clears. The maximum is either $\overline{L}_M = 1 - \overline{L}_A + \overline{L}_N$, where $\overline{L}_A$ is such that $w_M = p_A G_L(F, \overline{L}_A)$ and $\overline{L}_N$ is such that the market of nontradables clears, or $\overline{L}_M = 0$ if the market of nontradables does not clear with $w_T = w_M$.

[Figure 5 here]

### 2.3.1 Case 1: Expansion of the Manufacturing Sector

In case 1, employment in the $T$-sector, $L_{T0}$, is greater than the equilibrium level $L_T$, so that the value of *staying* in the sector is strictly lower than the value of *migrating*. Migration to manufacturing takes place until the "migration" condition (1) holds. Once $w_T = \underline{w}_T$, employment in agriculture $L_A$ is determined by the first order condition of the firm in that sector. Employment in manufacturing $\underline{L}_M$ and nontradables $L_N$ are simultaneously determined by imposing trade balance (or, equivalently, equilibrium in the nontradable market).

$$U\left(\frac{w_M + t}{p(\underline{w}_T)}\right) - U\left(\frac{\underline{w}_T + t}{p(\underline{w}_T)}\right) = E_M \tag{1}$$

Equation (1) shows how the fact that the entry cost in manufacturing is expressed in terms of utility implies that differences in $E_M$ do not translate into proportional differences in wages across sectors. Two elements are key here: the concavity of the utility function, and the average level of consumption in the economy. The effect of differences in the concavity of $U$ is straightforward: the higher the concavity, the larger the difference between $\underline{w}_T$ and $w_M$ for a given entry cost $E_M$. In other words, individuals with higher risk aversion will be willing to "tolerate" a lower wage $w_T$ before migrating to manufactures.

Similarly, the higher the level of consumption in both sectors, the larger the difference between $\underline{w}_T$ and $w_M$, which points to the potential effect of land rents ($t$) on the wage $\underline{w}_T$. In particular, everything else constant, *in an equilibrium with migration to manufacturing* higher rents are associated with a lower wage in the traditional sector $\underline{w}_T$. That is, in two otherwise identical economies in which employment in the manufacturing sector is expanding (i.e. the migration condition (1) holds), strict concavity of preferences implies that the wage in the traditional sector in the economy with *higher per capita rents* (presumably an economy richer in natural resources) is *lower*. This is a somehow counter-intuitive result that is key to understanding the mechanism played by real exchange rate undervaluations. The intuition is simple: the larger the rents or transfers $t$, the higher the level of consumption, and the lower the marginal utility of consumption. A larger difference in wages is therefore necessary to generate the same gap in utilities $E_M$. In other words, the richer the individuals in terms of rents or transfers that are not directly linked to their work, the lower the wage they will be willing to accept before deciding to migrate. This result does not mean that the *actual* (observed) wage in the traditional sector ($w_T$) of an economy richer in natural resources will necessarily be lower than in poorer ones. Instead, what the result implies is that the width of the inaction zone is larger in this case, so that the wage that triggers migration to manufacturing ($\underline{w}_T$, the minimum observable) is lower (and, therefore, less likely to be observed in equilibrium).

### 2.3.2 Case 2: Inaction

Case 2 corresponds to situations in which the equilibrium level of employment in manufacturing, $L_M$ is equal to the initial level, $L_{M0}$. The equilibrium wage $w_T$ is strictly higher than $\underline{w}_T$ but lower than $w_M$, and therefore remains inside the inaction zone $[\underline{w}_T, w_M]$.

In this case $L_M = L_{M0}$, and total employment in the $T$-sector remains unchanged $L_T = L - L_{M0}$. Employment in agriculture, $L_A$, and the wage in the sector, $w_T$, are determined by the first order conditions of the firm in agriculture and the trade balance condition.

### 2.3.3 Case 3: Contraction of the Manufacturing Sector (de-industrialization)

Case 3 corresponds to a situation in which initial employment in manufacturing is higher than the level consistent with the equilibrium (so that $w_M$ is initially lower than $w_T$). The achievement of equilibrium is accompanied in this case by a process of de-industrialization in which workers migrate to the traditional sectors. This scenario can occur if, for example, the productivity or the price in the agricultural sector increases (or if the productivity or price in manufactures decreases), or if the productivity in nontradables increases systematically less than in tradables (i.e. the Balassa-Samuelson effect).

The equilibrium wage in the traditional sector that is consistent with a *partial* de-industrialization (i.e. $0 < L_M = \overline{L}_M < L_{M0}$) is $w_T = w_M$ (Case 3a). Given this wage, $L_A$ is determined by the first order condition of the firm in agriculture and $L_M$ by the trade balance condition.

In the extreme case in which there is *complete* de-industrialization (i.e. $L_M = \overline{L}_M = 0$), the economy functions only with its traditional sectors (Case 3b), so that total employment is split between agriculture and nontradables. The equilibrium wage $w_T$ (which is strictly higher than $w_M$) and employment in agriculture $L_A$ are simultaneously determined by the first order condition of the firm in agriculture and the trade balance condition.

## 2.4 Comparative Statics

In this section I perform some comparative statics. I analyze changes in the entry cost, the assumptions regarding the distribution of land rents, the productivity of the manufacturing sector, and, most importantly, the availability of land.

### 2.4.1 Reduction in Entry Costs

[Figure 6 here]

The effect of a reduction in the entry cost $E_M$ is straightforward. It follows from equation (1) that, as $E_M$ decreases, $\underline{w}_T$ increases, so that the inaction zone narrows from below. Whether this change affects the observed equilibrium depends on the initial equilibrium. For example, if $w_T$ is relatively close to $\underline{w}_T$ in the initial equilibrium, then the change in $E_M$ will probably make the migration condition (1) binding and will induce migration to manufactures and an increase in $w_T$[24] (Case A in Figure 6). If, on the other hand, the initial $w_T$ is relatively distant from $\underline{w}_T$, it may occur that the reduction in $E_M$ does not effect the observed equilibrium (Case B in Figure 6).

### 2.4.2 Changes in the Distribution of Rents

[Figure 7 here]

The initial analysis assumed that land rents are equally distributed across the population. This section analyses the effects of two alternative distributions of such rents, which are presented in Figure 7.

The first case assumes a more "progressive" distribution, that is, one that favors the workers in the traditional sector. Incentives for migration to manufactures decrease, the wage that triggers migration, $\underline{w}_T$, falls and the inaction zone widens. The opposite is true if a more "regressive" distribution of rents is assumed, that is, one that favors relatively more the individuals in the manufacturing sector. In this case $\underline{w}_T$ increases, the inaction zone shrinks and workers in the traditional sector are more likely to migrate. In both cases, the magnitude of the effect on $\underline{w}_T$ from changes in the distribution of rents depends the amount on land, $F$[25].

[24] The increase in $w_T$ implies that employment and production in agriculture falls, as well as land rents, which reinforce the incentives for migration to manufactures. This is, however, a second order effect whose magnitude does not affect significatively the results.

[25] The role of the distribution of rents is key in economies with high endowments of natural resources, as is the case of many Latin American countries. If rents are sufficiently high, a redistribution that favors workers in the manufacturing sector can actually eliminate the inaction zone.

### 2.4.3 Increase in Manufacturing Productivity

The effects of an increase in the productivity of the manufacturing sector, $A_M$, are mixed. First, the most direct consequence is an increase in $w_M$ provided that the $p_M$ remains unchanged. Second, following this increment in $w_M$, equation (1) implies that $\underline{w}_T$ increases as well. The intuition of this change is simple: an improvement in $w_M$ increases the value of migrating to manufactures, raising therefore the wage that leaves individuals indifferent between staying in the $T$-sector and migrating ($\underline{w}_T$). Moreover, strict concavity of $U$ implies that the change in $\underline{w}_T$ is proportionally smaller than the increment in $w_M$, implying that the absolute width of the inaction zone actually increases.

The third consequence of an increase in $A_M$ is related to the income effect that accompanies the increase in $w_M$. Specifically, an increase in $w_M$ will increase aggregate income and the domestic demand for the three goods in the economy[26] (as long as manufactures are produced in the economy, i.e. $L_{M0} > 0$). The response of the nontradable sector to a higher demand is to expand production by adding more workers which, given the diminishing marginal product of labor in agriculture, is accompanied by an increase in $w_T$ and, consequently, in $p_N$. This implies an *appreciation*of the RER.

[Figure 8 here]

The final effects on the actual size of the productivity gap and on $L_M$ depend on the initial conditions. If the initial share of labor in manufacturing ($L_{M0}$) is relatively low and $w_T$ is close to $\underline{w}_T$ (Case A in Figure 8), the increase in $A_M$ will make the migration condition (1) binding and, therefore, will be associated with a *increase* of the productivity gap and an expansion of the manufacturing sector. This prediction of the model is consistent with the evidence from China, where the increase in manufacturing productivity that started in the early 1990s has been accompanied by, simultaneously, an increase in the productivity gap and an expansion of employment and production in the manufacturing sector. On the other hand, if $L_{M0}$ is relatively high and $w_T$ is high (close to $w_M$), the income effect will probably prevail, and the increase in $A_M$ will be followed by a contraction of manufacturing employment and an expansion of nontradables (Case B in Figure 8). Finally, in an intermediate case (with $L_{M0}$ and $w_T$ at "intermediate" levels - Case C in Figure 8), the increase in manufacturing productivity will have no effect on manufacturing employment. The composition of aggregate production will be affected, however, with manufacturing and nontradable production increasing (due to higher productivity and employment, respectively), and agricultural production diminishing (due to lower employment in the sector). In all cases there is a real appreciation of the RER.

### 2.4.4 Differences in Endowments of Natural Resources

[Figure 9 here]

The modification of the endowment of land, $F$, has two main implications for the equilibria. First, a higher endowment of land implies, everything else constant, that the productivity of workers in the agricultural sector is higher, so that both, the equilibrium wage in the $T$-sector, $w_T$, and the rents from land, $t$, are higher as well. Aggregate income and demand are, therefore, higher also, which, as in the previous case, implies a higher demand for nontradables, a further increase in $w_T$, and a more appreciated RER. Second, a higher $F$ implies a wider inaction zone. This simply follows from the fact that, as explained above, $\underline{w}_T$ depends negatively on the level rents, $t$. Therefore, a higher endowment of land, $F$, implies, on the one hand, that the equilibrium wage, $w_T$, is higher, and, on the other, that the wage that triggers migration to manufactures, $\underline{w}_T$, is lower. Figure 9 illustrates the equilibria of two (otherwise equal) countries with different endowments of natural resources. The country richer in natural resources (green) has a higher $w_T$ (and, therefore, a smaller wage gap between sectors) and a wider inaction zone. The opposite is true for the country poorer in natural resources (red).

[26] Assuming that the three goods are "normal" goods.

## 2.5 Costs and Gains from Labor Reallocation

As expected, the entry cost in the manufacturing sector potentially induces an inefficient allocation of labor, which is reflected in the wage gap between sectors (i.e. $w_M - w_T$) . Such wage differential represents, at the same time, the *potential gains* in terms of production associated with the reallocation of workers from the traditional to the manufacturing sector. These potential gains are, as it was seen above, greater in economies with lower endowments of natural resources, which have a lower equilibrium wage in the traditional sector, $w_T$[27].

But the reallocation of labor is also costly, provided that workers migrate voluntary to manufactures only if the wage in the $T$-sector, $w_T$, is at the bottom the inaction zone, $\underline{w}_T$. The difference between $w_T$ and $\underline{w}_T$, therefore, provides an idea of the *distortion* that has to be introduced in order to incentivize voluntary migration. In other words, in the same way that $w_M - w_T$ *represents the gains* from labor reallocation, the gap $w_T - \underline{w}_T$, *represents the costs* of such reallocation, given that in order for the condition $w_T = \underline{w}_T$ to hold, the initial misallocation has to be first exacerbated by either inducing a fall in $w_T$, an increase in $\underline{w}_T$, or both. These costs are, as explained above, higher in economies with lower endowments of natural resources which, besides having a lower $w_T$, have a higher wage that triggers migration, $\underline{w}_T$, due to lower rents.

[Figure 10 here]

Figure 10 illustrates the potential costs and gains of labor reallocation for the two countries of the previous example (which differ in the endoment of land, $F$). As it can be seen, a (policy-induced) reallocation of labor from the traditional to the manufacturig sector is, in principle, more beneficial for the economy with lower endowment of land (in red), which needs to introduce a less severe distortion to get $w_T = \underline{w}_T$ and, at the same time, enjoy larger gains in labor productivity.

## 2.6 Room for Government Intervention

The previous analysis suggests that, under certain conditions, a policy aimed at reallocating labor from the traditional to the manufacturing sector can potentially improve the allocation of labor and generate growth. Additionally, it was shown that the equilibrium depends on the initial allocation of labor and, in particular, on the share of employment in manufactures. This implies that a *temporary* government intervention that effectively modifies the initial conditions has, potentially, a *permanent* positive effect on the allocation of labor, moving the economy to a more efficient equilibrium with higher per capita income. In the context of the static model analyzed here, a two-stage exercise can be designed: First, given the initial distribution of labor, the government invervenes with the objective of inducing a reallocation of labor to manufactures, so that the new level of employment in the sector is consistent with an equilibrium efficient from a point of view of production (i.e. one in which the wage in all sectors is equalized). And, second, given the new allocation of labor the intervention ceases and the economy operates in a standard way.

This section analyzes a set of possible interventions that might achieve the desired reallocation of labor. Despite the differences in instrumentation, the objective is, in all cases, to equalize the wage in the traditional sector with the lower bound of the inaction zone, so that workers voluntary migrate to manufactures.

### 2.6.1 Policies Aimed at Reducing Domestic Absorption

In the context of the model, any policy that reduces domestic absorption as measured *in terms of tradable goods* should, in principle, induce a fall in the relative price of nontradables (i.e. a real depreciation)

[27]The potential gains are even greater in economies with low $F$ if measured relative to per capita income, provided that per capita income is lower such economies

and in the wage in the traditional sector. This type of outcome can be obtained, *in the model*, through a contraction of aggregate demand (generated, for example, by the introduction of income taxes). *In practice*, however, a real depreciation can be induced in many ways. One of the most common practices consists in inducing a *nominal* depreciation (or devaluation) followed by a containment of the domestic absorption as measured *in domestic currency* (which can require the use of sterilization and the increase of domestic interest rates, and the imposition of measures that restrict of the expansion of domestic credit and public expenditure). In this case, the *real* depreciation results from the fact that the nominal depreciation increases the price of tradable goods (as measured in domestic currency) relatively more[28]. Another (more direct but less popular) alternative consists in inducing a contraction of the domestic demand as measured in domestic currency (for which measures such as rising taxes, cutting public expenditure and reducing domestic credit can help), which induces a real depreciation through a deflationary process that affects, mainly, the nontradable sector. In both cases the policies might be complemented with the imposition of controls on capital inflows.

**An Example in the Model** This section analyzes a particular example, in the context of the model, of a policy aimed at reducing domestic absorption, inducing a real depreciation, and facilitating the migration of workers from the traditional to the manufacturing sector. The example is by no means exclusive.

**First Stage (Government Intervention)** Assume that, in the first stage, the government imposes an ad-valorem income tax (so that the individuals' available income is a fraction $\gamma \in (0,1)$ of its pre-tax income) and lends abroad the tax revenue (at, for example, the international interest rate). In this way, the government intervention effectively reduces the domestic demand and increases domestic savings.

If the original wage in the traditional sector is inside the inaction zone (that is, $\underline{w}_T < w_T < w_M$), the contraction of domestic consumption induces a fall in the price of nontradables[29], a fall in the $w_T$, and a reallocation of labor from nontradables to agriculture. This initial depreciation has no effect on manufacturing employment (and in fact has a negative effect in aggregate production). Only when $w_T$ hits lower bound of the inaction zone, $\underline{w}_T$ migration toward manufactures begins. As explained above, this initial depreciation might be particularly large and costly in economies rich in natural resources, but relatively small and less distortive in countries with scarce natural resources, where the initial $w_T$ is closer to $\underline{w}_T$.

In addition to its effect on $w_T$, depending on the concavity of preferences, the tax can have an effect on $\underline{w}_T$. This can be seen in the migration condition (1) from which $\underline{w}_T$ is determined, which now takes the form:

$$U\left(\gamma \frac{w_M + t}{p(\underline{w}_T)}\right) - U\left(\gamma \frac{\underline{w}_T + t}{p(\underline{w}_T)}\right) = E_M \tag{2}$$

With logarithmic preferences, for example, a proportional income tax (like the one analyzed here) does not affect $\underline{w}_T$, so that once $w_T$ reaches $\underline{w}_T$, it remains at that level and the remaining adjustment is made through reallocation of labor to manufactures. With preferences less concave than logarithmic, the the wage that triggers migration, $\underline{w}_T$, also falls, so a larger depreciation is necessary before migration begins. Finally, if $U$ is more concave than the logarithmic function, the policy induces an increase in $\underline{w}_T$, so a smaller depreciation would trigger migration. In this particular case, if $w_T$ is initially sufficiently close to $\underline{w}_T$, the government intervention might end up inducing migration to manufactures and an *appreciation* of the RER.

[28]In his study of the instrumentation of this kind of policies, Rapetti (2013) finds that a nominal depreciation "simultaneously implemented with domestic demand management policies that prevent non-tradable price inflation and wage management policies" is more likely to accelerate growth.

[29]Assuming that the income elasticity of consumption is strictly positive.

In all cases, migration takes place until the *new* trade balance condition is satisfied, which implies a positive trade balance equal to the amount of resources that the government transfers abroad.

When should the government cease intervening? Ideally, as mentioned above, the intervention should cease when employment in manufactures reaches the level that is consistent with the efficient equilibrium, which implies that $w_T = w_M$ in the absence of intervention. (For the determination of such optimal level of employment in manufactures it is necessary to have into account the net payments that the country receives from the stock of international assets accumulated abroad.)

**Second Stage (Final Equilibrium)** Assume that, in the second stage, the government ceases invervening and distributes uniformly across individuals the interest of the stock of interational assets accumulated during the first stage[30]. Contrary to what occurs in the first stage, there are now three main reasons for which an expansion of the domestic demand takes place: first, the elimination of the tax, which increases individuals' available income; second, the wage of the population that was orginally in the traditional sector ($L_{T0}$) is now higher (and equal to $w_M$); and, third, the interest payments from the international assets accumulated abroad are now distributed in population. In addition, the trade balance condition implies now a trade deficit equal to the payment of interests received. As a consequence, the new and final equilibrium is characterized by a higher per capita income, a more appreciated RER (remember that, now, $w_T = w_M$), a larger nontradable and a smaller agricultural sector.

### 2.6.2 Policies Targeting Specific Sectors

The policy analyzed above is only one of many that could induce migration to manufactures and move the economy to an equilibrium that is efficient from the point of view of production. This section briefly discusses three of such interventions that target specific sectors of the economy.

**Tax on Nontradables** Consider an ad valorem tax, $\tau_N$, on nontradable production. The net price received by the firm in the sector is now $p_N(1-\tau_N)$, and (using the the first order condition) the wage is $w_T = p_N(1-\tau_N)A_N$.

The final effect of the tax on $w_T$ depends on the elasticity of demand for nontradables. If the demand for nontradables is relatively inelastic, most of the tax is passed to consumers through an increase in $p_N$, and there is no significant effect on $w_T$ and the allocation of labor. If, on the other hand, the demand for nontradables is relatively elastic, most of the adjustment takes place through a fall in $w_T$ that induces, first, migration from nontradables to agriculture and, once $w_T$ reaches $\underline{w}_T$, migration to manufactures. The tax generates a real appreciation from the consumers' point of view, but a real depreciation from the producer's perspective.

The main difficulty, *in practice*, of the use of this policy is related to its enforceability, given that in most developing countries the nontradable sector is comprised by a large number of (small or even single-person) firms that operate with high levels of informality.

**Subsidy to Manufacturing Production** Consider now an ad valorem subsidy, $s_M$, to manufacturing production. Per unit revenue of the firm in the sector is now $p_M(1+s_M)$, and the wage is $w_M = p_M\tilde{A}_M$, where $\tilde{A}_M \equiv (1+s_M)A_M$. It follows that, given that $p_M$ is determined in the international market, the introduction of the subsidy has a similar effect on $w_M$ and $\underline{w}_T$ as the increase in the productivity $A_M$ previously analyzed: it induces a proportional increase in $w_M$ and, consequently, a less-than-proportional increase in $\underline{w}_T$ that can, eventually, induce migration to manufactures. As in the previous case, the subsidy induces a real depreciation from the producer's perspective, but a real appreciation from the consumers' point of view.

[30] This assumption regarding the distribution of the interests is for simplicity. Other distributions can be assumed WLOG.

There are several potential difficulties associated with the use of this type of policy. On the fiscal side, for example, the policy requires either raising taxes or issuing debt, which is usually problematic. Additionally, if the government issues foreign debt, there will be additional pressure for the appreciation of the RER, which could end up offsetting the initial effect (one -possibly good- alternative is to finance the subsidy with a tax on nontradables similar to the one analyzed above). Another potential problem with the use of this policy in practice is that it gives place to (justified) anti-dumping complaints by other countries. Finally, there might be problems when the policy has to be discontinued, given that the elimination of the subsidy would imply a fall in the wage of the manufacturing sector.

**Subsidy for Migrants** A more ”direct” approach would be to introduce a lump sum subsidy for workers that migrate from the traditional to the manufacturing sector. The effects of this policy are, overall, similar to the ones generated by the subsidy to manufacturing production analyzed above. The (relative) advantage of this policy lies in that the subsidy would only apply to *new* workers in the manufacturing sector (as opposed to *all* workers in the sector, as in the previous case), which implies a smaller fiscal problem, less pressure for appreciatio of the RER, less justified anti-dumping complaints, and avoids the fall in wages once the policy is eliminated. There might be still problems related to the implementation, particularly if the number of migrants is large.

### 2.6.3 Summary of Main Predictions of the Model

**Initial Conditions** According to the model, the potential positive effects on both, manufacturing employment and real growth, of a policy that induces a real undervaluation depend on the joint verification of the following *initial conditions*:

1. The existence of frictions in the labor market and, in particular, of entry costs *in terms of utility* for workers that want to migrate to the manufacturing sector.

2. An initial distribution of labor with a relatively low share of workers in manufactures.

3. Low endowments (relative to the population) of natural resources (agriculture in particular).

4. Low initial per capita income.

While conditions $1-3$ guarantee the existence of a productivity (and wage) gap of considerable size, condition $4$ (which may or may not be a consequence of the first ones) ensures that the productivity gain of the induced labor reallocation is high relative to the initial per capita income.

**Effects from Different Implementations of the Policy**

1. *Contraction of the domestic demand* (a saving policy): the most probable effect is a real *depreciation*, depending on how progressive the policy is. The trade and current account balance initially improve. Once the policy ceases, inflow of payments from the accumulated stock of international assets exacerbate the real appreciation.

2. *Internal Redistribution of Resources* (for example by subsidizing internal migration, taxing the nontradable or the traditional sector, and/or subsidizing manufactures): the real depreciation is moderated (there can even be a real appreciation). The trade and current account balance are unaffected.

**Asymmetric Effects of "Induced" Under- and Over-valuations** Given the existence of an "inaction zone" and the fact that the entry costs are (in principle) present only in the manufacturing sector, the effects of an induced real overvaluation (caused, for example, by capital inflows) are not necessarily symmetric with the effects of an induced real undervaluation discussed above.[31]

# 3 Empirical Analysis: Testing the Main Predictions of the Model

Two methods are used in this section to test empirically the main predictions of the model. The first method (Sections 3.1 and 3.2) consists in performing cross-section regressions (for different periods and samples) that show that the relationship between real undervaluation and both, GDP and manufacturing growth, is stronger in countries with the proper "initial conditions". In order to do that, two key variables are constructed: a measure of real undervaluation, and a "score" that summarizes the extent to which a country had, based on the predictions of the model, the proper conditions for a policy-induced real undervaluation. The second method (Section 3.3) consists in identifying the real undervaluations that are induced by government interventions (in opposition to those that respond to changes in *fundamentals*), and verifying that they are mostly observed in countries that, according to the model, have the best conditions for that kind of policies.

## 3.1 Assessing the Relationship between Real Undervaluation, GDP Growth, and Manufacturing Production

This section begins by specifying the baseline cross-section regressions that assess the predicted relationship between real undervaluation, GDP growth, and manufacturing production.[32] It describes the construction of the measure of real undervaluation used in the analysis, and the "score", and finishes by presenting and commenting the results.

### 3.1.1 Baseline Regressions and Data

The equations tested have the following form:

$$y_{it_{fin}} = \alpha + X'_{it_{ini}}\beta + \gamma_1 U_{it_{avg}} + \gamma_2 S(X_{it_{ini}}) \times U_{it_{avg}} + \varepsilon_i$$

where $y_{it_{fin}}$ is the observed outcome (dependent variable) for country $i$ at time $t_{fin}$ (the end of the period); $X_{it_{ini}}$ are exogenous or predetermined regressors at time $t_{ini}$ (the initial period); $U_{it_{avg}}$ is a mea-

[31]In the context of the model, if initially $w_T < w_M$, the first effect of a moderate overvaluation is to stop migration to manufactures (in case there was any), to reduce production of agricultural goods, and to increase the production and prices of nontradables. The wage gap between sectors shrinks. There is no growth if GDP is measured at constant initial prices, but there is an increase of GDP if it is measured at current prices. Aggregate consumption increases and, everything else equal, the trade and current account balances worsen.

If the overvaluation is more severe, so that $w_T$ equalizes $w_M$, there is migration from manufactures to nontradables (deindustrialization). This is more likely to occur in countries rich in natural resources, where the wage gap is initially smaller. Eventually, a complete deindustrialization might take place, and a further increase in the wage, price, and production of nontradables.

[32]It is worth mentioning that the results presented below are robust to different specifications with panel data, including panel with country-specific fixed-effects, as well as Difference and System GMM. While the main problem with panel with country fixed-effects is the endogeneity of the regressors due to the inclusion of lags of the dependent variable in the RHS of the equation (e.g. lags of per capita income), the lack of good instruments is the main problem in the case of Difference or System GMM. I deal with these issues by limiting the analysis to the use of cross-section regressions, in which all the included regressors are either exogenous (such as endowments of natural resources) or predetermined in the initial period (e.g. initial per capita income, size of the manufacturing sector, size of the traditional sector, etc.). The costs of restricting the analysis to this type of regressions are at least two: first, the estimated standard errors might suffer from the fact that I have relatively few countries in the sample, and, second, I do not make use of the variation within country. Yet, I think is worth to assume those costs in order to ensure the reliability of the results.

sure of the average level of real undervaluation over the period; and $S(X_{it_{ini}})$ is a score that summarizes the extent to which the regressors $X_{it_{ini}}$ are in line with the conditions that, according to the model, make a country a good candidate for an undervaluation. In particular, the score is defined such that $S(X_{it_{ini}}) = 0$ means that country $i$ at time $t_{ini}$ is an "ideal" candidate, while $S(X_{it_{ini}}) = 1$ means that the country has none of the (theoretical) conditions for an undervaluation. It should be verified that $\gamma_1 > 0$ and $\gamma_2 < 0$, meaning that real undervaluation is positively associated with the outcome for countries with low $S$ (i.e. the good candidates), but that relationship weakens and may even become negative in countries with higher $S$ (i.e. the ones that do not have the conditions for a real depreciation).

#### 3.1.2 Dependent Variables

The dependent variable in the first set of regressions is the average rate of growth of per capita income (PPP in 2005$, from PWT 7.1) over the respective period. In the second set of regressions the explained variable is the share of manufacturing in total tradable production (computed as value added in manufacturing -category D, ISIC Rev.3- over the sum of value added in industry -categories C-E- and agriculture, forestry and fishery -categories A-B, at current prices from UNSD).

#### 3.1.3 A Measure of Real Undervaluation

Following Rodrik (2008), and as a way of accounting for changes in RER related to the Balassa-Samuelson effect, the measure of undervaluation is computed as the residual of regressing the logarithm of the real exchange rate on the logarithm of per capita income PPP.[33] The residuals capture, in principle, deviations of the RER from the level predicted by the country's per capita income.[34]

Specifically, the regression has the following form:

$$\ln(RER_{it}) = \alpha + \beta \ln(pcIncome_{it}) + I_t + \varepsilon_{it}$$

where $i$ and $t$ are country and year respectively, $I_t$ are year fixed effects, and $\varepsilon_{it}$ is an error term with standard properties. Data for both the RER[35] and per capita income PPP are from Penn World Table Version 7.1. The original regressions are performed for the period 1970-2010 with all the countries in the database, with the exception of Serbia and Georgia, which are notable outliers.

[33]The justification for controlling for per capita GDP is that, being a proxy for the relative level of productivity of tradables to nontradables, it controls for the Balassa-Samuelson effect. The question is how well per capita income proxies the relative productivity of tradables. As a robustness check, an alternative measure of undervaluation is computed using, instead of per capita income, the actual ratio of average productivities in tradables and nontradables sectors (which is computed using the measures of sectoral labor productivities available in Timmer & de Vries (2009) and McMillan & Rodrik (2011) for the available countries and years). The correlation between both measures of undervaluation is very high, at $0.89$, for all the countries and years for which both measures are available. In fact, the only countries for which the measure based on per capita income underestimates the alternative measure of undervaluation are Nigeria and Venezuela, the only oil-exporter countries in the sample.

[34]Pagan (1984) analyses various issues related to the use of residual generated regressors (as is the case of this measure of undervaluation). He shows that in the model

$$y = \delta z^* + \gamma (z - z^*) + e \quad (3)$$
$$z = z^* + \eta = W\alpha + \eta \quad (4)$$

where $z^*$ is the predicted or anticipated part of $z$ and the term $(z - z^*)$ represents the "unanticipated" part of $z$, "$2SLS$ estimates provide the correct values for $\delta$ and $OLS$ estimates the correct ones for $\gamma$". Furthermore, if only "unanticipated" regressors are included in equation (3) (i.e. $\delta = 0$), then $OLS$ produces the correct estimates of variance and efficient coefficient estimates. This is precisely the case analyzed here.

[35]The RER is actually computed as $RER = \frac{1}{p}$, where $p$ is "Price Level of GDP, G-K method (US = 100)" in PWT 7.1 (Heston *et al.* (2012))

### 3.1.4 Measuring Initial Conditions

Initial income is proxied by the logarithm of per capita income (PPP in 2005 $) in the initial year of the respective period.

The share of value added in the manufacturing sector (% of total value added, at current prices) proxies the size of the manufacturing sector.[36] The series corresponds to category D of ISIC Rev. 3, and is from the U.N. Statistical Division, which contains annual sectoral value added for most countries from 1970 to 2010[37].

Two different proxies are used for entry costs: first, average years of schooling of the population (from Barro & Lee (2010)) in the initial year of the respective period, which is intended to capture the costs associated with the acquisition of the appropriate skills and human capital (in principle, individuals with a lower level of education should face a higher entry cost if they move into manufacturing); and, second, the country's average index of ethnic, linguistic and religious homogenization (computed as $1 - fractionalization$, from Alesina *et al.* (2003)), which is intended to capture the migration costs associated with differences in these variables (implicitly, it is assumed that lower ethnic, linguistic or religious homogenization imply higher costs for individuals that migrate into the industrial sector).

The size of the traditional sector is proxied by the percentage of rural population (from WDI) in the initial year of the respective period, which, on the one hand, provides a rough idea of fraction of the labor force that can be reallocated into the industrial sector and, on the other hand, is as an indicator of the presence of entry costs.

Finally, per capita agricultural -arable and cultivable- land (from WDI, average of the period) and per capita oil reserves (from CIA factbook 2002/03, average of the period)[38] are used as measures of the relative endowments of agricultural and mineral resources, respectively.

### 3.1.5 Computation of the Scores

The score that summarizes the extent to which a country satisfies the "initial conditions" that make it a good candidate for a real undervaluation, is computed based on six indicator variables:

1. $I(High\ Initial\ Income)$, which takes value $1$ if per capita income of the country in the first year of the period is higher than the sample median in the same year, and $0$ otherwise.

2. $I(High\ Schooling)$, which takes value $1$ if the average years of schooling in the country in the first year of the period is higher than the sample median in the same year, and $0$ otherwise.

3. $I(High\ Urban\ Pop.)$, which takes value $1$ if the percentage of urban population in the country in the first year of the period is higher than the sample median in the same year, and $0$ otherwise.

4. $I(High\ Agric.\ Land)$, which takes value $1$ if the average per capita agricultural land of the period in the country is higher than the sample median in the same period, and $0$ otherwise.

5. $I(High\ Homogenization)$, which takes value $1$ if the average ethnic, linguistic, and religious homogenization in the country is higher than the sample median, and $0$ otherwise.

[36] Unfortunately the availability of data on manufacturing and industrial employment is limited. Timmer & de Vries (2009) offer data for 28 countries for different periods (only 14 of them are currently developing countries). McMillan & Rodrik (2011) complement the dataset with some African countries and China. Yet, when using these data, the number of observations in the regressions was always less than 30.

[37] Value added in manufacturing (category D, ISIC Rev. 3) as a % of total value added is from UNSD for all countries except for China, for which the data is obtained from WDI. The reason for this is that, for China in particular and for the period 1970-2005, the UNSD only reports the value added of the industrial sector (categories C-E, ISIC Rev.3) instead of manufacturing (category D).

[38] Per capita oil reserves in each year is estimated with total oil reserves in 2002/3 and each year's population.

6. $I(Low\ \%\ of\ Manufacturing\ in\ Tradables)$, which takes value $1$ if the share of manufacturing production in total tradable production in the country in the first year of the period is lower than the sample median in the same year, and $0$ otherwise.

The score used in the first set of regressions (the growth regressions) is the simple average of the first five indicators (high initial income, high schooling, high urban population, high agricultural land, and high homogenization). The score used in the second set of regressions (the ones that explain the share of manufacturing in tradables) is the simple average of the last three indicators (high agricultural land, high homogenization, and low initial share of manufacturing in tradables). A score equal to $0$ implies that the country has, from the model's perspective, the conditions that maximize the potential positive effects of undervaluation on GDP growth or on the share of manufacturing in tradables, respectively, while a score equal to $1$ implies the opposite.

#### 3.1.6 Periods and Samples

Two periods are analyzed: the period between 1970 and 2010, for which there are data on sectoral value added from UNSD, and the sub-period between 1982 and 2003 which, by excluding the oil shocks of the 1970s and the more recent commodities boom, presents more stable commodities prices.

There are $180$ countries for which the measure of undervaluation is available for all the years included in these periods. For each country, the average of the measure of undervaluation in the respective period is computed. In order to minimize the potential effect of extreme values of undervaluation, the countries whose average of undervaluation is below the percentile $2.5$ or above the percentile $97.5$ are dropped. Of the remaining $171$ countries, only $116$ have complete data for the first set of regressions for the period 1970-2010, and $118$ for the period 1982-2003.

Additionally, a subset of developing countries from East and South Asia, Latin America and Caribbean, and S.S. Africa is considered (these are all the countries in the dataset whose per capita income at the beginning of the respective period was less than 50% that of the U.S. in the same year). There are $73$ such countries with complete data for the first set of regressions for the period 1970-2010, and $72$ for the period 1982-2003.

### 3.2 Regressions

[Table 3 here]

Table 3 presents the results of regressing the average rate of growth of per capita income on the measure of real undervaluation, a set of controls, and the interaction of undervaluation with some of the controls. All the regressions in the table include the following set of controls: initial per capita income (ln), per capita agricultural land (avg.), per capita oil reserves (avg.), initial years of education (ln), initial urban population (%), the index of homogenization, and the initial share of manufactures in GDP (%). Additionally, regressions (2) through (6) (panels $A$ & $B$) include the interactions between undervaluation and some of the controls. Finally, regression (7) includes the interaction between undervaluation and the score (whose computation is, as explained above, based on the controls).

Regressions ($A1$) and ($B1$) (Table 3) show that the relationship between undervaluation and growth for all countries is, *on average*, positive and significant at $5\%$ when considering the entire period ($A1$), but *not significant* for the period 1982-2003 ($B1$). This result is in line with the prediction of the model that the association between real undervaluation and growth is not necessarily positive for all countries and periods, but only for those that satisfy certain conditions. The introduction of the interaction term in regressions ($A2$) & ($B2$) shows how the association between undervaluation and growth depends on the initial level of per capita income. The coefficients of undervaluation and of its interaction with initial per capita income are, in both periods, significant at $1\%$ or $5\%$ respectively, and their signs imply that, as expected, the relation between undervaluation and growth is positive for countries with low income, but diminishes and eventually becomes negative as the initial per capita income of the countries increase (the thresholds are around $11,500 and $5,200 -in 2005USD- for the periods 1970-2010 and 1982-2003 respectively). These results are in line with both, the predictions of the model, and the results presented in Rodrik (2008).

Regressions $(3-6)$ (panels $A$ & $B$) in Table 3 include the interaction term between undervaluation and the variables that, along with initial income, control for the "initial conditions" (namely, per capita agricultural land, years of education, the index of homogenization, and urban population). It can be seen, again, that the sign and significance of the coefficients are in line with the predictions of the model, suggesting that the association between undervaluation and growth is stronger in economies with less agricultural land, lower levels of education and urbanization, and more fractionalized populations (i.e. lower homogenization). Interestingly, the significance of the coefficients of the interaction terms of regressios $3-6$ is higher in the period 1982-2003 (panel $B$). One possible reason for this is the fact that the period 1970-2010 (panel $A$) includes the commodities boom of the 1970s and the more recent one of the (late) 2000s. The improvement of the terms of trade that many countries rich in natural resources experienced during those episodes was followed, in most cases, by real appreciations and economic growth, which weakens (and might even reverse) the relationship between real undervaluation and growth. An important question is whether the interaction terms in regressions (3) to (6) (panels $A$ & $B$, Table 3) provide indeed new information, or they simply reflect the fact that per capita agricultural land, education, homogenization and urban population are correlated with initial income (in fact, the $R^2$ of regression ($A2$) is higher than that of regressions ($A3$), ($A4$) and ($A6$), and the $R^2$ of regression ($B2$) is higher than that of regressions ($A3$)-($A6$), which suggests that the explanatory power of initial per capita income is higher than that of any other individual variable -with the only exception of the index of homogenization for the period 1970-2010). The answer to this question is given by regressions ($A7$) and ($B7$) (Table 3), which include the interaction between real undervaluation and the score. Despite the simplicity with which the score is calculated, the coefficient of the interaction term is in both periods significant at $1\%$. Furthermore, both regressions ($A7$ and $B7$) produce the highest $R^2$ of their respective period, which suggests that, as predicted by the model, the potential effect of real undervaluation on growth depends on the joint verification of the initial conditions.

[Table 4 here]

Table 4 presents the results of replicating the previous analysis in a sub-sample of developing countries in East and South Asia, Latin America and Caribbean, and S.S. Africa. Three regressions are presented for each of the periods (1970-2010 and 1982-2003): the baseline regression (columns (1) and (4), respectively); the regressions with the interactions between real undervaluation and the score (columns (3) and (6)); and a third regression that includes the interaction with the individual initial condition that produces the highest $R^2$ (columns (2) and (5), respectively), which should be, in principle, the variable with highest "traction" in the score.

Despite the small size of the samples (73 and 72 observations respectively), the performance of the score as a predictor of the potential effect of undervaluation remains strong. As expected, the explanatory power of initial per capita income (not reported in the table) diminishes among low income countries (the coefficient of the interaction of initial per capita income with the measure of undervaluation is only significant at $10\%$ for the period 1970-2010, and is not significant for 1982-2003). Instead, most of the traction for the score is given in this case by the index of homogenization (columns (2) and (5) in Table 4), implying that the association between real undervaluation and growth is particularly strong in low-income countries with high degree of ethnic, linguistic and religious *fractionalization*, which, as mentioned above, could be associated with higher migration or entry costs for workers into manufacturing.

### 3.2.1 Real Undervaluation and the Composition of Tradable Production

Besides the relationship between real undervaluation and growth, the model has interesting predictions regarding the composition of tradable production. In particular, the model predicts that in countries with the appropriate initial conditions, a real undervaluation should lead to an increase in the production of manufactures and a (relative) fall in the production of agricultural and other natural resources-based goods. These predictions are tested in this section.

The regressions presented here are similar to the "growth" regressions analyzed in the previous section. The difference is that the explained variable is, in this case, the *share of manufacturing in total tradable production* at the end of the analyzed period. There are at least three important reasons why this variable is a good indicator of the degree of development of the manufacturing sector that can be used to test the prediction mentioned above. First, there is no "right" number for this ratio, given that varies between 0 and 1 depending on the productive structure and other particular conditions of the economy. For example, the share of manufacturing in total tradable production will probably be lower in countries with relatively high endowments of natural resources, whose production of tradable goods tends to be dominated by commodities. Second, this ratio is not *directly* affected by changes in the real exchange rate. This is so because changes in the price of nontradables (relative to the price of tradables) should have, in principle, a proportional effect on both, the numerator (i.e. the value of manufacturing production) and the denominator (i.e. the value of total tradable production), leaving therefore the ratio unaffected[39]. Third, and final, the model predicts that a policy-induced depreciation of the RER should have a positive, longer term, effect on this ratio *only* in economies with the proper initial conditions. In such economies, the predicted increment in the production of manufactes and the relative fall in the production of other tradable goods imply that the ratio increases (i.e. the numerator increases relative to the denominator). This specific prediction is tested here.

[Table 5 here]

As mentioned above, the dependent variable in all the regressions in Table 5 is the *final* share of manufacturing in total tradable production. On the right hand side, the regressions include, in addition to the measure of undervaluation, the following set of controls: initial per capita income (ln), per capita agricultural land (avg.), per capita oil reserves (avg.), initial years of education (ln), initial urban population (%), the average index of homogenization, and the level and square of the *initial* share of manufacturing in total tradable production (%). Regressions ($A1$) and ($B1$) present the baseline regression (for 1970-2010 and 1982-2003, respectively) with no interaction term, and show that in both periods the association between real undervaluation and relative production of manufactures is positive but not significant. The coefficients also have the expected sign in the regressions that include the interaction between real undervaluation and each of the initial conditions (($A2$) to ($A5$) and ($B2$) to ($B5$)), but they only become significant in the period 1982-2003 and when interacting with initial years of schooling or with the index of homogenization, suggesting that the positive association between real undervaluation and the relative expansion of manufactures in total tradable production is particularly strong in countries with initially low levels of education and/or highly fractionalized populations.

Finally, regressions ($A6$) and ($B6$) include the interaction between real undervaluation and the score, which is computed as the simple average of four indicator variables: $I(High\ Income)$, $I(High\ Agric.\ Land)$, $I(High\ Schooling)$ and $I(High\ Homogenization)$ in the first period of the respective period. The coefficients are significant at 5%, and the $R^2$'s reach their maxima in both periods, proving, again, that (in line with the predictions of the model) the association between undervaluation and manufacturing development is better assessed when considering a set of initial conditions simultaneously. The results are confirmed when the analysis is performed only with the sub-sample of developing countries, whose results are reported in Table 6.

[39] This is different in the case of the ratio of manufacturing production to GDP, given that a real depreciation (i.e. a fall in the price of nontradables) mechanically deflates the value of GDP or inflates the value of manufactures, and therefore increases the ratio.

[Table 6 here]

### 3.3 Identification of Real Undervaluations Induced by Government Interventions

One of the most critical issues in almost every analysis that involves the use of the real exchange rate is the fact that, being an endogenous variable, it is difficult of determine whether the observed variations respond to truly ”exogenous” government interventions, or simply represent ”endogenous” responses to changes in ”fundamentals” (such as changes in sectoral productivities or in the terms of trade). The traditional approach to addressing this issue consists in computing deviations of the RER from what is defined as the “equilibrium real exchange rate”[40], which depends critically on the adopted definition of RER equilibrium and on the availability of data that allows for the computation of measures that are comparable across countries[41].

A different approach is used here in order to determine the origin of the observed movements in the RER, which consists in analyzing the co-movement of the (relative) size of the tradable sector with the RER. Specifically, the ratio of tradable production to GDP can be expressed as:

$$\begin{aligned} TP\_GDP &= \frac{p_T T}{p_T T + p_N NT} \\ &= \frac{T}{T + \frac{p_N}{p_T} NT} \end{aligned} \tag{5}$$

where $p_T$ and $T$ are the price and production indices of tradable goods, and $p_N$ and $NT$ the price and production of nontradables, respectively. According to the model, an *endogenous* real depreciation (that is, a fall in the relative price $\frac{p_N}{p_T}$ induced by changes in the parameters of the model) takes place if:

1. The productivity of the tradable sector decreases, in which case the production of tradables, $T$, decreases;

2. The productivity of the nontradable sector increases, in which case the production of nontradables, $NT$, increases;

3. The terms of trade decrease (in particular, wich a fall in the price of exports), in which case the value of total tradable production, $p_T T$, falls relative to GDP.

In all these cases, the real depreciation is accompanied by a fall in the ratio of tradable production to GDP.

The opposite is also true: either an increase in the productivity of tradables, a fall in the productivity of nontradables, or an improvement in the terms of trade induce, simultaneously, an endogenous real appreciation and an increase in the share of tradables in GDP.

On the other hand, it follows from expression (5) that an *exogenous* real depreciation (that is, a fall in $\frac{p_N}{p_T}$ that is not caused by changes in sectoral productivities or in the price of exports) is accompanied by a fall in the term $\frac{p_N}{p_T} NT$ relative to $T$ and, therefore, by an increase in the ratio of tradable production to GDP. Again, the opposite is also true: an *exogenous* real appreciation is accompanied by a fall in the ratio of tradable production to GDP.

[40] As explained in IMF (2006) -the 2006 report on the revised and extended methodologies for exchange rate assessments used by the IMF’s Consultative Group on Exchange Rate Issues-, there are at least three complementary but different methodologies for the computation of the ”equilibrium” RER: the “macroeconomic balance” approach, a reduced form “equilibrium real exchange rate” approach, and an “external sustainability” approach.

[41] In addition to the lack of data on many of the variables that could, in principle, be important determinants the equilibrium RER, there are also problems with the comparability of country-specific indices across countries (the typical examples are RER and Terms of Trade indices).

[Figure 11 here]

The four possible cases are summarized in Figure 11. This particular relationship between the causes behind the movements in the RER and the relative size of the tradable sector (predicted by virtually any model with tradable and nontradable goods) provides a simple tool for the identification of real under- and over-valuations that respond to "exogenous" government interventions, which only requires the computation of the share of tradable production on GDP (which is perfectly comparable across countries) and has a very intuitive and informative graphic representation.

### 3.3.1 A Measure of Relative Size of Tradable Production in GDP

The measure of relative size of the tradable sector is computed in two stages. The first stage is the computation of the ratio of tradable production to GDP, which is calculated as the sum of the value added (at current prices, as % of GDP) in Agriculture, Hunting, Forestry and Fishing (categories A-B, ISIC Rev. 3), and Industry (categories C-E -ISIC Rev. 3- which includes Mining, Manufacturing, and Utilities)[42]. This ratio displays a strong negative correlation with per capita income (see Appendix A), which complicates its comparison across countries. In order to account for the differences in the ratio related to the differences in income levels, the ratio is regressed (in a second stage) on the logarithm of per capita income and a set of year fixed effects[43]. The residuals from this regression constitute the measure of relative size of the tradable sector, and captures the deviations of the ratio of the tradable production to GDP from what the level of per capita GDP predicts. The details about the construction of this variable are presented in Appendix A.

### 3.3.2 Identification of "Exogenous" Undervaluations

[Figure 12 here]

Figure 12 presents scatter plots of the measures of oversize of the tradable sector and undervaluation for the periods 1970/79, 1980/89, 1990/99, and 2000/10. The sample includes all the developing countries[44] with population larger than 1 million in East Asia, Latin America and Caribbean, South Asia, and S.S. Africa. In each period, countries are represented by points whose coordinates are the average of the measure of undervaluation (horizontal) and the average of the measure of relative size of tradable sector (vertical), in the respective period. As explained above (figure 11), the co-movement of those variables provides information on the extent to which the degree of real undervaluation (or overvaluation) experienced by each country in a particular period is "endogenous" (i.e. responds to changes in fundamentals) or "exogenous" (i.e. are policy-induced).

It can be seen from the figure that there is significant dispersion in terms of both, undervaluation and relative size of the tradable sector. The period between 1980 and 1989 exhibits the lowest dispersion in terms of relative size of the tradable sector, and the largest dispersion of undervaluation. During those years, while some countries in S.S. Africa (in particular Tanzania, in the SW quadrant) and East Asia (Cambodia, Mongolia) experienced large real appreciations, other countries in South Asia (Afghanistan, in the NE quadrant) and Latin America (mainly Central American and Caribbean countries, but also Mexico and, for some years Brazil, Peru and Venezuela) experienced significant real depreciations. The years between 2000 and 2010, on the other hand, exhibit the lowest dispersion in real undervaluation and, in coincidence with the boom in commodity prices, the largest dispersion of relative size of the

[42] Notice that even though utilities (water, power, gas, etc.) are by definition *tradables*, in practice they are *nontradables* in most of the cases. As a robustness check (and in order to verify the potential impact that the inclusion of utilities might have on the measure of tradable production), sectoral data from Timmer & de Vries (2009) and McMillan & Rodrik (2011) is used. It is verified that utilities represent, on average, only 2% of GDP, with small variations across countries.

[43] The two-step computation is similar to the computation of the measure of real undervaluation.

[44] A country is defined as *developing country* in a particular year if its per capita income (PPP USD2005) is lower than 50% that of the U.S. in the same year.

tradable sector (being Angola and Rep. of Congo -in the NW quadrant- the countries with the most (relatively) *oversized* tradable sectors and large *overvaluations*, and Eritrea -in the SE quadrant- the country with the most *undersized* tradable sector and a large endogenous *undervaluation*).

Figure 12 allows also to analyze the patterns the different regions have followed over time. A common feature of most countries in the two Asian regions is that their tradable sectors remain relatively oversized during the four periods (the main exceptions are Hong Kong and Singapore in the 1970s and Mongolia in the 1980s). This pattern was combined during the first 20 years (1970-1989) with high dispersion in terms of undervaluation: while Thailand, Korea, Vietnam, the Philippines and Indonesia remained relatively undervalued for several years, other countries including China were actually overvalued. Beginning in the 1990s, however, most Asian countries moved to positions of relative undervaluation. In fact, with the exception of Korea, Indonesia and Papua New Guinea that for some years in the 1990s experienced slight ″endogenous″ overvaluations, all the East Asian countries were positioned in the NE quadrant between 1990 and 2010, experiencing ″exogenous″ (or policy-induced)real undervaluations. As it was seen in Section 1, many of these Asian countries have the conditions that, according to the model, make them good candidates for the use policy-induced real depreciations. Interestingly, with the exception of Afghanistan and India for a few years, the South Asian countries remain in SE quadrant for most of the period between 1990 and 2010, which suggests that the real undervaluations experienced by them are, at least in part, endogenous responses to the conditions of the fundamentals in those economies[45].

An important observation can be made regarding the African region. The figure shows that between 1970 and 2000 most of the S.S. African countries were relatively overvalued (and, in many cases, ″exogenously″ overvalued -SW quadrant). It is only in the last decade that several of these economies shift to positions of real undervaluation closer to zero or positive. Compared to other regions, however, the region remains, on average, relatively overvalued. These findings are in line with the evidence on the role of foreign aid on the appreciation of the real exchange rate in Africa presented, for example, by van Wijnbergen (1985) and Rajan & Subramanian (2011).

Finally, the countries in Latin America and Caribbean display large dispersion in terms of undervaluation, and do not show a consistent pattern over the four periods. The tradable sector (relative to GDP) remained relatively undersized during the 1990s and part of the 2000s, a period characterized by low commodities prices. This trend was reverted in several countries of the region (Venezuela, Chile, Argentina and Bolivia among others) in the early 2000s, following the increase in commodities prices, which moved Venezuela and Chile (two of the most important commodities producers of the region) to a position of endogenous appreciation (NW quadrant).

# 4 Conclusions

In this paper I ask whether it is true that a “competitive real exchange rate” is behind China’s success, something that the media and many policy makers sustain but that is not supported by the most prominent economic models. I develop a model that uses insights from the “unlimited supply of labor” and ″de-industrialization″ literatures (Lewis (1954), Corden & Neary (1982)) to gain a better understanding of these issues. I perform an extensive empirical analysis with the purpose of understanding the key underlying conditions that make China and other Asian economies suitable for policies aimed at depreciating the real exchange rate. I then compare the case of Asia with those of Latin America and South Saharan Africa. I propose a 3-sector model with labor market frictions that explains how a policy that depreciates the real exchange rate (by, for example, fostering domestic savings) can, at the same time,

[45]This implies that the reasons behind South Asia’s undervaluations may be related, for example, to low levels of productivity in the production of tradables -as documented in Figure 3 in the case of India-, and the fact that the recent commodity boom represents for them a fall in their terms of trade. This would also explain why the relationship between undervaluation and growth in this region is weaker than in East Asia (Figure 1).

generate real growth through a reallocation of workers from a low-productivity traditional economy into a high-productivity manufacturing sector. The policy is particularly effective in countries with initially low industrial development, relative abundance of labor and scarcity of agricultural resources, and high barriers for the entry of workers into the manufacturing sector. This is, precisely, the case of many Asian economies. I verify empirically that the association between real undervaluation and growth, and real undervaluation and development of the manufacturing sector is stronger in countries with these conditions. Finally, I propose an empirical strategy for the identification of real depreciations induced by government interventions, and verify that such episodes have been mainly observed in the last two decades in the East Asian economies.

An extremely simplified model was presented here with the purpose of explaining the proposed mechanism and highlighting the role played by each of its key elements. Future research should explore the quantitative implications of the model in a dynamic setting, introducing capital accumulation and endogenous sources of growth associated with the expansion of the industrial sector. Interesting implications regarding the timing of the transition and the pattern of structural transformation and income distribution can result from variations in the instrumentation of policies aimed a depreciating the RER or the way frictions are modeled.

Despite its simplicity, the theoretical framework developed here contributes to better understand the mechanics of a real undervaluation, its potential effects on the labor market and, more generally, its link with real growth. The theory helps to understand the role played by the recently documented sectoral productivity gaps (Bosworth & Collins (2008), McMillan & Rodrik (2011), Gollin *et al.* (2011), and de Vries *et al.* (2012)), and provides an explanation for its puzzling persistence in some developing countries. In the same line, the model provides an explanation for the different patterns of sectoral reallocation of labor observed in Asia, Africa and Latin America, as recently documented by McMillan & Rodrik (2011) and de de Vries *et al.* (2012).

Before closing, two important comments on some of the limitations of the empirical analysis are in order. First, as is the case with most studies that use cross sectional data, the analysis does not imply causality but simply verifies the existence of the proposed empirical regularities. And second and most importantly, the endogeneity of the decision regarding the use of the RER as a policy instrument raises a clear "identification" issue that plagues this entire empirical literature. Addressing this issue is one of the greatest challenges of the literature. In spite of this, the results presented here provide useful information for understanding how the association between undervaluation and both, growth and the composition of tradable production, depends on the initial conditions.

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# A A Measure of Relative Size of the Tradable Sector

[Figure 13 here]

Figure 13 presents a scatter plot of the share of tradable production in GDP and per capita income for the periods 1970-2010. As it can be seen from the figure, there is a strong negative relationship between both variables.

Explaining the reasons behind that negative relation would require digging into the literature on structural transformation, and is not the matter of this work (that might be explained, for example, by non-homotheticity of preferences). What I do, instead, is to take this negative relationship as a fact, and construct a measure that informs about how much countries deviate from that particular trend at each moment in time. This measure of relative size of the tradable sector is estimated with a two-stage procedure, similar to the one used for the estimation of measure of real undervaluation. First, I regress the share of tradables in GDP on the logarithm of per capita income and a set of year fixed effects; and, second, I compute the residuals from that regression, which constitute the measure of relative size of the tradable sector. Specifically, the regression has the following form:

$$Trad\_GDP_{it} = \alpha + \beta \ln(pcIncome_{it}) + I_t + \varepsilon_{it}$$

where the subindices $i$ and $t$ refer to country and year respectively, $I_t$ are year fixed-effects, and $\varepsilon_{it}$ is a standard error term. I run the regression for the period 1970-2010 and exclude Serbia and Georgia. The estimated coefficient of (ln) per capita income is $-6.5$, with a $t$-statistic (based on robust standard errors) higher than 49. Since per capita income is in logarithmic scale, one way of interpreting of the result is that, in average, the share of tradable production in total GDP falls by 4.5 percentage points when per capita income doubles. The distribution of the residuals of the regression (i.e. the measure of relative size of the tradable sector) is displayed in Figure 14. It can be seen that the distribution is centered at zero and, with the exception of a few cases above $30\%$, most of the observations lie in the range $[-30\%, 30\%]$.

[Figure 14 here]

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Table 1: Regional Economic Indicators, 1970-2010

| | *pc GDP PPP* | *pc GDP growth* | *Underva-luation* | *Gross Savings* | *Manufacturing Production* | |
|---|---|---|---|---|---|---|
| | *2000US$* | *%* | *Ln* | *% GDP* | *% GDP* | *% Tradables* |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* |
| **China** | | | | | | |
| *1970-74* | 385 | 4.8 | -0.88 | 28.8 | 35.3 | 48.9 |
| *2006-10* | 6,006 | 10.0 | 0.23 | 51.6 | 32.6 | 63.1 |
| *1970-2010* | 2,010 | 7.6 | -0.07 | 38.6 | 34.6 | 55.1 |
| **India** | | | | | | |
| *1970-74* | 894 | -0.2 | -0.03 | 16.2 | 14.5 | 24.4 |
| *2006-10* | 3,047 | 6.7 | 0.54 | 31.9 | 15.4 | 40.7 |
| *1970-2010* | 1,588 | 3.3 | 0.35 | 22.5 | 15.9 | 32.5 |
| **Rest of East & South Asia** | | | | | | |
| *1970-74* | 1,392 | 4.1 | 0.14 | 15.2 | 14.8 | 27.0 |
| *2006-10* | 5,188 | 3.8 | 0.26 | 22.1 | 21.9 | 48.0 |
| *1970-2010* | 3,097 | 3.2 | 0.21 | 20.5 | 19.0 | 39.0 |
| **Latin America & Caribbean** | | | | | | |
| *1970-74* | 5,445 | 5.0 | 0.23 | 20.0 | 23.6 | 55.7 |
| *2006-10* | 8,739 | 2.6 | -0.10 | 20.5 | 16.6 | 52.2 |
| *1970-2010* | 6,948 | 1.6 | 0.11 | 20.2 | 20.7 | 55.6 |
| **South Saharan Africa** | | | | | | |
| *1970-74* | 1,435 | 2.6 | -0.26 | 14.8 | 11.3 | 22.7 |
| *2006-10* | 1,643 | 3.1 | -0.06 | 10.5 | 8.0 | 17.7 |
| *1970-2010* | 1,389 | 0.5 | -0.22 | 11.0 | 10.4 | 21.2 |

*Note:* Population-weighted means by region-year of countries with pc GDP PPP (2000USD) ¡10,000 in 1970. Number of countries: Asia 31, LAC 30, SSA 46. Data on savings is missing for some country-years, Nigeria is missing in SSA, and Taiwan in Asia. Manufacturing Production/Tradable production is the ratio of Manufacturing/GDP and Total Tradable production/GDP, which is estimated as Industrial Production/GDP+ Agricultural Production/GDP. *Source:* pc GDP is from PWT 7.1. Undervaluation is estimated using data from PWT 7.1. Gross Savings are from WDI. Manuf. Prod./GDP, Industrial Prod./GDP and Agr.Prod./GDP are from UNSD complemented with WDI.

Table 2: Regional Demographic and Natural Resources Indicators, 1990-2010

| | *Natural Resources Rents 1990-2010* | | *pc Agric. Land* | *pc Oil Reserves* | *Rural Pop.* | *Years of Education* |
|---|---|---|---|---|---|---|
| | *USD2005* (1) | *% GDP* (2) | *ha 1990* (3) | *bbl 2002* (4) | *% 1990* (5) | *1990* (6) |
| **China** | 53.3 | 4.1 | 0.114 | 20.9 | 73.6 | 4.9 |
| **India** | 22.7 | 3.4 | 0.202 | 4.1 | 74.5 | 3.0 |
| **Rest of East & South Asia** | 64.0 | 5.8 | 0.170 | 14.3 | 68.1 | 4.2 |
| **Latin America & C.** | 309.8 | 6.2 | 0.343 | 182.0 | 29.4 | 5.2 |
| **S. S. Africa** | 109.8 | 14.3 | 0.347 | 58.1 | 71.7 | 3.2 |

Population-weighted means by region-year of countries with pc GDP PPP (2000USD) ¡ 10,000 in 1970. *Pc Agr. Land* is total cultivable and arable land divided by population. *Pc Oil Reserves* is total oil reserves in 2002/03 (earliest year available) divided by population. *Pc Natural Resources Rents USD2005* is approximated by multiplying Total Nat. Res. Rents/GDP (current prices) by pc GDP at constant prices in 2005 USD. *Education* is average years of schooling of the population above 25 years. Source: Oil reserves are from CIA Factbook. Education is from Barro-Lee. The rest is from WDI.

Table 3: Real Undervaluation and Per Capita Income Growth Rate

Cross-Section Regressions

**A - 1970-2010**

| **pc Inc. Growth (Avg.)** | *(A1)* | *(A2)* | *(A3)* | *(A4)* | *(A5)* | *(A6)* | *(A7)* |
|---|---|---|---|---|---|---|---|
| Undervaluation (Avg.) | 0.355** | 2.976** | 0.688** | 0.710** | 1.728*** | 0.916** | 1.038*** |
| | (0.171) | (1.135) | (0.278) | (0.305) | (0.594) | (0.366) | (0.333) |
| *Interactions Underval, x:* | | | | | | | |
| Initial pc Income (Ln) | | -0.318** | | | | | |
| | | (0.128) | | | | | |
| pc Agric. Land (Avg.) | | | -1.285* | | | | |
| | | | (0.771) | | | | |
| Initial Yrs. School. (Ln) | | | | -0.360* | | | |
| | | | | (0.203) | | | |
| Homogenization (Index) | | | | | -2.565** | | |
| | | | | | (1.039) | | |
| Initial Urban Pop. (%) | | | | | | -0.014* | |
| | | | | | | (0.007) | |
| Initial Score | | | | | | | -1.342*** |
| *[and additional controls]* | | | | | | | (0.459) |
| Observations | 116 | 116 | 116 | 116 | 116 | 116 | 116 |
| R-squared | 0.403 | 0.430 | 0.415 | 0.422 | 0.435 | 0.419 | 0.440 |

**B - 1982-2003**

| **pc Inc. Growth (Avg.)** | *(B1)* | *(B2)* | *(B3)* | *(B4)* | *(B5)* | *(B6)* | *(B7)* |
|---|---|---|---|---|---|---|---|
| Undervaluation (Avg.) | 0.024 | 2.519** | 0.357** | 0.638* | 1.160** | 0.596* | 0.601** |
| | (0.120) | (0.999) | (0.171) | (0.383) | (0.482) | (0.325) | (0.240) |
| *Interactions Underval, x:* | | | | | | | |
| Initial pc Income (Ln) | | -0.294*** | | | | | |
| | | (0.109) | | | | | |
| pc Agric.l Land (Avg.) | | | -1.317** | | | | |
| | | | (0.504) | | | | |
| Initial Yrs. School. (Ln) | | | | -0.434** | | | |
| | | | | (0.208) | | | |
| Homogenization (Index) | | | | | -2.059*** | | |
| | | | | | (0.754) | | |
| Initial Urban Pop. (%) | | | | | | -0.013** | |
| | | | | | | (0.005) | |
| Initial Score | | | | | | | -1.097*** |
| *[and additional controls]* | | | | | | | (0.305) |
| Observations | 118 | 118 | 118 | 118 | 118 | 118 | 118 |
| R-squared | 0.292 | 0.352 | 0.320 | 0.337 | 0.344 | 0.322 | 0.352 |

Robust standard errors in parentheses. *** p¡0.01, ** p¡0.05, * p¡0.1. 5% of the observations were excluded (the 2.5% with the highest and the 2.5% with the lowest values of undervaluation) to minimize the effect of extreme values. *Controls:* All regressions include the following set of controls: per capita income (ln, initial year), per capita agricultural land (period average), per capita oil reserves (period average), years of education (ln, initial year), urban population (%, initial year), index of homogenization, share of manufactures in GDP (%, current prices, initial year). *Score:* Simple ave- rage of 5 indicator variables: I(high income), I(high schooling), I(high Agric. land), I(high Homogenization) and I(high Urban Pop.), which take value 1 if the respective variable is above the sample median in the initial year, and 0 otherwise.

Table 4: Real Underval. and Per Capita Income Growth Rate - Dev. Countries

Cross-Section Regressions - Developing Countries in Four Main Regions*

| | 1970-2010 | | | 1982-2003 | | |
|---|---|---|---|---|---|---|
| **pc Inc. Growth (Avg.)** | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* |
| Undervaluation (avg.) | 0.542** | 2.863*** | 1.127*** | 0.238 | 1.397** | 0.623** |
| | (0.239) | (0.889) | (0.408) | (0.192) | (0.678) | (0.266) |
| *Interactions Underval. x:* | | | | | | |
| Index Homogenization | | -4.876*** | | | -2.413* | |
| | | (1.791) | | | (1.297) | |
| Initial Score | | | -1.875** | | | -1.344*** |
| | | | (0.857) | | | (0.490) |
| *[and additional controls]* | | | | | | |
| Observations | 73 | 73 | 73 | 72 | 72 | 72 |
| R-squared | 0.473 | 0.530 | 0.507 | 0.357 | 0.399 | 0.405 |

(*) Countries in East Asia, Latin America & Caribbean, South Asia, and S.S. Africa with per capita income lower than 50% that of the U.S. in the initial year. Robust standard errors in parentheses. *** p¡0.01, ** p¡0.05, * p¡0.1. 5% of the observations were excluded (the 2.5% with the highest and the 2.5% with the lowest values of undervaluation) to minimize the effect of extreme values. *Controls:* All regressions include the following set of controls: per capita income (ln, initial year), per capita agricultural land (period average), per capita oil reserves (period average), years of education (ln, initial year), urban population (%, initial year), index of homogenization, share of manufactures in GDP (%, current prices, initial year). *Score:* Simple ave- rage of 5 indicator variables: I(high income), I(high schooling), I(high Agric. land), I(high Homogenization) and I(high Urban Pop.), which take value 1 if the respective variable is above the sample median in the initial year, and 0 otherwise.

Table 5: Real Undervaluation and Manufacturing Production
Dep. Variable: Share of Manufacturing in Total Tradable Production

**A - 1970-2010**

| | *(A1)* | *(A2)* | *(A3)* | *(A4)* | *(A5)* | *(A6)* |
|---|---|---|---|---|---|---|
| Undervaluation (Avg.) | 0.076 | 0.268 | 0.077 | 0.081 | 0.214 | 0.161** |
| | (0.056) | (0.350) | (0.080) | (0.056) | (0.135) | (0.076) |
| *Interactions Undervaluation x:* | | | | | | |
| Initial pc Income (Ln) | | -0.024 | | | | |
| | | (0.045) | | | | |
| pc Agricultural Land (Avg.) | | | -0.004 | | | |
| | | | (0.212) | | | |
| Initial Yrs. Schooling (Ln) | | | | -0.006 | | |
| | | | | (0.056) | | |
| Homogenization (Index) | | | | | -0.263 | |
| | | | | | (0.260) | |
| Initial Score | | | | | | -0.180 |
| *[and additional controls]* | | | | | | (0.132) |
| Observations | 115 | 115 | 115 | 115 | 115 | 115 |
| R-squared | 0.684 | 0.685 | 0.684 | 0.684 | 0.686 | 0.688 |

**B - 1982-2003**

| | *(B1)* | *(B2)* | *(B3)* | *(B4)* | *(B5)* | *(B6)* |
|---|---|---|---|---|---|---|
| Undervaluation (avg. of the period) | 0.025 | 0.293 | 0.105 | 0.128* | 0.269** | 0.156** |
| | (0.041) | (0.198) | (0.075) | (0.068) | (0.109) | (0.060) |
| *Interactions Undervaluation x:* | | | | | | |
| Initial pc Income (Ln) | | -0.032 | | | | |
| | | (0.024) | | | | |
| pc Agricultural Land (Avg.) | | | -0.311 | | | |
| | | | (0.240) | | | |
| Initial Yrs. Schooling (Ln) | | | | -0.074 | | |
| | | | | (0.046) | | |
| Homogenization (Index) | | | | | -0.443** | |
| | | | | | (0.202) | |
| Initial Score | | | | | | -0.250*** |
| *[and additional controls]* | | | | | | (0.094) |
| Observations | 117 | 117 | 117 | 117 | 117 | 117 |
| R-squared | 0.765 | 0.768 | 0.771 | 0.770 | 0.773 | 0.776 |

Robust standard errors in parentheses. *** p¡0.01, ** p¡0.05, * p¡0.1. 5% of the observations were excluded (the 2.5% with the highest and the 2.5% with the lowest values of undervaluation) to minimize the effect of extreme values. *Controls:* All regressions include the following set of controls: per capita income (ln, initial year), per capita agricultural land (period average), per capita oil reserves (period average), years of education (ln, initial year), urban population (%, initial year), index of homogenization, share of manuf. in tradable prod. (level & square, initial year). *Score:* Simple average of 5 indicator variables: I(high income), I(high schooling), I(high Agric. land), I(high Homogenization) and I(high Urban Pop.), which take value 1 if the respective variable is above the sample median in the initial year, and 0 otherwise.

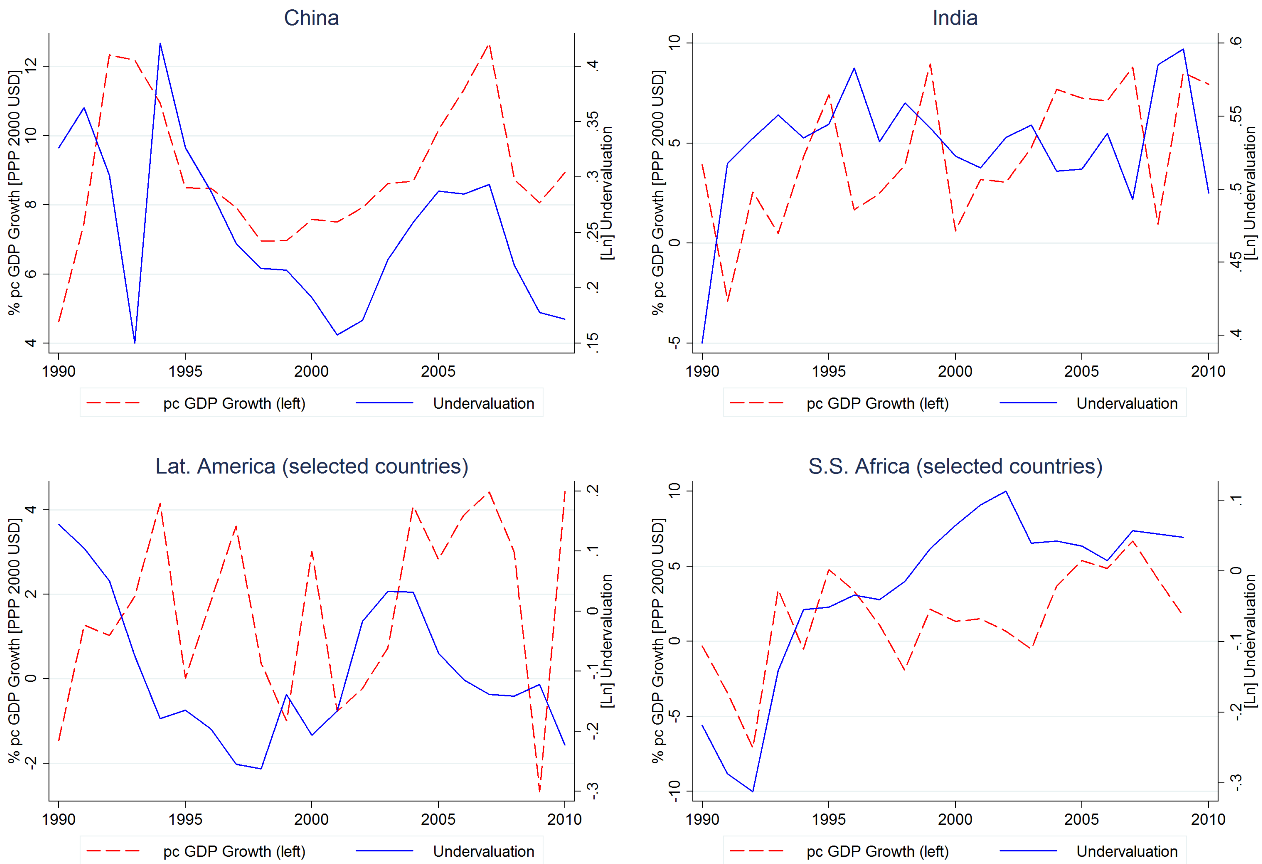
Table 6: Real Undervaluation and Manufacturing Production - Dev. Countries*

Dep. Variable: Share of Manufacturing in Total Tradable Production

| | *(A1)* | *(A2)* | *(A3)* | *(A4)* | *(A5)* | *(A6)* |
|---|---|---|---|---|---|---|
| Undervaluation (Avg.) | 0.111 | -0.115 | 0.194 | 0.111 | 0.414** | 0.205** |
| | (0.071) | (0.559) | (0.138) | (0.074) | (0.191) | (0.092) |
| *Interactions Undervaluation x:* | | | | | | |
| Initial pc Income (Ln) | | 0.031 | | | | |
| | | (0.078) | | | | |
| pc Agricultural Land (Avg.) | | | -0.297 | | | |
| | | | (0.372) | | | |
| Initial Yrs. Schooling (Ln) | | | | -0.000 | | |
| | | | | (0.071) | | |
| Homogenization (Index) | | | | | -0.641 | |
| | | | | | (0.409) | |
| Initial Score | | | | | | -0.290 |
| *[and additional controls]* | | | | | | (0.175) |
| Observations | 72 | 72 | 72 | 72 | 72 | 72 |
| R-squared | 0.589 | 0.589 | 0.591 | 0.589 | 0.601 | 0.600 |
| **B - 1982-2003** | | | | | | |
| | *(B1)* | *(B2)* | *(B3)* | *(B4)* | *(B5)* | *(B6)* |
| Undervaluation (Avg.) | 0.077 | 0.034 | 0.205 | 0.107 | 0.360** | 0.194*** |
| | (0.062) | (0.384) | (0.131) | (0.075) | (0.143) | (0.065) |
| *Interactions Undervaluation x:* | | | | | | |
| Initial pc Income (Ln) | | 0.006 | | | | |
| | | (0.055) | | | | |
| pc Agricultural Land (Avg.) | | | -0.540 | | | |
| | | | (0.421) | | | |
| Initial Yrs. Schooling (Ln) | | | | -0.032 | | |
| | | | | (0.070) | | |
| Homogenization (Index) | | | | | -0.591* | |
| | | | | | (0.306) | |
| Initial Score | | | | | | -0.380*** |
| *[and additional controls]* | | | | | | (0.134) |
| Observations | 72 | 72 | 72 | 72 | 72 | 72 |
| R-squared | 0.646 | 0.646 | 0.656 | 0.647 | 0.661 | 0.669 |

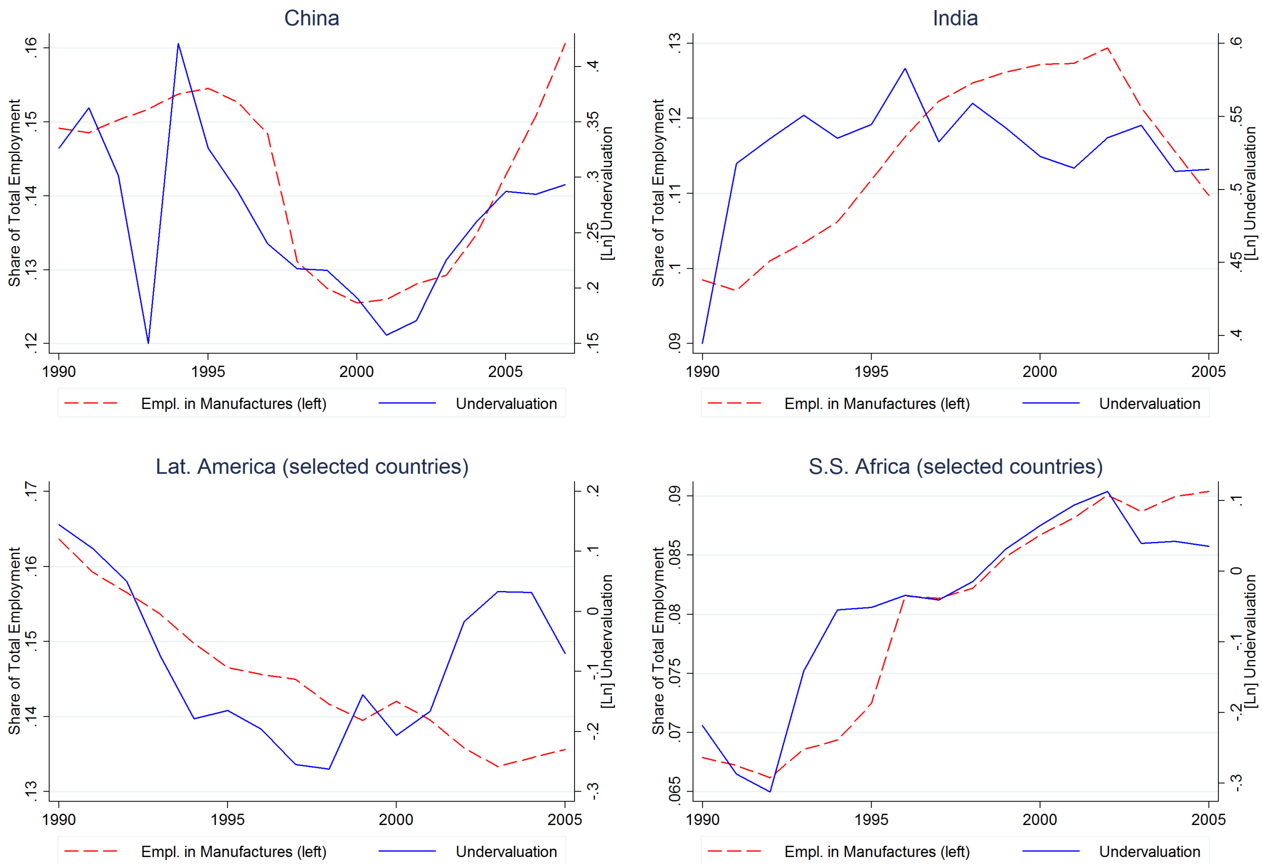
(*) Countries in East Asia, Latin America & Caribbean, South Asia, and S.S. Africa with per capita income lower than 50% that of the U.S. in the initial year. Robust standard errors in parentheses. *** p¡0.01, ** p¡0.05, * p¡0.1. 5% of the observations were excluded (the 2.5% with the highest and the 2.5% with the lowest values of undervaluation) to minimize the effect of extreme values. *Controls:* All regressions include the following set of controls: per capita income (ln, initial year), per capita agricultural land (period average), per capita oil reserves (period average), years of education (ln, initial year), urban population (%, initial year), index of homogenization, share of manuf. in tradable prod. (level & square, initial year). *Score:* Simple average of 3 indicator variables: I(high schooling), I(high Agric. land), and I(high Homogenization, which take) value 1 if the respective variable is above the sample median in the initial year, and 0 otherwise.

Figure 1: Undervaluation and per capita GDP Growth
Selected Economies




Sources: Estimated using PWT 7.1.
Lat. America: Pop. weighted means of Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, and Peru.
S.S. Africa: Pop. weighted means of Ethiopia, Ghana, Kenya, Malawi, Mauritius, Senegal, South Africa and Zambia.

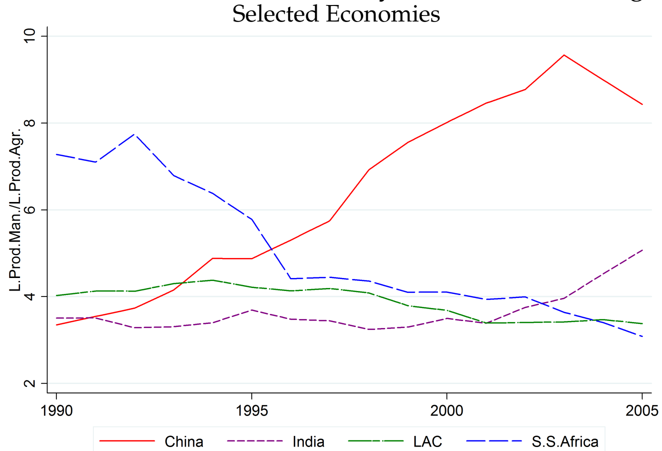
Figure 2: Undervaluation and Employment in Manufactures
Selected Economies




Sources: Undervaluation estimated using PWT 7.1. Employment in Manufactures is from Timmer & de Vries (2009) and McMillan & Rodrik (2011).
Lat. America: Pop. weighted means of Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, and Peru.
S.S. Africa: Pop. weighted means of Ethiopia, Ghana, Kenya, Malawi, Mauritius, Senegal, South Africa and Zambia.

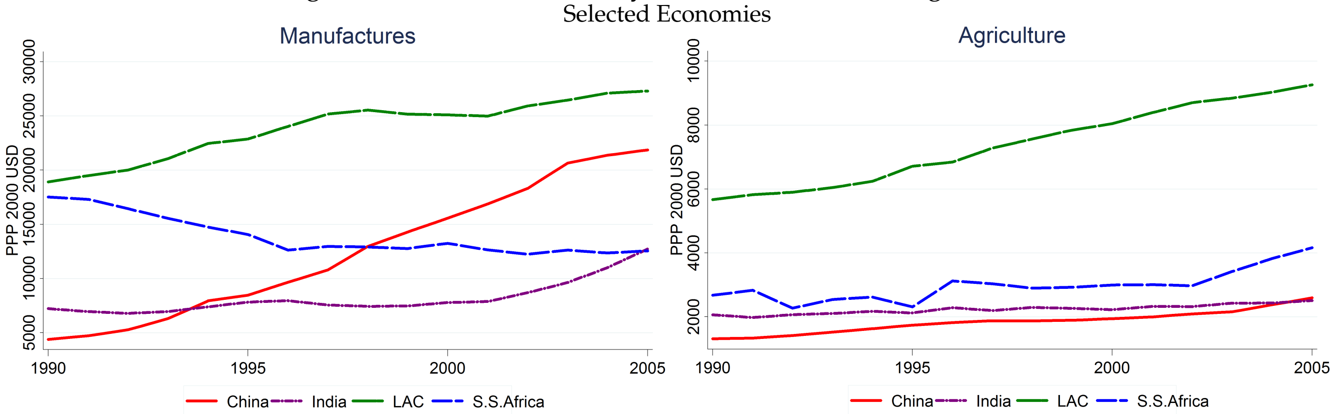
Figure 3: Relative Labor Productivity: Manufactures/Agriculture

Selected Economies




Ratio: Lab. Prod. Manuf./Lab. Prod. Agr. Based on Timmer & de Vries (2009) and McMillan & Rodrik (2011).
Lat. America: Pop. weighted means of Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico and Peru.
S.S. Africa: Pop. weighted means of Ethiopia, Ghana, Kenya, Malawi, Mauritius, Senegal, South Africa and Zambia

Figure 4: Labor Productivity: Manufactures and Agriculture
Selected Economies




Sector labor productivity = Sector Value Added PPP 2000 US$ / Sector Employment. Based on Timmer & de Vries (2009) and McMillan & Rodrik (2011). Lat. America: Pop. weighted means of Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico and Peru. S.S. Africa: Pop. weighted means of Ethiopia, Ghana, Kenya, Malawi, Mauritius, Senegal, South Africa and Zambia.

Figure 5: Model - Equilibrium (3 Cases)

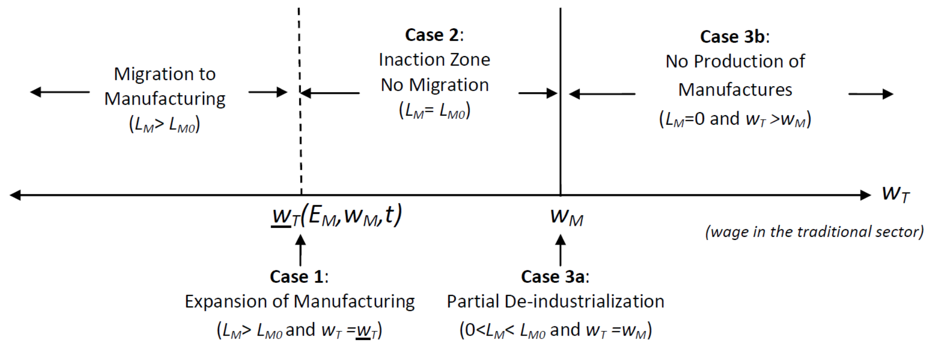


Figure 6: Model - Effects of a Reduction of Entry Costs

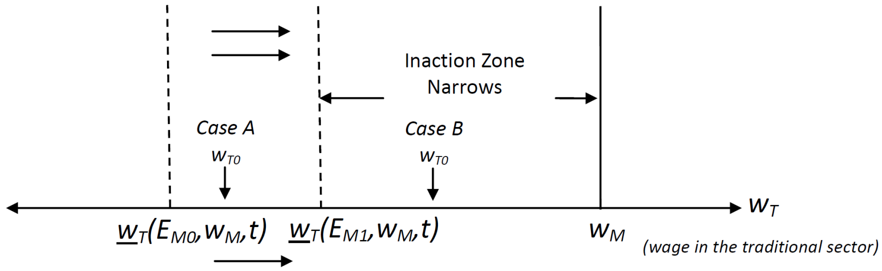


Figure 7: Model - Effects of a Change in the Distribution of Rents

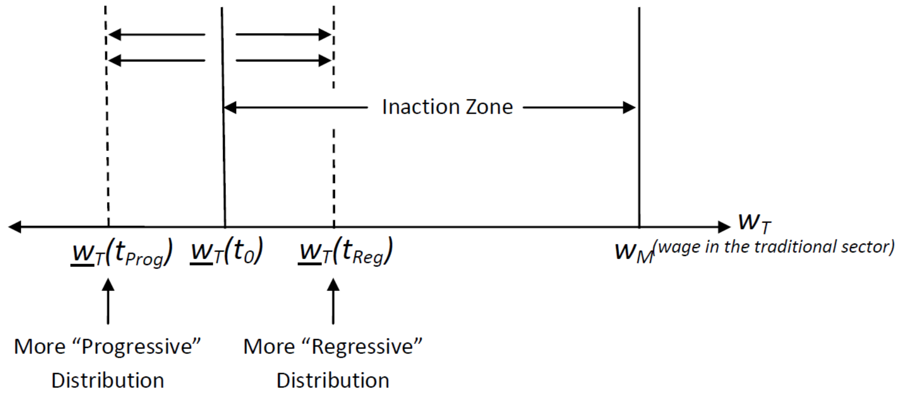


Figure 8: Model - Effects of an Increase in Manufacturing Productivity

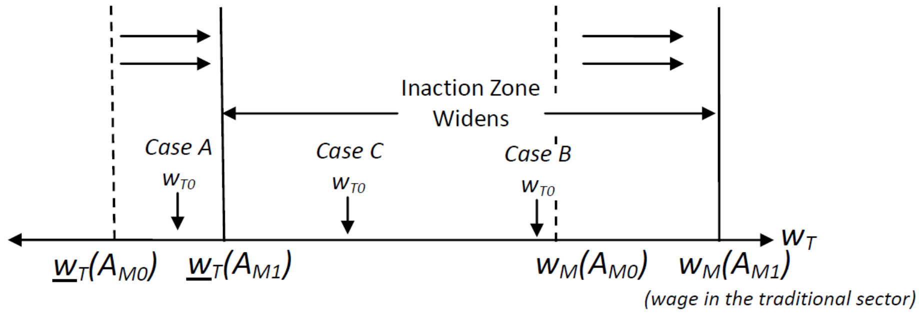


Figure 9: Model - Effects of Differences in Endowments of Natural Resources

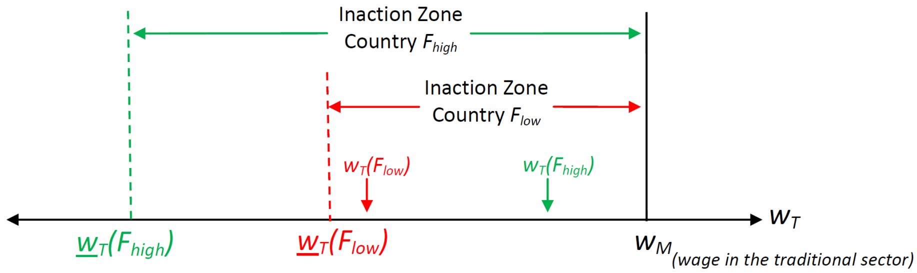


Figure 10: Model - Diff. in Endowments of Nat. Res. - Gains & Costs
Potential Gains & Costs of Labor Reallocation

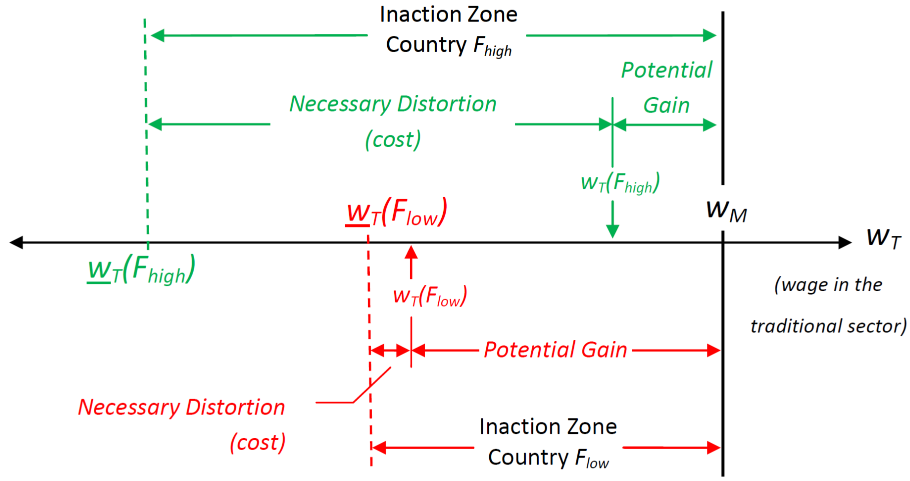
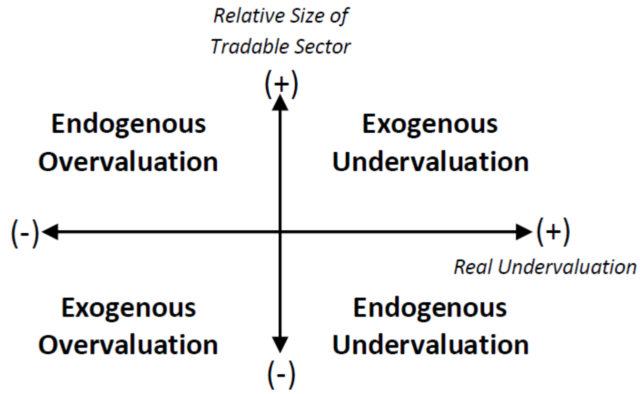


Figure 11: Real Undervaluation & Relative Size of Tradable Sector

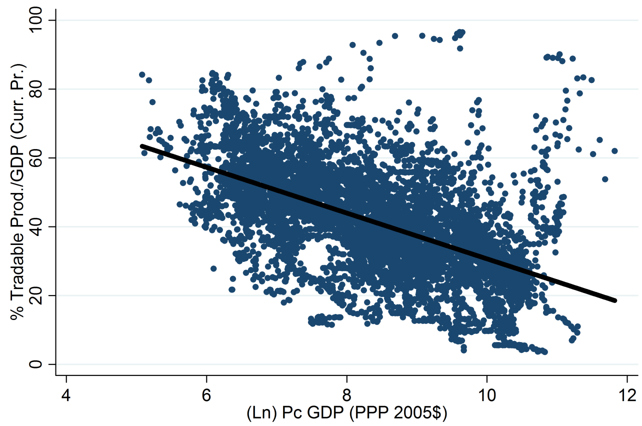



**Note:** *Endogenous* (under- or overvaluation) refers to changes in the RER associated with changes in *fundamentals* (i.e. changes in sectoral productivities or in the TOT). *Exogenous* refers to changes in the RER that are not associated with changes in fundamentals.

Figure 12: Undervaluation & Oversize of Tradable Sector
Four Main Regions - Developing Countries

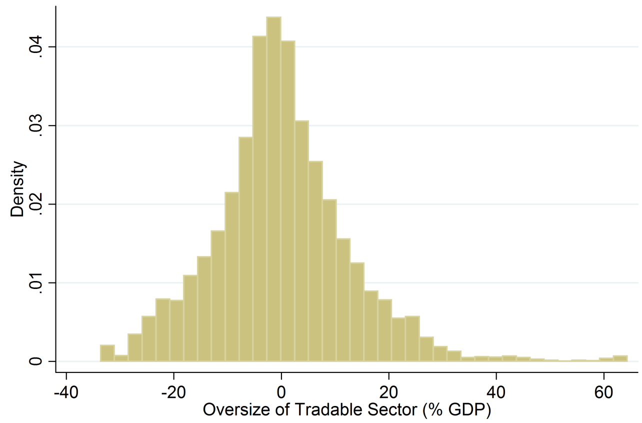

*Note:* Only countries with population larger than 1 Million and per capita GDP (PPP) lower than 50% that of the U.S. through each period are considered.
*Source:* Author's calculations based on data from PWT 7.1 and UNSD.

Figure 13: Tradable Production (% GDP) & Pc Income
1970-2010




Note: Share of Tradable Production on GDP is the sum of the shares of value added of categories A-E (ISIC Rev.3) on GDP, at current prices - US dollars. Years 1970-2010.
Source: Pc Income PPP 2005 is from PWT 7.1. Sectoral value added is from UNSD.

Figure 14: Estimated Oversize of Tradable Sector (% GDP)
Histogram




Note: Estimated measure of Oversize of Tradable Production on GDP (residuals)
Years 1970-2010. Excludes Georgia and Serbia.
Source: Author's calculations.