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Essays in International and Development Macroeconomics

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Declaration

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I warrant that this authorisation does not, to the best of my belief, infringe the rights of any third party.

I declare that my thesis consists of 21,529 words.

London, 30 September 2013

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Abstract

The thesis comprehends four chapters: the first chapter concerns with the positive correlation between cross-country price level and per-capita income, which is generally regarded as a stylized fact renowned as the Penn-Balassa-Samuelson effect. The chapter provides evidence that the price-income relationship is actually non-linear and that it turns negative in low income countries. The result is robust along both cross-section and panel dimensions. The main contribution of this chapter is to uncover a new empirical regularity such that the price level firstly decreases and then increases along the development process.

The second chapter argues that, in order to capture the non-monotonicity of the price-income relationship, we need a modified Balassa-Samuelson framework that accounts for the fact that low-income and high-income countries have very different economic structures and are at different stages of development. Particular emphasis needs to be put on the relevance of the agricultural sector in poor countries and for . The contribution of this chapter is to show that a model linking the price level to the process of structural transformation captures the non-monotonic pattern of the data.

The third chapter departs from the Balassa-Samuleson framework and analyses the price-income relationship in a multisector Eaton-Kortum model of

trade. The chapter shows that also within this framework a negative-price income relationship emerges. This provides further support to the empirical result shown in the first chapter and additional insights on the determinants of such relationship.

The fourth chapter focuses on the relationship between foreign capital flows and income inequality in emerging countries. Developing countries experience a prolonged period of real exchange rate overvaluation after they have opened their capital and current account. This real exchange rate overvaluation is associated with rising income inequality within a country. The chapter provides evidence of a significant positive correlation between net capital flows and the Gini coefficient. The chapter presents also a model connecting the dynamics of the balance of payments with a search and matching model of the labor market. This provides a useful analytical framework to disentangle the mechanisms that can link foreign capital flows to income inequality through the impact of real exchange rate adjustment on the price of labor and quantity of employment.

Chapter 1

The price of development

1.1 Introduction

It is widely understood that market exchange rates do not give accurate measures of real income in different economies and that adjustment by purchasing power parity (PPP) factors is necessary for such measures. This understanding is based on an observed empirical regularity that richer countries have a higher price level than poorer countries. The positive correlation between cross-country price level and per-capita income is generally regarded as a stylized fact. This result was documented for twelve developed countries in the seminal paper of Bela Balassa (1964), was confirmed for a large sample of countries as soon as data from the International Comparison Program (ICP) became available and is now renowned as the Penn-Balassa-Samuelson effect (Penn- BS).[1]

The paper makes an important qualification to this general understanding. Using non-parametric estimation, it provides evidence that the price-income

[1] The Penn-BS effect was documented also by Summers and Heston (1991), Barro (1991), and Rogoff (1996). Samuelson (1994) stresses that the proper name for it would be *Ricardo-Viner-Harrod-Balassa-Samuelson-Penn-Bhagwati-et alt. effect.*

relationship is non-linear and that it turns negative in low-income countries both along a cross-section and a panel dimension. Standard regression analysis in sub-samples of poor, middle-income, and rich countries is consistent with this finding. The results of the paper are robust to possible sources of bias from PPP estimation and measurement error in low-income countries.

The Penn-Balassa-Samuelson effect is at the basis of our understanding of long-run real exchange rate movements. The paper makes a significant contribution on the positive side by uncovering a twist to what has long been accepted as a well-established empirical regularity. From a policy point of view, by showing that in poor countries the price-income relationship is negative, the paper suggests that there is a "natural" depreciation of the real exchange rate along the development process. If so, this is an important finding that central banks and governments of low-income countries should take into account as they pursue their exchange rate policy.

The paper is structured as follows: Section 1.2 shows that the price-income relationship is non-monotonic using both non-parametric and linear estimations. Section 1.3 establishes that the results are robust to measurement error, to the structure of the Penn World Tables database I use and that the findings are not driven by biases in PPP estimation. Section 1.4 concludes, summarizing the main findings and discussing possible explanation for these results.

1.2 The price-income relationship

In this section I show that the price-income relationship is non-monotonic. I provide evidence along a cross-section, panel, and time-series dimension through both linear and non-linear estimation. Following the literature on the Penn-BS effect, I measure income per capita in purchasing power parity (PPP) and define the price level as the ratio of the PPP to the exchange rate with the US dollar.[2] Unless alternatively specified, the database of reference is the Penn World Table (PWT) 7.0 version.

1.2.1 Cross-section dimension

In Figure 1.1 we can see an example of the little attention that the literature has paid to the Penn-BS effect in developing countries. The figure illustrates the positive price-income relationship provided in Rogoff's (1996) excellent review of the purchasing power parity puzzle. Since observations with an income per capita lower than Syria are gathered in a cloud of points, it is difficult to properly disentangle the relationship between price and income in poor countries.

Therefore, in Figure 1.2, using the same data-set as in Rogoff (1996), I plot the *log*-values of income per capita.[3] I investigate the price-income relationship using a non-parametric estimation technique known as LOWESS (locally weighted scatter smooth), which allows me to impose as little structure as possible on the functional form. This estimation suggests that the Penn-BS effect does not hold in the poorest 25% of countries in the sample, where the relationship is actually downward sloping. The minimum point of the curve corresponds to an income level of around 1350 PPP $ (1985 prices), which is equivalent to the income of Senegal in the year 1990.

[2] I use income per capita at constant prices for the panel and time-series analysis and income at current prices for the cross-section analysis.
[3] This is Penn World Table 5.6 (reference year 1985); he considers the year 1990

In commenting the result of figure 1.1, Rogoff (1996) stressed that "*The relationship between income and prices is quite striking over the full data set (...); it is far less impressive when one looks either at the rich countries as a group, or at developing countries as group.* In this paper we take Rogoff's point further using a non-parametric estimation that shows that the relationship is actually striking when looking at rich countries as a group and negative when looking at poor countries as a group. According to our knowledge, the non-monotonicity of the price-income relationship has not been previously documented in the literature.

The LOWESS estimation works as follows: Consider an independent variable x_n and a dependent variable y_n. For each observation y_n the LOWESS estimation technique runs a regression of x_n using few data points around x_n. The regression is weighted so that the central point $(x_n; y_n)$ receives the highest weight and points further away get less weight. The fitted value of this regression evaluated at y_n represents the smoothed value y_n^S which is used to construct the non-parametric curve that links y and x. The procedure is repeated for each observation $(x_n; y_n)$. The number of regressions is equal to the number of observations, and the smoothed curve is the set of all $(x_n; y_n^S)$.

LOWESS estimation requires that the bandwidth of observations included in the regression of each point be chosen. Specifying a large bandwidth provides a smoother estimation, but increases the risk of bias by including observations from other parts of the density. A small bandwidth can better identify genuine features of the underlying density, but increases the variance of the estimation. In this section I use the default STATA bandwidth of 0.8 and in the robustness section 1.3.3 I show how using different bandwidths affects the results. It turns out that the current choice is conservative, because a bandwidth of 0.8 provides a lower-bound of the non-monotonic pattern of the data.

Next, I extend the analysis to the PWT 7.0 using only the benchmark countries and the benchmark year.[4] Arguably, this is the best available sample of countries for running this exercise. PWT 7.0 relies on the 2005 ICP round, which provides the most exhaustive dataset for international comparison of real income and prices; moreover, using only the benchmark countries and year minimizes the source of measurement error. I can confirm the strong positive relationship predicted by the Penn-BS effect by running a standard linear estimation of price on income: the OLS coefficient is 0.20 with a t-statistic of 9.67 (see figure 1.3).[5]

Once I allow for non-linearities, the Penn-BS effect breaks down for low income countries. Figure 1.4 shows the results of running a LOWESS estimation between price and income imposing little restriction on the functional form. We can see that the expected upward sloping relationship holds only for middle- and high-income countries. The relationship is downward sloping for low-income countries; this involves 22% of the countries in the sample. The turning point is at 1,396 PPP $ per-capita (2005 prices) equivalent to the income of Zambia in the year 2005. The countries on the downward sloping path are listed in figure 1.5; we can notice that these are mainly African and Asian (no Latin-American).

Figure 1.6 reports 95% confidence bands of the LOWESS estimation de-

[4] I exclude countries with less than one million people in the year 2000 and Zimbabwe and Tajikistan which are clear outliers; including these countries would reinforce the findings. The list of the countries included can be found in the appendix.

[5] I run an OLS regression, with robust standard errors, of the log of the price level of GDP (variable p from PWT) and the log of GDP per capita in PPPs at current prices (y from PWT).

rived from the standard errors of the smoothed values. The confidence interval confirms the non-monotonic pattern of the data. The Pseudo-R^2 of the non-parametric estimation is 0.66, which is higher than the 0.44 R^2 of the linear model. The F-test comparing the non-parametric model to the linear one rejects the null hypothesis that the non-linear model does not provide a statistically significant better fit.

Standard cross-country OLS regression supports the finding of the non-parametric estimation. In Table 1.1, I rank countries by their income level and divide the full sample into three groups.[6] The price-income relationship is negative, sizable, and significant for the countries in the bottom group of income. As the GDP per-capita of the reference group increases the relationship changes sign and the Penn-BS effect becomes larger and more significant. The results of the OLS regressions are consistent with the non-monotonicity of the price-income relationship stressed by the non-parametric estimation.

1.2.2 Panel and time-series dimensions

In this section, I analyze the price-income relationship in a panel dimension. The ICP collects data prices only in benchmark years. Then, the PWTs estimate prices for other years by rescaling according to the inflation rate differential with the US. Although the reliability of this method is unclear, PWTs are regularly used in empirical analyses with panels; moreover, panel regressions of price on income are commonly used to build measures of real exchange rate over/undervaluation. Thus, it is relevant to assess if the non-monotonicity of the price-income relationship holds along a panel dimension too. [7]

[6] There are 42 observations per group on average. The first group includes the countries up to the income level of Mongolia, the second one up to Lebanon, the third ones includes the remaining countries with a higher level of income

[7] Feenstra et al. (2011) are working on a new version of the Penn World Tables that

If I extend the analysis to a panel of countries between 1950-2009, standard linear estimation of price on income confirms the positive relationship predicted by the Penn-BS effect: the OLS coefficient is 0.20 with a t-statistic of 27.60 (figure 1.7).[8] However, non-parametric estimation shows that the price-income relationship is non-monotonic along a panel dimension too. The Penn-BS effect holds for middle- and high-income countries, but in low-income countries the relationship is negative (figure 1.8).

Figure 1.9 reports the fitted value of the LOWESS estimation. The turning point is at 1600 PPP $ per-capita (2005 prices), which corresponds to the income of Nigeria in the year 2005. The downward sloping arm of the curve includes 30% of the total observations, and 40% of the countries in the sample. The countries on the downward sloping arm and their frequencies are reported in Figure 1.10. We can see that some of the countries are persistently on the downward-sloping arm (i.e. Nigeria and Tanzania); others moved along the curve (i.e. China and Vietnam).

Standard panel-data analysis (Table 1.2) confirms the result of the non-parametric estimation. I show that for developing countries the relationship between price and income is negative and significant with and without country fixed-effects.[9] I do this by running a regression for the full sample, and then

will make use of historical ICP benchmarks to extrapolate the time series of prices and real incomes. This new data set will certainly provide better evidence of the price-income relationship in a panel dimension.

[8]This is for a sample of 150 countries from 1950 to 2009 using PWT 7.0. Countries with less than one million people in the year 2000 and clear outliers are excluded; including these outliers would reinforce the findings. I run an OLS regression of the log of the price level of GDP (variable p from PWT) and the log of GDP per capita in PPPs at constant prices ($RGDPCH$ from PWT).

[9]The relative stability of the coefficients and of the standard errors suggests that in developing countries the price-income relationship within-country is very similar to the one between-countries

for developing countries only.[10] This result comes despite a strict definition of developing countries and a linear restriction on the price-income relationship.

Time-series analysis on selected countries supports the finding that the development process of low-income countries presents a negative relationship between price and income; in developed countries this relationship is positive (Figure 1.11). This is consistent with larger and more significant coefficients in the panel regression of developing countries when I use country fixed-effects. This is a striking result that, to my knowledge, has not been previously shown and merits further research. It suggests that the development process of a country is characterized by a pattern of real exchange rate depreciation; this is consistent with the positive correlation between an undervalued real exchange rate and growth in developing countries documented by the literature as in Rodrik (2008).

1.3 Robustness checks

In this section I analyze the robustness of the results to possible sources of measurement error. The data involved in the previous estimations are GDP per-capita, exchange rates, and PPPs. Data on GDP are very aggregate and are worldwide computed through the standardized SNA method, they should not be a mayor concern for measurement error.[11] Official exchange rates can be very different from black market exchange rates in developing countries; though this applies mainly until the '80s (Reinhart and Rogoff, 2004), we need

[10] I define developing countries as those with a GNI per-capita less than 11,115 US$ (2007), which is the World Bank's threshold for high income countries. Notice that in the full sample with country fixed effects the coefficient is not significantly different from zero.

[11] Gollin et al. (2012) analyze the definitions and measurement approaches used in the construction of national accounts data in poor countries. They conclude that these aggregate data are robust to problems associated with informality or household production and that there is no reason to believe that they are intrinsically flawed.

to control for this possible source of bias. PPP is clearly the variable that can be mostly affected by measurement error and it is the one I draw more attention on.

In this section I show that the findings of the paper are robust to possible sources of bias from PPP estimation, to the PWT's structure and to black market exchange rates. Moreover, I also show that the non-parametric estimations of section 1.2 are more likely to be a lower-bound of the true non-monotonicity that characterizes the data.

1.3.1 Purchasing power parities

The most important source of measurement error comes from the computation of Purchasing Power Parities, above all in low-income countries. Biased estimates could seriously affect the results of the paper because PPPs enter the numerator of the dependent variable and the denominator of the independent variable.[12] This generates issues of classical measurement error where a high variance of measurement error leads to a biased and inconsistent estimation. Moreover, I control also for the bias generated by the average of the measurement error, not only by its variance.

Bias from the variance of measurement error

Chen et al. (2007) analyze the bias of OLS estimation of price on income when there is a measurement error in the computation of PPPs. They argue that the independent variable is correlated with the error term, so that the standard assumptions for a consistent and unbiased least square estima-

[12] I remind the reader that $p = \frac{PPP}{XRAT}$ and $y = \frac{GDP}{PPP}$

tor break down. They conclude that if the β coefficient of the price-income relationship is positive, the OLS estimate will be biased downwards and can become negative if the variance of the measurement error is high. In fact, they show that:[13]

$$\text{plim } \hat{\beta} = \frac{\beta - \frac{\sigma_\eta^2}{\sigma_{y^*}^2}}{1 + \frac{\sigma_\eta^2}{\sigma_{y^*}^2}} \tag{1.1}$$

where σ_η^2 is the variance of measurement error and $\sigma_{y^*}^2$ is the variance of the "true" real income per-capita.

From this expression we can see that as the variance of the measurement error σ_η^2 increases, the estimated $\hat{\beta}$ can become negative. Among the poorest group of countries (the bottom-third) I find an OLS estimation of -0.135. What level of measurement error's variance can drive this result? Assuming that measurement error is correlated to the level of income but not to the level of price, we can rewrite expression 1.1 as: [14]

$$\text{plim } \hat{\beta} = \frac{\beta - \frac{\sigma_\eta^2}{\sigma_{y^*}^2}}{1 + \frac{\sigma_\eta^2}{\sigma_{y^*}^2}} = \frac{\beta - \frac{\sigma_\eta^2}{\sigma_Y^2 + \sigma_p^2 + \sigma_\eta^2 + \sigma_{Yp} + \sigma_{Y\eta}}}{1 + \frac{\sigma_\eta^2}{\sigma_Y^2 + \sigma_p^2 + \sigma_\eta^2 + \sigma_{Yp} + \sigma_{Y\eta}}} \tag{1.2}$$

In the sub-sample of countries where the price-income relationship is negative, we have $\sigma_Y^2 = 0.302$, $\sigma_p^2 = 0.067$, $\sigma_{Yp} = 0.27$(remember that all the variables are expressed in logs). I assume that $\sigma_{Y\eta} = \sigma_{Yp} = 0.27$, so that the covariance between the income level and the measurement error of price is equal to the covariance between income and price.

[13] They start specifying the price-income relationship such that $p_i^* = \alpha + \beta y_i^* + \epsilon_i$, where p_i^* is the true price level without measurement error and $y_i^* = Y_i - p_i^*$ is the "true" real income per-capita. Consider the case where the measured price level p_i contains an error such that $p_i = p_i^* + \eta_i$, where η_i has mean zero and is normally distributed; then expression 1.1 follows.

[14] From Chen et al. specification we have that $y_i^* = Y_i - p_i - \eta_i$, from which expression 1.2 follows.

The variance of measurement error that would lead to the negative estimation of -0.135 depends on the value of β_{true}. Let's suppose that β_{true} is equal to the OLS estimation over the full sample (0.20). In this case, in order to get $\hat{\beta} = -0.135$, I would need $\sigma_\eta^2 = 0.57$: the measurement error on prices should have a variance 9 times higher than the variance of the observed prices. If we rather assume that β_{true} is zero, we would need $\sigma_\eta^2 = 0.16$: this value is equal to the variance of price in the full sample of countries; hence the variance of the measurement error in the sub-sample of poor countries should be as big as the overall variance of prices that we observe over the full data set.

Therefore, even if measurement error could potentially drive my result, an implausible variance of the measurement error itself is required to get the negative price-income relationship presented in the paper.

Bias from the mean of measurement error

In Figure 1.12 we can see that if PPPs are systematically underestimated in poor countries, measurement error would deliver a stronger Penn-BS effect; the reverse would be true if PPPs tend to be overestimated.[15] It is easy to show that the same argument applies in the case of a negative price-income relationship: if PPPs tend to be more underestimated in poor countries than in middle-income ones, the true price-income relationship would be more negative than the estimated one. Therefore, it is crucial to understand if measurement errors in computing PPPs tend to overestimate or underestimate the true PPPs in low-income countries.

The process of computing PPPs is subject to intrinsic fragilities, making

[15] The underlying assumption in the figure is that measurement error of PPPs affects poorer countries only.

comparisons of real income and prices across countries a difficult exercise. Deaton and Heston (2010) and the ICP Handbook (2007) stress that the main sources of bias in PPPs' estimation are the method of aggregation, quality matching and good representativity.

The PWTs compute PPPs using the Geary-Khamis (GK) method of aggregation: the PPP index of a country is computed as a modified Paasche index that compares domestic prices with world prices. In the GK method the world price of a good is defined as a weighted average of countries' price where the weights are given by a country's consumption share at the global level. This implies that countries with a larger physical volume of consumption get a greater weight in the construction of the composite world prices; so that the international price used to evaluate consumption in all countries is closer to the price in rich countries. As Deaton and Heston (2010) point out, this creates a Gershenkron effect for low income countries: if we measure their consumption by prices that are closer to those of rich countries, their consumption is overvalued. Therefore, the GK method of aggregation tends to understate PPPs in low-income countries.

The method of aggregation is not the only source of bias in PPPs. Quality matching and goods representativity may also affect our results. As Deaton and Heston (2010) stress, one of the most criticized issues of ICP rounds is that lower quality goods and services in poor countries are often matched to higher quality items in rich countries. Quality mismatch leads to an underestimation of the price level in poor countries.

The representativity of the goods priced could also bias PPPs. In each country the ICP calculates prices for about 155 goods (called basic headings) by collecting prices for 1500-2000 items. A basic heading is the most disaggregated level at which expenditure data are available from national accounts statistics. The ICP collects quotes for different items within each basic head and then aggregates them with different procedures.[16] If an item within the basic heading is representative in some countries but not in others, PPPs may be estimated incorrectly.[17] This is a common problem for all ICP rounds.[18]

Nevertheless, Diewert (2008) argues that if non-representative prices are well-distributed across all countries in a region, they may not cause serious distortions. Moreover, Deaton (2010) computes a Tornqvist index to measure how much different goods moves the overall PPP-index in Africa and Asia.[19] He then concludes that there is no evidence to support the idea that prices in Africa or in the Asia-Pacific region are systematically overstated by the representativity issue.

Another source of concern could be the difference between urban and rural prices. Feenstra et al. (2012) show that in China the price level has been overstated because of a urban bias in the data collection. In order to account for this bias the PWT introduces a uniform reduction of 20% to the ICP prices. This adjustment is consistent with their estimates of China's real GDP. Our results account for this downward revision. However, there is no clear evidence of price overestimation for other countries due to the urban bias. Actually Atkin and Donaldson (2012) show that the price of detailed products

[16] For instance, for the basic heading *rice*, the ICP collects quotes for six different kinds of rice, including long-grained, short-grained, and brown rice. See Rao (2004) for a detailed explanation of the items' methods of aggregation

[17] See for instance the wheat vs. teff example in Deaton and Heston (2010).

[18] The Latin American region tried to overcome this issue in the 2005 round by using an extended CPD method, adding a representativity dummy. The OECD/Eurostat and CIS regions used an EKS method based on Javon indexes of representative products between countries; see Hill (2007b) for a brief description of this method.

[19] He estimates a pairwise Tornqvist index for the ring African countries vs. the UK and at regional level for Africa and Asia-Pacific vs. OECD/Eursotat.

in Ethiopia and Nigeria are on average 5-12% higher in rural areas.

To summarize, the method of aggregation and quality matching tend to understate PPPs in low-income countries respect to the "true" values. Moreover, there is no evidence that products representativity systematically biases PPPs upwards and that the urban bias affect the countries on the downward sloping path. If that's the case, the non-monotonicity showed in section 2 is actually a lower-bound of the true one.

1.3.2 PWT structure: benchmark analysis and black market exchange rates

The Penn World Tables (PWT) rely on data from the International Comparison Program (ICP) which collects prices only in benchmark years and benchmark countries. The PWT estimates PPPs for other years through rescaling according to the inflation rate differential with the US. Whereas, the PPPs of countries where the ICP did not collect prices are estimated by a two-stage process based on the relationship between nominal and real shares for the benchmark countries.[20]

In figure 1.13 I run a non-linear estimation of the price-income relationship only for benchmark years and benchmark countries of subsequent versions of the PWT.[21] As Bergin et alt. (2006) stress, the overall measurement error for benchmark samples is low. Even if I restrict the analysis to these more reliable samples, the non-monotonicity of the price-income relationship is confirmed.

[20] For details on the estimation procedure see the appendix to PWT.

[21] I use PWT 5.6 for 1985, PWT 6.1 for 1996, and PWT 7 for 2005

As a robustness check for the panel analysis, I focus on the University of Queensland International Comparisons Database (UQICD). The UQICD computes PPPs through an econometric model constructed using information contained in all the benchmark comparisons of the ICP, rather than through extrapolations formed from a single benchmark only. Figure 1.14 shows the fitted values of a LOWESS estimation from a panel that includes only the benchmark years and the benchmark countries of the ICP rounds in 1985,1996, and 2005. This is a very limited sample of 47 countries that excludes most of the low-income countries of the previous estimations. Despite that, figure 1.14 confirms the non-monotonicity of the price-income relationship.

Another point worth to highlight is that the exchange rate that PWT uses to compute the price level is the official one. In developing countries the official exchange rate can greatly differ from the one used in daily transactions, above all in the early years of our sample. Nevertheless, this issue does not undermine the finding of the paper. In fact, as Reinhart and Rogoff (2004) argue, multiple exchange rate arrangements decreased greatly over time and the non-monotonicity of the price-income relationship that the paper documents holds also for the year 2005. Moreover, in figure 1.15 I report the non-parametric estimation of price on income using black market exchange rates for the year 1996.[22] The non-monotonicity of the relationship is confirmed also in this case.

Finally, the analysis in Section 1.2 refers to the PWT 7.0 database. This relies on the 2005 ICP round, which provides arguably the best available data for international comparisons of real income. The PPPs of many developing countries were revised upwards after this round, and these countries have a

[22]Data on black market rates are taken from Reinhart and Rogoff (1996). Prices are computed dividing PPPs from PWT 6.1 by the black market exchange rates. I choose the year 1996 because this is the oldest benchmark year for which raw PPPs are available.

lower real income than was previously thought (Deaton, 2010). Although higher PPPs in poor countries work in favor of my findings, the last ICP round does not drive the results of the paper. The results presented in section 1.2 holds also for previous versions of the PWTs. [23]

Feenstra, Inklaar and Timmer are working on a new version of the Penn World Tables that will provide price and real GDP data not only on the expenditure side, but also on the output side. Moreover, in order to derive a time series of price and income, it will rely on historical benchmarks of the ICP and not only on national accounts as it is currently the case. It is not clear how these new two dimensions will affect the analysis of the paper. Nevertheless, this new data set will allow further analysis of the price-income relationship.

1.3.3 LOWESS estimation: alternative bandwidths

Section 1.2 briefly discussed the trade off between smoothness and bias in choosing the bandwidth for the LOWESS estimation. A large bandwidth includes observations from other part of the density increasing the risk of bias. A small bandwidth can better capture the true feature of the data, but at the cost of higher variance. The analysis hitherto presented used the default bandwidth of STATA which is 0.8. This is a large value that may lead to a biased estimation of the non-parametric pattern of the data.

In figure 1.16 I report non-parametric estimations of the same sample of figure 4, but using a bandwidth of 1 and of 0.4. We can see that with a bandwidth of 1, which is the maximum, nothing changes respect to the estimation of figure 1.4. However in the case of a 0.4 bandwidth, the non-monotonicity

[23] Details available upon request.

of the price-income relationship is stronger: the negative pattern now includes 33% of the sample and it becomes positive only after a level of income of 2,604 PPP$ equivalent to that of Mongolia in the year 2005. This suggests that the non-monotonicity presented in section 1.2 can be a lower-bound of the true one.

This section has shown that the results of the paper are robust to possible bias in PPPs estimation; that they hold for benchmark years and countries; that are not affected by using black market exchange rates; and that different bandwidths in the non-parametric estimation would reinforce the results. All this provides evidence that the non-monotonicity of the price-income relationship is not a spurious result, but a hitherto undocumented economic fact.

1.4 Conclusions

In this paper I show that the relationship between the price and the income level is non-monotonic. To my knowledge this is an original finding and it is a hitherto undocumented empirical regularity. This result contradicts the conventional wisdom of a positive price-income relationship, which draws upon a linear estimation. If I apply a non-parametric estimation, the price-income relationship turns out to be significantly negative in poor countries. This finding is robust along both cross-section and panel dimensions. The new evidence presented in this paper raises general questions about the relationship between the process of economic development and the price level, as well as about the long-run determinants of real exchange rate in poor countries.

In fact, the standard Balassa-Samuelson hypothesis, which provides the mainstream explanation for the Penn-Balassa-Samuelson effect, cannot explain the negative price-income relationship in poor countries. This hypothesis relies on the assumption that higher income countries have relatively higher productivity in the tradable sector. Accounting for free labor mobility between the tradable and non-tradable sectors and for the law of one price, higher relative productivity in the tradable sector leads to higher wages in both sectors and to higher price in the non-tradable sector, hence to a higher overall price level. For a negative price-income relationship, we would need richer countries to be characterized by lower productivity in the tradable sector, but the empirical evidence does not support this option.

The next paper analyses possible explanations of the non-monotonic pattern of the price-income relationship. The focus is going to be on the different stage of development that characterizes low- and high-income countries and the process of structural transformation that developing countries undergo.

A possible empirical extension of the paper could focus on regional variation within countries like India or China, where there are regions at very different stages of development. This kind of regional variation would also be ideal to verify if the process of structural transformation that the next paper analyzes is at the basis of the non-monotonic price-income relationship.

This paper lays the ground for further theoretical and empirical research on the relationship between economic development and the price level. The results presented, although surprising, should not be disturbing. It is probable that Samuelson himself would not have been startled. In his 1994 article for the thirty-year anniversary of the Balassa-Samuelson model, he wrote that " *The Penn-Balassa-Samuelson effect is an important phenomenon of actual* *history but not an inevitable fact of life. It can quantitatively vary and,* ***in different times and places, trace to quite different processes***".

1. Appendix: countries in the cross-section analysis of section

Albania	Congo, Rep. of	Israel	Namibia	Sudan
Angola	Cote d'Ivoire	Italy	Nepal	Swaziland
Argentina	Croatia	Japan	Netherlands	Sweden
Armenia	Czech Republic	Jordan	New Zealand	Switzerland
Australia	Denmark	Kazakhstan	Niger	Syria
Austria	Ecuador	Kenya	Nigeria	Taiwan
Azerbaijan	Egypt	Korea, Rep. of	Norway	Tanzania
Bangladesh	Estonia	Kuwait	Oman	Thailand
Belarus	Ethiopia	Kyrgyzstan	Pakistan	Togo
Belgium	Finland	Laos	Paraguay	Tunisia
Benin	France	Latvia	Peru	Turkey
Bolivia	Gabon	Lebanon	Philippines	Uganda
Bosnia and Herz.	Gambia, The	Lesotho	Poland	Ukraine
Botswana	Georgia	Liberia	Portugal	Sweden
Brazil	Germany	Lithuania	Romania	Switzerland
Bulgaria	Ghana	Macedonia	Russia	Syria
Burkina Faso	Greece	Madagascar	Rwanda	Taiwan
Cambodia	Guinea	Malawi	Saudi Arabia	Tanzania
Cameroon	Guinea-Bissau	Malaysia	Senegal	United Kingdom
Canada	Hong Kong	Mali	Serbia	United States
Central Afr. Rep.	Hungary	Mauritania	Sierra Leone	Uruguay
Chad	Guinea-Bissau	Mauritius	Singapore	Venezuela
Chile	India	Mexico	Slovak Rep.	Vietnam
China Version 1	Indonesia	Moldova	Slovenia	Yemen
China Version 2	Iran	Mongolia	South Africa	Zambia
Colombia	Iraq	Morocco	Spain	
Congo, Dem. Rep.	Ireland	Mozambique	Sri Lanka	

1. Figures and Tables

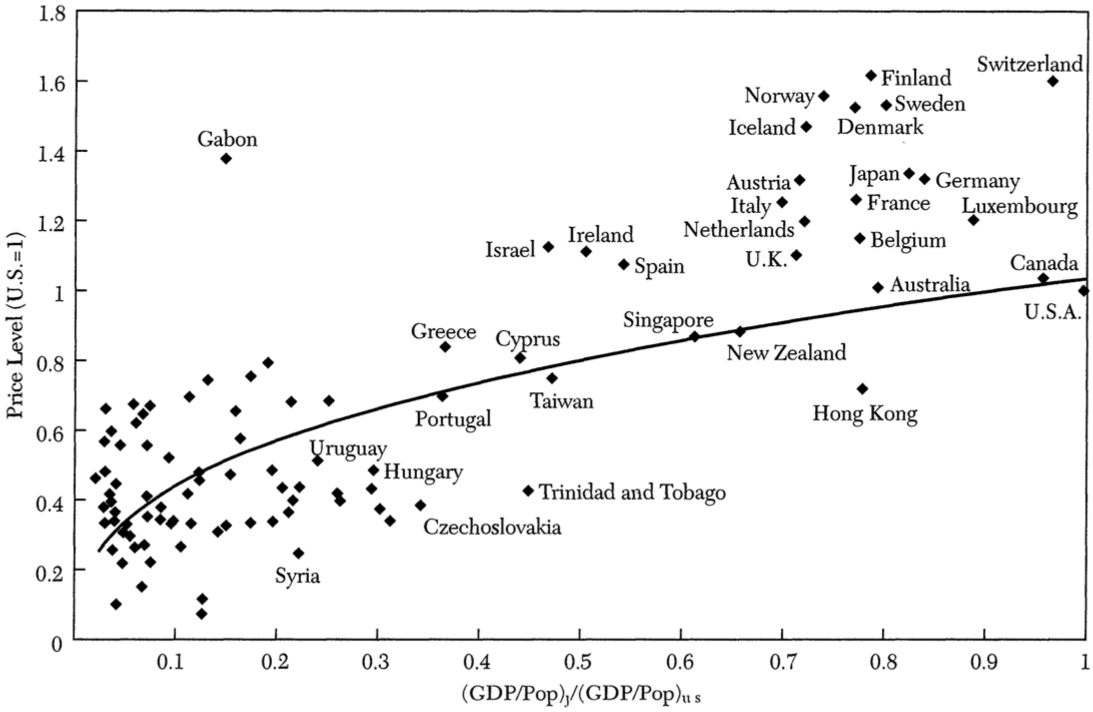

Figure 1.1: Price Level and Income - Rogoff (1996)

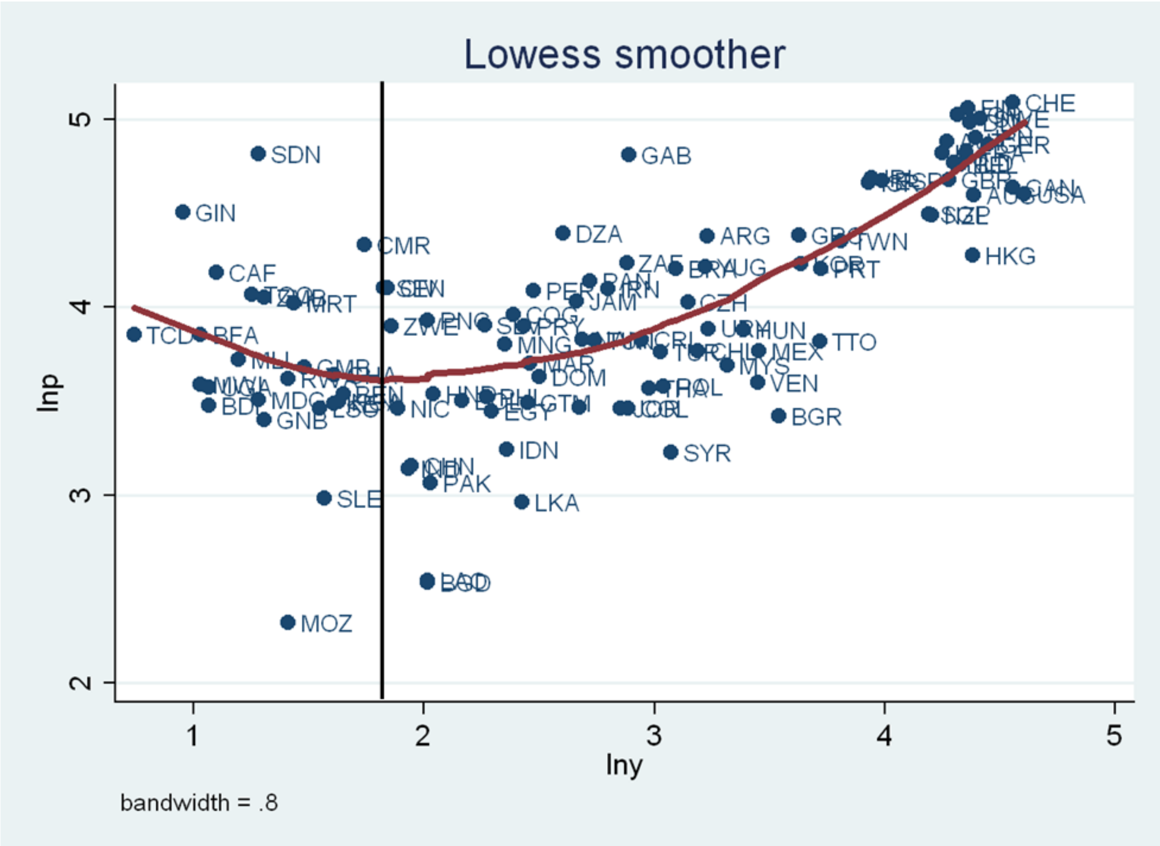

Figure 1.2: Price Level and Income - Rogoff (1996); log-income & non-param. estimation

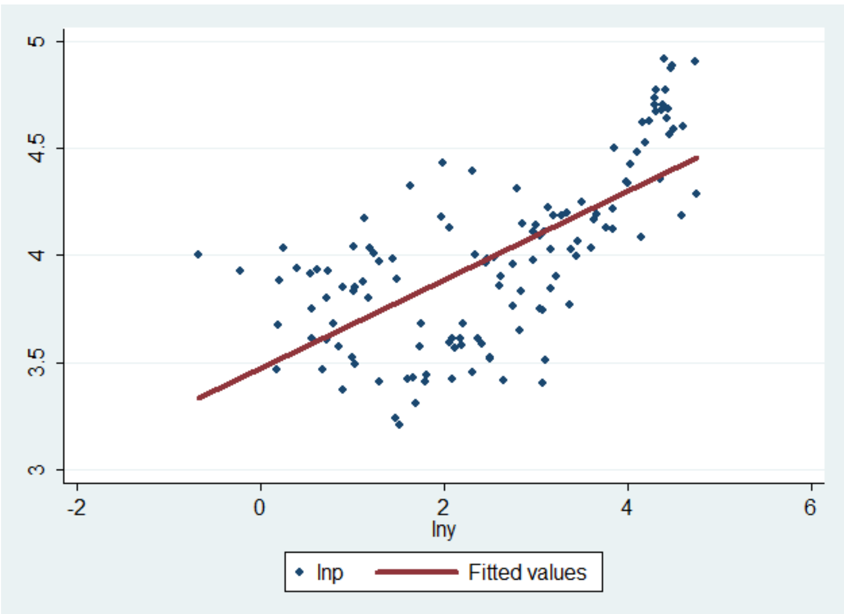

Figure 1.3: Price level and Income PWT 7.0, benchmark countries, 2005: Linear Estimation

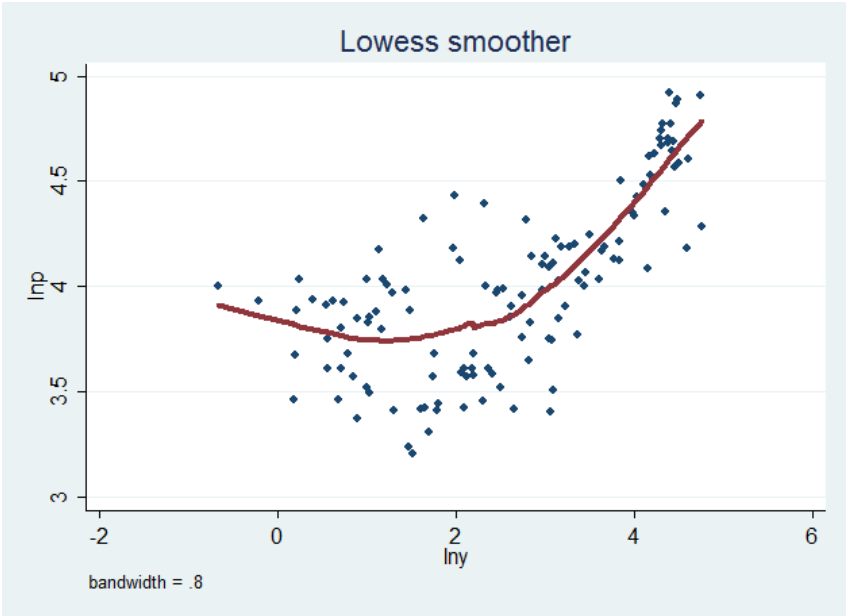

Figure 1.4: Price level and Income PWT 7.0, benchmark countries, 2005: Non-Parametric Estimation

Country	Country
Bangladesh	Liberia
Benin	Madagascar
Burkina Faso	Malawi
Central African Republic	Mali
Chad	Mauritania
Congo, Dem. Rep.	Mozambique
Cote d`Ivoire	Nepal
Ethiopia	Niger
Gambia, The	Rwanda
Ghana	Sierra Leone
Guinea	Tanzania
Guinea-Bissau	Togo
Kenya	Uganda
Lesotho	Zambia

Figure 1.5: Countries on the downward sloping arm: cross-section dimension

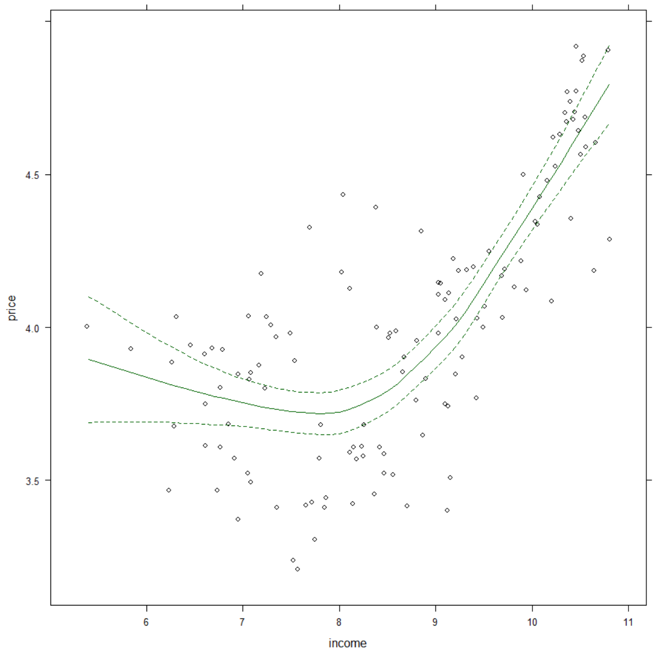

Figure 1.6: Price and Income PWT 7.0, benchmark countries, 2005: Non-Parametric Estimation, 95% confidence bands

Table 1.1: Cross-country OLS regression by income ranking, year 2005

Dependent var: ln p	ln y
1st Third	-0.135**
	(-2.05)
2nd Third	0.145
	(1.17)
3rd Third	0.514***
	(6.90)
Full sample	0.20***
	(9.67)

*** Significant at the 1% level; ** significant at the 5% level; *significant at the 10% level; robust t-statistics in parenthesis.

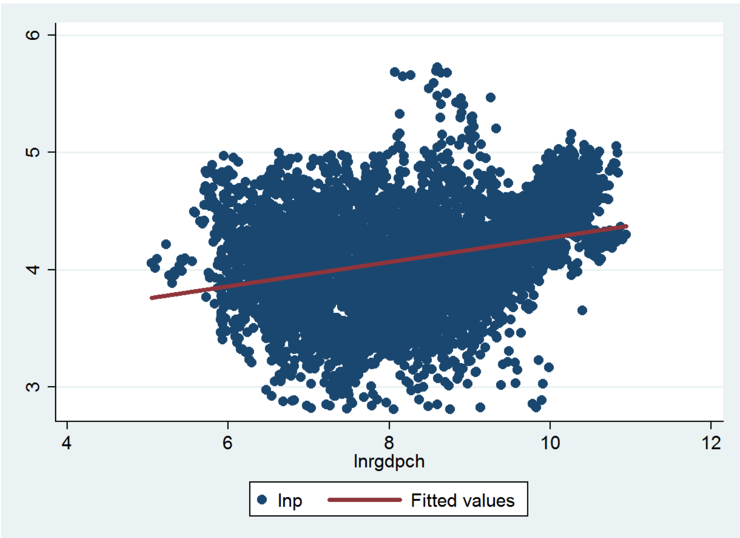

Figure 1.7: Prices and Income 1950-2009: Non-Parametric Estimation

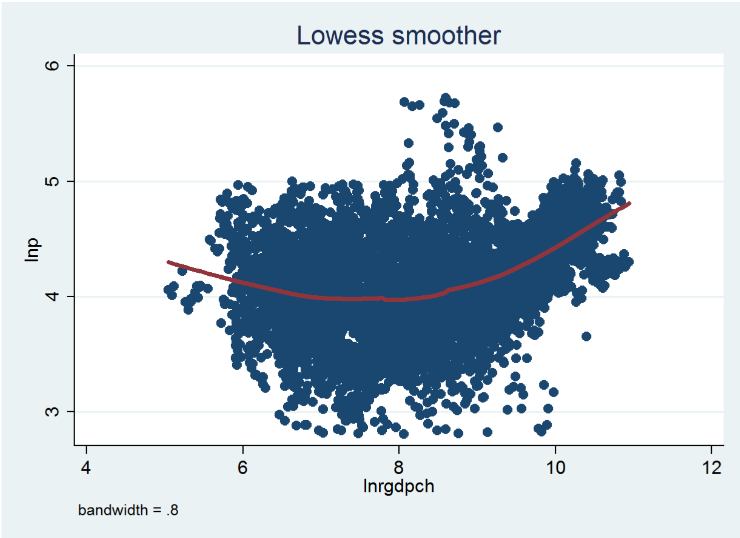

Figure 1.8: Prices and Income 1950-2009: Non-Parametric Estimation

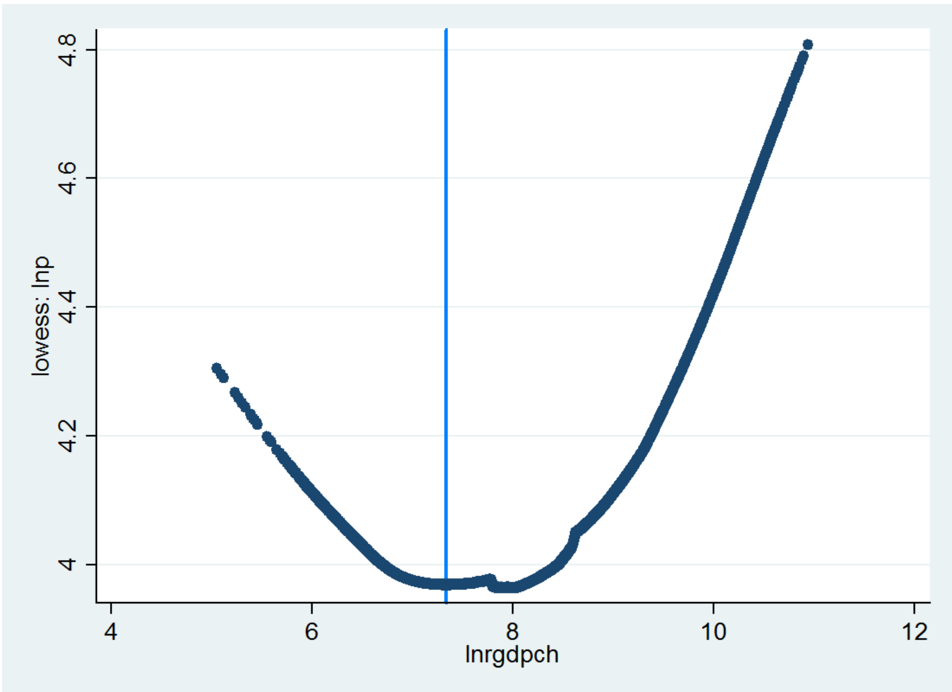

Figure 1.9: Prices and Income 1950-2009: Non-Parametric Estimation, fitted values

Country	Frequency	Country	Frequency	Country	Frequency
Afghanistan	40	Guinea	24	Pakistan	33
Bangladesh	51	Guinea-Bissau	48	Papua New Guine:	15
Benin	51	Haiti	18	Philippines	19
Bosnia and Herzegovin:	1	India	45	Rwanda	50
Botswana	12	Indonesia	20	Senegal	50
Burkina Faso	51	Kenya	60	Sierra Leone	49
Burundi	45	Kyrgyzstan	3	Somalia	39
Cambodia	33	Laos	32	Sri Lanka	32
Cameroon	17	Lesotho	50	Sudan	26
Central African Republi	50	Liberia	27	Swaziland	4
Chad	50	Madagascar	50	Taiwan	5
China Version 1	38	Malawi	53	Tajikistan	14
China Version 2	33	Malaysia	7	Tanzania	50
Congo, Dem. Rep.	56	Mali	50	Thailand	20
Congo, Republic of	16	Mauritania	46	Togo	49
Cote d`Ivoire	35	Moldova	1	Tunisia	1
Egypt	28	Morocco	23	Uganda	55
Eritrea	18	Mozambique	26	Uzbekistan	9
Ethiopia	59	Nepal	50	Vietnam	28
Gambia, The	50	Niger	50	Yemen	5
Ghana	48	Nigeria	44	Zambia	25

Figure 1.10: Countries on the downward sloping arm: panel dimension

Table 1.2: Panel evidence on price level and real income

Dependent var: ln p	**Full Sample**		**Developing Countries**	
	(1)	(2)	(1)	(2)
ln RGDPCH	0.109***	0.103	-0.125**	-0.138*
	(2.55)	(1.56)	(-1.95)	(-1.78)
Country, fe	NO	YES	NO	YES
Time dummies	YES	YES	YES	YES
No. of countries	149	149	107	107
Avg obs per country	46.1	46.1	45.7	45.7

*** Significant at the 1% level; ** significant at the 5% level; * significant at the 1% level; robust t-statistics in parenthesis.

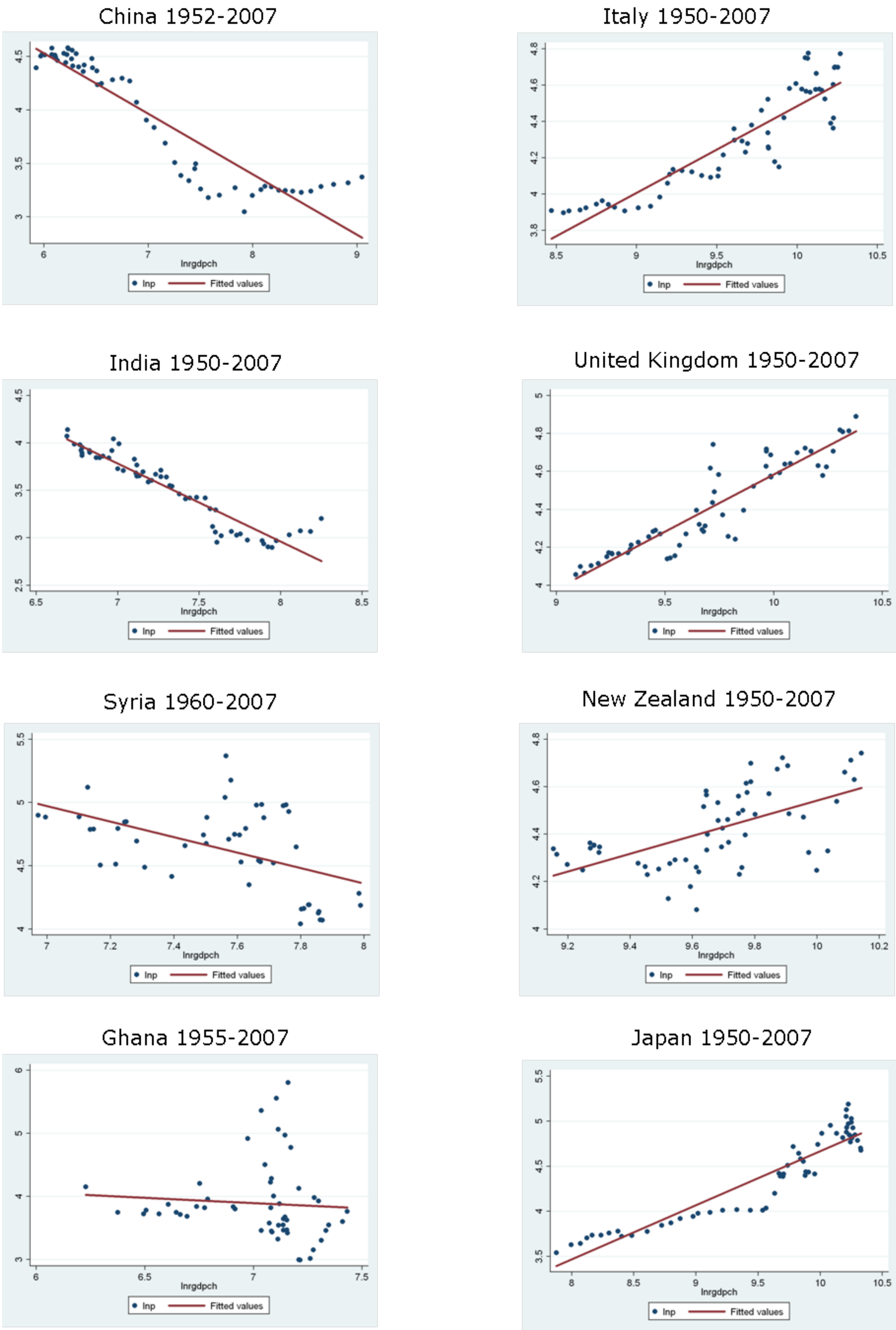

Figure 1.11: Price-Income, time series dimension: developing vs. developed countries, selected cases

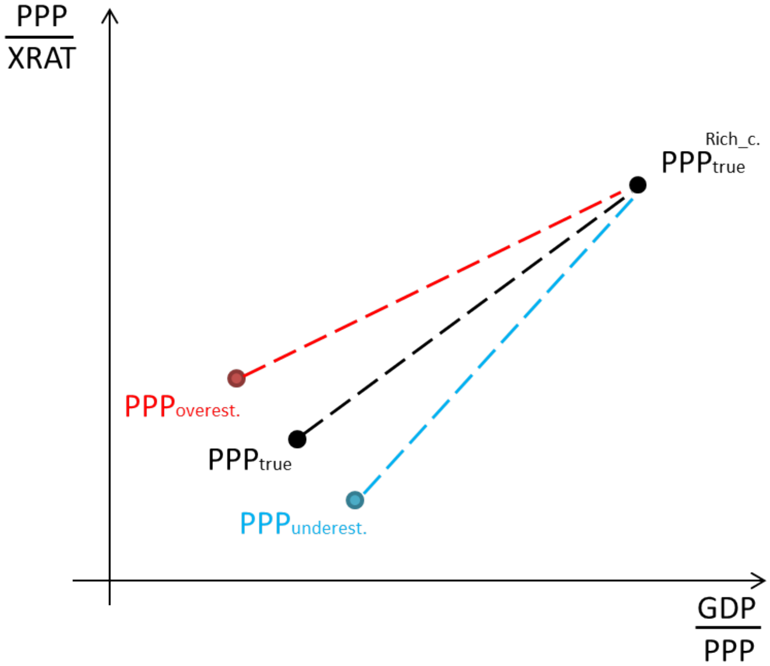

Figure 1.12: The effect of PPPs bias

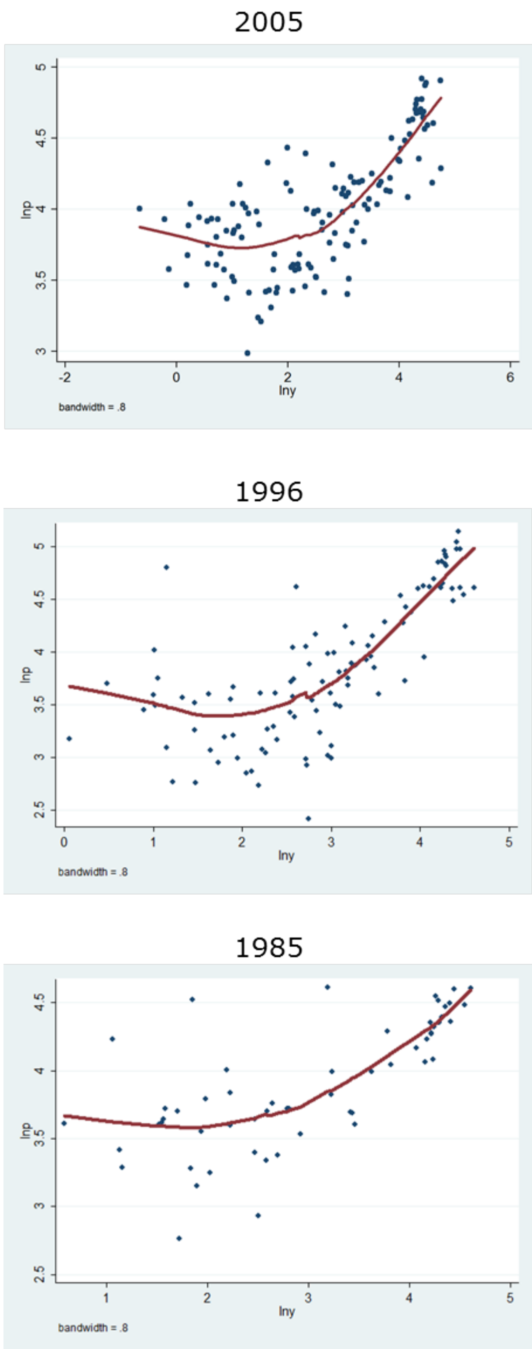

Figure 1.13: Price and income: benchmark years and countries

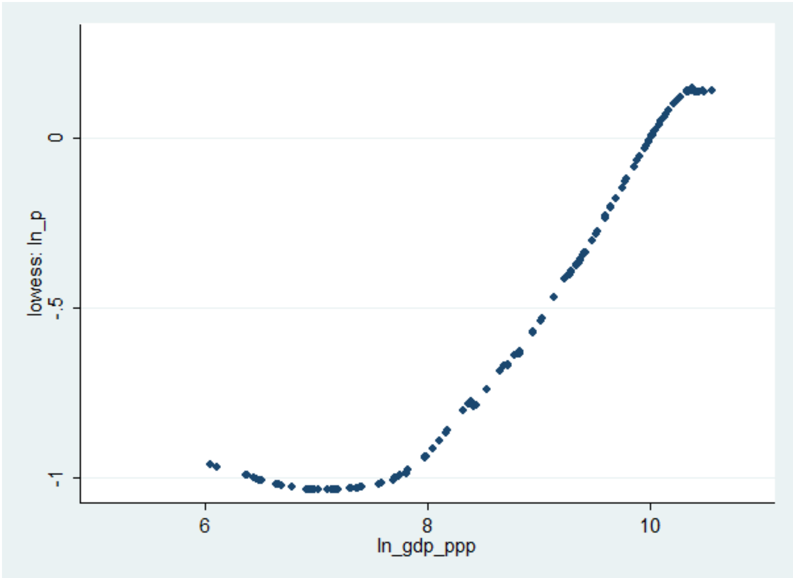

Figure 1.14: Price and income: panel of benchmark years and countries, UNIQD. Non-parametric estimation, fitted values

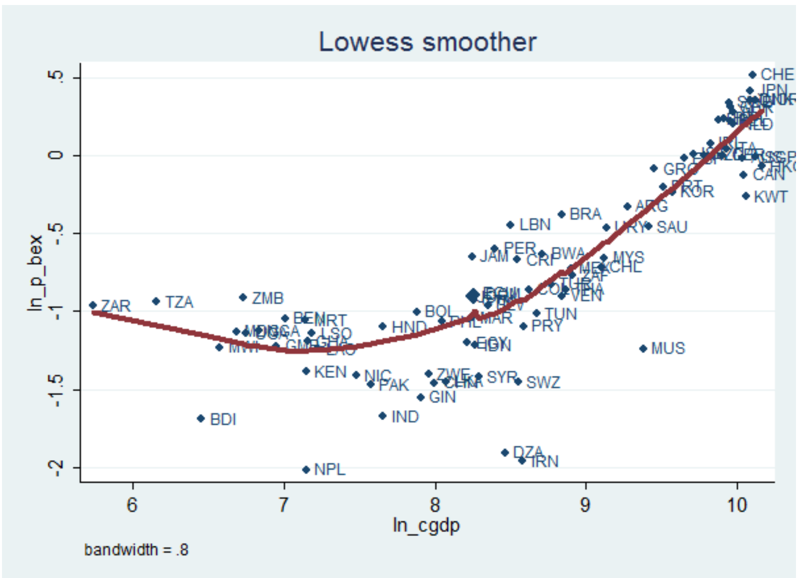

Figure 1.15: Prices and Income 1996 using black-market exchange rates: Non-Parametric Estimation

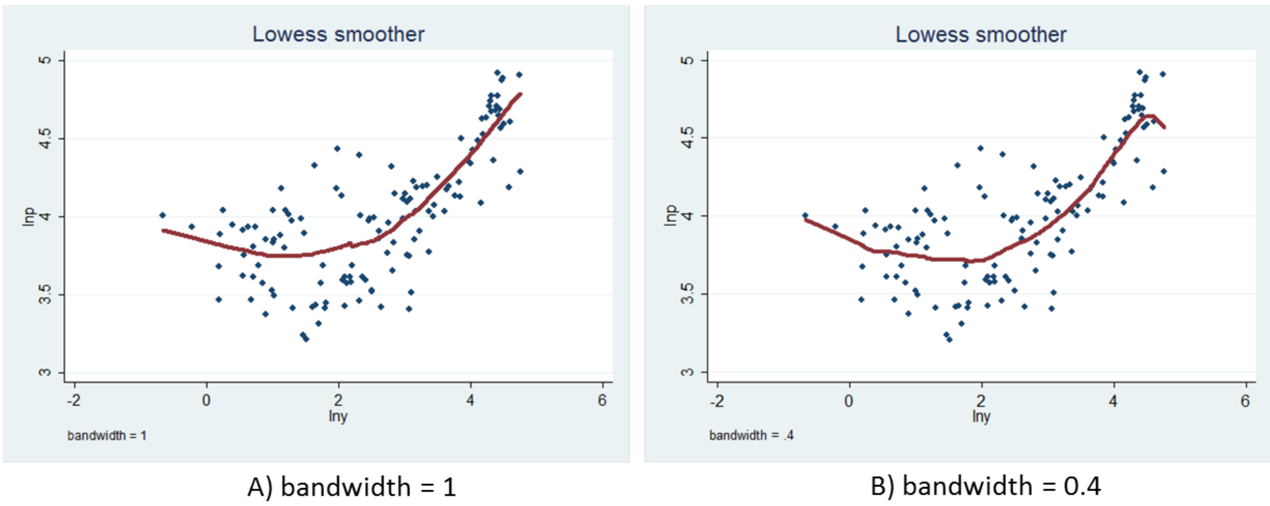

Figure 1.16: Price and Income, PWT 7.0, benchmark countries, 2005: Non-Parametric Estimation with different bandwidths

Chapter 2

The Balassa-Samuelson hypothesis, structural transformation, and the price level

2.1 Introduction

The most accepted explanation of the Penn-Balassa-Samuelson effect is the Balassa-Samuelson (BS) hypothesis. This explanation focuses on productivity differentials between the tradable and the non-tradable sector. Assuming free labor mobility across sectors and that the law of one price holds for tradables, the BS hypothesis shows that countries with higher relative productivity in the tradable sector have a higher price level. Since richer countries tend to have higher relative productivity in the tradable sector, the price level should then raise with per-capita income.

In order to capture the non-monotonicity of the price-income relationship, this paper argues that we need a modified BS framework that accounts for the relevance of the agricultural sector in poor countries and for the fact that low-income and high-income countries have very different economic structures and are at different stages of development. In table 2.1, I consider the benchmark countries of PWT 7 for the year 2005. I rank countries by their level of income and divide the sample into three groups. Then, following the tradition of the development macroeconomics literature, I focus on a sectoral division of the economy between agriculture, manufacturing, and services.

We can see that the countries in the bottom group of income have a remarkably different structure in terms of valued added, expenditure, and employment shares. The most significant differences refer to the agricultural sector: the group of countries where the price-income relationship is negative have a 10 times higher valued added share in agriculture, a 4 times higher expenditure share and a 9 times higher employment share than the countries in the top group of income. This clearly reflects the early stage of development that characterizes these countries.

If structural change is an important determinant of the non-monotonicity of the price-income relationship, we should observe some degree of non-monotonicity when the price level is regressed against key indicators of structural change. Figure 2.1 confirms this by showing a non-monotonic pattern of the price level respect to employment and expenditure shares in agriculture.

The differences in value added, expenditure and employment shares highlighted in table 2.1 are associated to a different structure of relative prices. Using disaggregated data kindly provided by the International Comparison Program at the World Bank, I can compute sectoral PPPs and price levels (table 2.1).[1] Perhaps contrary to conventional wisdom, the relative price of

[1]The price level of sector i is given by $p_i = PPP_i/XRAT$ with $p_i^{US} = 1$. In order to preserve aggregation at the GDP level, I use the Geary-Khamis method to compute sectoral PPPs. See the appendix for a detailed description of goods' sectoral classification; as suggested by Herrendorf and Valentinyi (2011) I map the agricultural sector with the food sector.

agriculture in terms of both services and manufacturing turns to be higher in low-income countries than in rich-countries.[2] The key result of this exercise is that, whereas the average price level of services and manufacturing increases by income group, the price level of agriculture decreases between the bottom and the intermediate group. Non-parametric estimations of sectoral prices on income confirm this pattern: figures 2.2, 2.3, 2.4 show that the price dynamics of the agricultural sector accounts for most of the non-monotonicity of the overall price-income relationship. This clearly points out that the cause of the negative pattern should be related to the dynamics of the agricultural sector.

The explanation for the non-monotonic price-income relationship that this paper proposes is therefore the following: When a poor country starts to develop, its productivity growth relies mainly in the agricultural sector. This allows for a reduction of the relative price of agricultural goods. Since in a country at an early stage of development, agriculture represents a big share of both expenditure and value added production, there is an overall reduction of the price level. After a certain stage of development the share of the agricultural sector in the economy decreases. Hence the previous effect fades out and productivity gains from the manufacturing sector becomes a more important source of growth, so that we are back to the standard Balassa-Samuelson mechanism.

The two key elements of this explanation are that productivity growth in the agricultural sector is higher than in other sectors and that agricultural goods are not tradable. Duarte and Restuccia (2010) show for a panel of 29 countries between 1956-2004 that productivity growth was 4% in agriculture, 3% in manufacturing and 1.3% in services; moreover Ngai and Pissarides (2007)

[2]Caselli (2005) hints at this possibility in a footnote. Lagakos and Waugh (2012) have a similar finding.

calibrate US TFP growth between 1929-1998 such that it is 1% higher in agriculture than in manufacturing and 1% higher in manufacturing than in services.

As for the non-tradability of agricultural goods, this is a reasonable assumption for low-income countries. On average the share of agricultural exports to agricultural GDP is 17% for the groups of countries with a negative price-income relationship, 45% for the middle group, and 98% for the top group with a positive relationship. Moreover, as Gollin et al. (2007) stress, FAO reports show that about 70% of arable land in 159 developing countries is devoted to staple food crops. With the exception of few developing countries, almost all of the resulting production was for domestic consumption. Moreover, food imports and food aid are not a major source of food consumptiom for poor countries: imports of food supply around 5% of total calories consumed.

2.2 The Balassa-Samuelson+ framework

This section develops a model that links the price level of a country to its process of structural transformation. It derives a consumption-based price index from the utility function, within a modified version of the Balassa-Samuelson framework. Then, it expresses the consumption shares of that index as a function of the employment shares. In this way the price level can reflect a country's stage of development. The purpose of this exercise is to add some minimal feature to the standard Balassa-Samuleson model in order to capture the effect that process of structural transformation has on the price level; for this reason I label the following framework "Balassa-Samuleson +".

2.2.1 Model set-up

Production functions are given by:

$$F_i(k_i, l_i) = A_i k_i^{\alpha} l_i^{1-\alpha}; \quad i = a, m, s \tag{2.1}$$

Factors' market clearing satisfies:

$$\sum_{i=1}^{m} l_i = 1; \quad \sum_{i=1}^{m} k_i = k; \tag{2.2}$$

Moreover, we have that $F_i = c_i$ for $i = a, s$. We also assume that manufacturing produces both a final consumption good and the economy's capital stock so that $\dot{k} = F^m - c_m - (\delta + n)k$.

The underlying assumptions of the model, as in the Balassa-Samuelson framework, are that manufacturing is the only tradable and that trade is balanced period by period. These imply that the effect of trade is to equalize the price of manufacturing across countries and that there is financial autarky, which is a reasonable assumption for low-income countries. The purpose of these assumption is to have a model as close as possible to the standard Balassa-Samuelson framework, in order to be able to highlight better the implications of accounting for the process of structural transformation.

The utility function is assumed to have constant elasticities across goods so that:

$$U(c_a, c_m, c_s) = \left[\gamma_a^{\frac{1}{\theta}} c_a^{\frac{\theta-1}{\theta}} + \gamma_m c_m^{\frac{\theta-1}{\theta}} + \gamma_s c_s^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{2.3}$$

2.2.2 The Consumption-Based Price Index

The consumption-based price index P is defined as the minimum expenditure:

$$z = P_a c_a + P_m c_m + P_s c_s \tag{2.4}$$

such that $c = U(c_a, c_m, c_s) = 1$ given P_i.

So defined, the consumption-based price index measures the least expenditure that buys a unit of the consumption index on which period utility depends.

From consumer's utility maximization we know that:

$$\frac{MU_i}{MU_j} = \frac{P_i}{P_j} \tag{2.5}$$

so that:

$$\left(\frac{\gamma_a}{\gamma_m}\right)^{\frac{1}{\theta}} \left(\frac{c_m}{c_a}\right)^{\frac{1}{\theta}} = \frac{P_a}{P_m}; \quad c_a = \frac{\gamma_a}{\gamma_m} c_m \left(\frac{P_a}{P_m}\right)^{-\theta} \tag{2.6}$$

and

$$\left(\frac{\gamma_s}{\gamma_m}\right)^{\frac{1}{\theta}} \left(\frac{c_m}{c_s}\right)^{\frac{1}{\theta}} = \frac{P_s}{P_m}; \quad c_s = \frac{\gamma_s}{\gamma_m} c_m \left(\frac{P_s}{P_m}\right)^{-\theta} \tag{2.7}$$

Substituting c_a and c_s from (2.6) and (2.7) into (2.4) we have:

$$z = \frac{P_a^{1-\theta}}{P_m^{-\theta}} \frac{\gamma_a}{\gamma_m} c_m + P_m c_m + \frac{P_s^{1-\theta}}{P_m^{-\theta}} \frac{\gamma_s}{\gamma_m} c_m \tag{2.8}$$

so that rearranging:

$$c_m = \frac{\gamma_m P_m^{-\theta} z}{\gamma_a P_a^{1-\theta} + \gamma_m P_m^{1-\theta} + \gamma_s P_s^{1-\theta}} \tag{2.9}$$

and consequently:

$$c_a = \frac{\gamma_a P_a^{-\theta} z}{\gamma_a P_a^{1-\theta} + \gamma_m P_m^{1-\theta} + \gamma_s P_s^{1-\theta}} \tag{2.10}$$

$$c_s = \frac{\gamma_s P_s^{-\theta} z}{\gamma_a P_a^{1-\theta} + \gamma_m P_m^{1-\theta} + \gamma_s P_s^{1-\theta}} \tag{2.11}$$

Equations (2.9), (2.10), and (2.11) are the demands that maximize c given spending z. The highest value of the utility function given z is found by substituting these demands into (2.3), such that:

$$\left[\gamma_a^{\frac{1}{\theta}} \left(\frac{\gamma_a P_a^{-\theta} z}{x}\right)^{\frac{\theta-1}{\theta}} + \gamma_m^{\frac{1}{\theta}} \left(\frac{\gamma_m P_m^{-\theta} z}{x}\right)^{\frac{\theta-1}{\theta}} + \gamma_s^{\frac{1}{\theta}} \left(\frac{\gamma_s P_s^{-\theta} z}{x}\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{2.12}$$

where $x = \gamma_a P_a^{1-\theta} + \gamma_m P_m^{1-\theta} + \gamma_s P_s^{1-\theta}$.

Since P is defined as the minimum expenditure z such that $c = 1$ we have:

$$\left[\gamma_a^{\frac{1}{\theta}} \left(\frac{\gamma_a P_a^{-\theta} P}{x}\right)^{\frac{\theta-1}{\theta}} + \gamma_m^{\frac{1}{\theta}} \left(\frac{\gamma_m P_m^{-\theta} P}{x}\right)^{\frac{\theta-1}{\theta}} + \gamma_s^{\frac{1}{\theta}} \left(\frac{\gamma_s P_s^{-\theta} P}{x}\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} = 1 \tag{2.13}$$

from which the solution for P is:

$$P = \left(\gamma_a P_a^{1-\theta} + \gamma_m P_m^{1-\theta} + \gamma_s P_s^{1-\theta}\right)^{\frac{1}{1-\theta}} \tag{2.14}$$

This is the consumption-based price index consistent with the CES utility function specified in equation (2.3). When $\theta = 1$ the utility function becomes Cobb-Douglas; in this case the price index becomes:

$$\log P = \frac{\log(\gamma_a P_a^{1-\theta} + \gamma_m P_m^{1-\theta} + \gamma_s P_s^{1-\theta})}{1-\theta} \tag{2.15}$$

Applying L'Hopital's rule we have:

$$\lim_{\theta\to 1} \frac{\log(\gamma_a P_a^{1-\theta} + \gamma_m P_m^{1-\theta} + \gamma_s P_s^{1-\theta})}{1-\theta} = \frac{f(\theta)}{g(\theta)} = \lim_{\theta\to 1} \frac{f'(\theta)}{g'(\theta)} = \gamma_a \log P_a + \gamma_m \log P_m + \gamma_s \log P_s \tag{2.16}$$

so that for the Cobb-Douglas case, the consumption-based price index is given by the standard expression:

$$\log P = \gamma_a \log P_a + \gamma_m \log P_m + \gamma_s \log P_s \tag{2.17}$$

Accounting for the cross-country equalization of the price of manufacturing through trade and normalizing it to one, the consumption-based price index can be written as:

$$\log P = \gamma_a \log p_a + \gamma_s \log p_s \tag{2.18}$$

2.2.3 Relative prices, consumption shares and employment

From the supply-side, static efficiency condition requires equal marginal rate of technical substitution across sectors, so that $k_i = k$; while free movement of capital and labor leads to equal remuneration of the factors of production. Therefore, firms' profit maximization implies:

$$\frac{P_a}{P_m} = \frac{A_m}{A_a} \tag{2.19}$$

$$\frac{P_s}{P_m} = \frac{A_s}{A_a} \tag{2.20}$$

From consumer's optimality conditions (2.6) and (2.7) we can define the relative expenditure of agriculture and services respect to manufacturing as:

$$\frac{P_a c_a}{P_m c_m} = \frac{\gamma_a}{\gamma_m}\left(\frac{P_a}{P_m}\right)^{1-\theta} \equiv x_a \tag{2.21}$$

$$\frac{P_s c_s}{P_m c_m} = \frac{\gamma_s}{\gamma_m}\left(\frac{P_s}{P_m}\right)^{1-\theta} \equiv x_s \tag{2.22}$$

We then define $X = x_a + x_s + x_m$, where clearly $x_m = 1$. We also define:

$$c \equiv \sum_{i=1}^{m} P_i c_i; \quad y \equiv \sum_{i=1}^{m} P_i F^i \tag{2.23}$$

Using equations (2.21) and (2.22) and the efficiency conditions, we can rewrite equations (2.23) as:

$$c = P_m c_m X; \quad y = P_m A_m k^{\alpha} \tag{2.24}$$

Notice that the technology parameter for output is TFP in manufacturing not an average of all sectors.

As in Ngai and Pissarides (2007) we can link relative expenditure with the employment shares. If we substitute we substitute $F^i = c_i$ for $i = a, s$ in (2.21) and (2.22), using the market clearing conditions in (2.2), we can show that it results:

$$l_a = \frac{c}{y}\frac{x_a}{X} \tag{2.25}$$

$$l_s = \frac{c}{y}\frac{x_s}{X} \tag{2.26}$$

The employment share in the manufacturing sector is derived by firstly observing that $l_m = 1 - l_a - l_s$, so that we have:

$$l_m = \frac{c}{y}\frac{x_m}{X} + \left(1 - \frac{c}{y}\right) \tag{2.27}$$

Let's consider the price index (2.18), where $\theta = 1$ and manufacturing is the numeraire. We can substitute for γ_a and γ_s from (2.21) and (2.22), so that we have:

$$\log P = x_a \gamma_m \log p_a + \gamma_m x_s \log p_s \tag{2.28}$$

Substituting for p_a and p_s from (2.19) and (2.20) we have:

$$\log P = x_a \gamma_m (\log A_m - \log A_a) + \gamma_m x_s (\log A_m - \log A_s)$$

$$= \gamma_m \left[x_a (\log A_m - \log A_a) + x_s (\log A_m - \log A_a)\right] \tag{2.29}$$

Substituting for x_a and x_s from (2.25) and (2.26) we have:

$$\log P = \gamma_m \left[\frac{l_a X}{c/y}(\log A_m - \log A_a) + \frac{l_s X}{c/y}(\log A_m - \log A_a)\right] \tag{2.30}$$

If we define $c/y = 1 - \sigma$ we can rearrange (2.27) such that $X = \frac{1-\sigma}{l_m - \sigma}$. Therefore the price index is given by:

$$\log P^{BS+} = \gamma_m \left[\frac{l_a}{l_m - \sigma}(\log A_m - \log A_a) + \frac{l_s}{l_m - \sigma}(\log A_m - \log A_s)\right] \tag{2.31}$$

where l_i is the employment share of sector i, A_i is TFP in sector i. I label it Balassa-Samuelson+ price index.

2.3 The Price-Income relationship: Balassa-Samuelson vs. Balassa-Samuelson+

In this section I compute the price level implied by the standard Balassa-Samuelson hypothesis and by the "Balassa-Samuleson+" hypothesis. I then use these price levels to estimate the price-income relationship non-parametrically and compare the fitted values with the actual pattern of the data.

Under the Balassa-Samuelson hypothesis, the price level of a country is:

$$\log P^{BS} = \gamma_{NT}(\log A_T - \log A_{NT}) \tag{2.32}$$

where γ_{NT} is the expenditure share of non-tradables.

The difference between (2.31) and (2.32) is that in the Balassa-Samuelson+ there is a better focus on the agricultural sector and that the sectoral relative TFPs of agriculture and services are weighted by the relative employment shares, so that the price index reflects the stage of structural transformation at which countries are.

In order to compute these price levels, employment shares are taken by the WDI database and by national sources. The saving rate σ is set equal to the share of investment in GDP. The consumption share in manufacturing γ_m is given by the expenditure share in manufacturing computed from the ICP database. I obtain sectoral estimates of TFP across countries following the methodology of Herrendorf and Valentinyi (2011).[3]

[3] I am able to compute the price levels for 60 countries out of 127 because of the lack of sectoral employment data in many poor countries and lack of investment data in middle-income and former URSS countries.

2.3.1 Sectoral TFPs

Herrendorf and Valentinyi (2011) elaborate a sectoral development accounting framework that allows to compute sectoral TFPs using PWT. The key assumptions of their methodology are: competitive markets; factor's mobility across sectors; Cobb-Douglas production function with factor shares common to all countries.

The production function for sector i in country z is given by:

$$y_i^z = A_i^z (k_i^z)^{\theta_i} (l_i^z)^{\phi_i} (h_i^z)^{1-\theta_i-\phi_i} \tag{2.33}$$

where k is capital, l is land, and h is human capital.

Under the assumption stated above, Herrendorf and Valentinyi (2011) show that the sectoral factors of production are:

$$k_i^z = \frac{\theta_i p_i^z y_i^z}{\sum_j \theta_j p_j^z y_j^z} \sum_i k_i^z \tag{2.34}$$

$$l_i^z = \frac{\phi_i p_i^z y_i^z}{\sum_j \phi_j p_j^z y_j^z} \sum_i l_i^z \tag{2.35}$$

$$h_i^z = \frac{(1-\theta_i-\phi_i) p_i^z y_i^z}{\sum_j (1-\theta_j-\phi_j) p_j^z y_j^z} \sum_i h_i^z \tag{2.36}$$

In order to compute sectoral TFPs, I take the sectoral factor shares from Herrendorf and Valntinyi (2011), who calculate them from the US input-output tables. Then, following their methodology, I compute the capital stock in the economy k^z with the perpetual inventory method as in Caselli (2005).[4] Land l^z is arable land for agriculture and urban land for manufacturing and services.

[4]I exclude countries with data on investment starting only after the '70s; this also contributes to limit the sample of countries for which I can compute the price index.

I take data on arable land from FAOSTAT and following World Bank (2006) estimates, I set urban land equal to 24% of physical capital. Finally, I compute human capital h^z as in Caselli (2005) and it is a piecewise increasing function of average years of schooling per worker.

2.3.2 Models' predictions

Figure 2.5 shows the fitted values of the non-parametric estimation of the price-income relationship, where prices are given by equation (2.32): I am able to confirm the strictly positive relationship predicted by the Balassa-Samuelson hypothesis.

Figure 2.6 shows that the price implied by the "Balassa-Samuleson+" hypothesis allows for more flexibility in the price-income relationship and can generate a negative pattern at low levels of development. Therefore, by taking into account that countries are at a different stage of their process of structural transformation, I am able to match better the actual pattern of the data reported in figure 2.7.

Table 2.2 analyzes the quantitative fit: under the BS+ hypothesis 26% of countries in the sample are on the downward sloping path of the price-income relationship; in the standard BS hypothesis this is 0% and in the actual data it is 22% of the sample. The variance of prices generated by the BS+ hypothesis is two and half times higher than in the data (1.02 vs 0.41). Finally, the turning point of the BS+ model is around 3,000 PPP$, but in the data it is around 1,400 PPP$.

The quantitative result of the "Balassa-Samuleson+" hypothesis clearly outperforms that of the Balassa-Samuelson hypothesis. The model derived in this paper is relatively simple and a richer approach that accounts for other factors like the tradability of agriculture in rich countries or the reduction of trade costs as a country develops might deliver a better quantitative fit. However the results presented are encouraging and lay the ground for further theoretical and empirical research on the relationship between structural change and the price level.

2.4 Conclusions

The paper shows that the dynamics that characterize the agricultural sector are the main drivers of the non-monotonic pattern of the price-income relationship. This suggests that, in order to capture the non-monotonicity of the data, we should consider the different stage of development at which countries are.

The paper proposes a modified version of the Balassa-Samuelson hypothesis, labeled "Balassa-Samuelson +". The main points of this framework are that: it focuses on a three-sectors decomposition between agriculture, manufacturing and services; agriculture is considered non-tradable; in the overall price level the relative TFPs of agriculture and services are weighted by the respective employment shares. In this framework the price level can capture the different stage of development at which countries are.

The results of the paper show that linking the price level to the process of structural transformation that characterize developing countries can generate a non-monotonic pattern of the price-income relationship. The Balassa-

Samuelson+ framework outperforms the standard Balassa-Samuleson hypothesis in matching the data. This result suggests that structural change and, more in general, inter-sectoral dynamics can be important determinants of real exchange rates movements.

The next chapter introduces a multisector Eaton-Kortum model of trade as in Michaels et al. (2011) and Tombe (2012). This approach might deliver a better quantitative prediction because, through endogenous tradability, it relaxes the assumption of agriculture being non-tradable and it accounts for the role played by trade costs.

2. Appendix: ICP 2005, classification of goods

Category	Basic Heading	*BS-SC framework:* **Sector allocation**	*BS-framework:* **Tradability**
Food	Rice	A	T
	Other cereals and flour	A	T
	Bread	A	T
	Other bakery products	A	T
	Pasta products	A	T
	Beef and veal	A	T
	Pork	A	T
	Lamb, mutton and goat	A	T
	Poultry	A	T
	Other meats and preparations	A	T
	Fresh or frozen fish and seafood	A	T
	Preserved fish and seafood	A	T
	Fresh milk	A	T
	Preserved milk and milk products	A	T
	Cheese	A	T
	Eggs and egg-based products	A	T
	Butter and margarine	A	T
	Other edible oils and fats	A	T
	Fresh or chilled fruit	A	T
	Frozen, preserved or processed fruits	A	T
	Fresh or chilled vegetables	A	T
	Fresh or chilled potatoes	A	T
	Frozen or preserved vegetables	A	T
	Sugar	A	T
	Jams, marmalades and honey	A	T
	Confectionery, chocolate and ice cream	A	T
	Food products n.e.c.	A	T

Category	Basic Heading	*BS-SC framework:* **Sector allocation**	*BS-framework:* **Tradability**
Beverages and tobacco	Coffee, tea and cocoa	M	T
	Mineral waters,soft drinks,fruit and veg juices	M	T
	Spirits	M	T
	Wine	M	T
	Beer	M	T
	Tobacco	M	T
Clothing and footwear	Clothing materials and accessories	M	T
	Garments	M	T
	Cleaning and repair of clothing	S	NT
	Footwear	M	T
	Repair and hire of footwear	S	NT
Housing, water, electricity and gas	Actual and imputed rentals for housing	S	NT
	Maintenance and repair of the dwelling	S	NT
	Water supply and miscellaneous services relating to the dwelling	S	NT
	Miscellaneous services relating to the dwelling	S	NT
	Electricity	M	T
	Gas	M	T
	Other fuels	M	T
Furniture, household equipment and maintenance	Furniture and furnishings	M	T
	Carpets and other floor coverings	M	T
	Repair of furniture, furnishings and floor coverings	S	NT
	Household textiles	M	T
	Major household appliances whether electric or not	M	T
	Small electric household appliances	M	T

Category	Basic Heading	*BS-SC framework:* **Sector allocation**	*BS-framework:* **Tradability**
Furniture, household equipment and maintenance	Repair of household appliances	S	NT
	Glassware, tableware and household utensils	M	T
	Major tools and equipment	M	T
	Small tools and miscellaneous accessories	M	T
	Non-durable household goods	M	T
	Domestic services	S	NT
	Household services	S	NT
Health	Pharmaceutical products	M	T
	Other medical products	M	T
	Therapeutical appliances and equipment	M	T
	Medical Services	S	NT
	Dental services	S	NT
	Paramedical services	S	NT
	Hospital services	S	NT
Transport	Motor cars	M	T
	Motor cycles	M	T
	Bicycles	M	T
	Fuels and lubricants for personal transport equipment	M	T
	Maintenance and repair of personal transport equipment	S	NT
	Other services in respect of personal transport equipment	S	NT
	Passenger transport by railway	S	NT
	Passenger transport by road	S	NT
	Passenger transport by air	S	NT

Category	Basic Heading	*BS-SC framework:* **Sector allocation**	*BS-framework:* **Tradability**
Transport	Passenger transport by sea and inland waterway	S	NT
	Combined passenger transport	S	NT
	Other purchased transport services	S	NT
Communica tion	Postal services	S	NT
	Telephone and telefax equipment	M	T
	Telephone and telefax services	S	NT
Recreation and culture	Audio-visual, photographic and information processing equipment	M	T
	Recording media	M	T
	Repair of audio-visual, photographic and information processing equipment	S	NT
	Major durables for outdoor and indoor recreation	M	T
	Other recreational items and equipment	M	T
	Gardens and pets	S	NT
	Veterinary and other services for pets	S	NT
	Recreational and sporting services	S	NT
	Cultural services	S	NT
	Games of chance	S	NT
	Newspapers, books and stationery	S	NT
	Package holidays	S	NT
Education	Education	S	NT
Restaurant and hotels	Catering services	S	NT
	Accommodation services	S	NT
Miscellaneous goods and services	Hairdressing salons and personal grooming establishments	S	NT
	Appliances, articles and products for personal care	S	NT

Category	Basic Heading	*BS-SC framework:* **Sector allocation**	*BS-framework:* **Tradability**
Miscellaneous goods and services	Prostitution	S	NT
	Jewellery, clocks and watches	M	T
	Other personal effects	M	T
	Social protection	S	NT
	Insurance	S	NT
	FISIM	S	NT
	Other financial services n.e.c	S	NT
	Other services n.e.c.	S	NT
Government expenditure	Government compensation of employees	S	NT
	Government intermediate consumption	M	T
	Government gross operating surplus	S	NT
	Government net taxes on production	S	NT
	Government receipts from sales	S	NT
Capital formation	Metal products and equipment	M	T
	Transport equipment	M	T
	Residential buildings	M	T
	Non-residential buildings	M	T
	Civil engineering works	M	T
	Other products	M	T
Inventories	Changes in inventories and acquisitions	M	T

A=agriculture; M=manufacturing; S=services; T=tradable; NT=non-tradable.

The sectoral allocation and the tradability allocation apply respectively to the estimation of the Balassa-Samuelson-Structural-Change and the Balassa-Samuelson framework in section 5.

2. Figures and Tables

Table 2.1: Price-income relationship and the stage of development

		1st Third	2nd Third	3rd Third
price-income relationship		-0.135**	0.14	0.51***
Value-added share of GDP				
	Agriculture	30.46	11.09	2.84
	Manufacturing	26.42	37.00	31.95
	Services	43.12	51.92	65.21
Employment share				
	Agriculture	60.61	28.02	6.65
	Manufacturing	10.50	22.10	26.01
	Services	28.33	49.13	66.97
Expenditure share				
	Agriculture	35.08	20.45	8.47
	Manufacturing	41.71	43.86	41.42
	Services	20.28	25.15	29.91
Price level				
	Agriculture	0.67	0.63	1.06
	Manufacturing	0.56	0.63	1.03
	Services	0.19	0.27	0.77

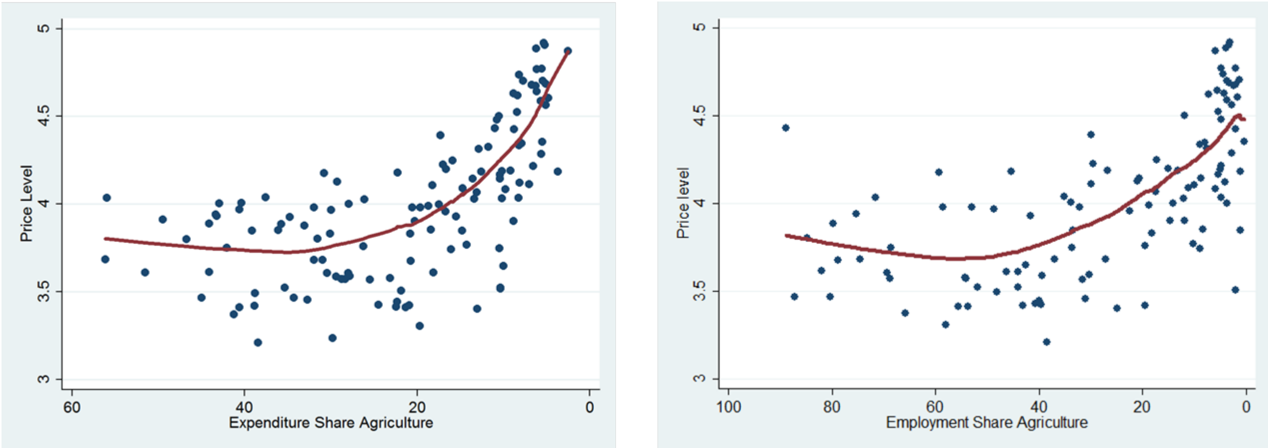

Figure 2.1: Price Level, Expenditure and Employment Share of Agriculture (reversed scale): Non-Parametric Estimation

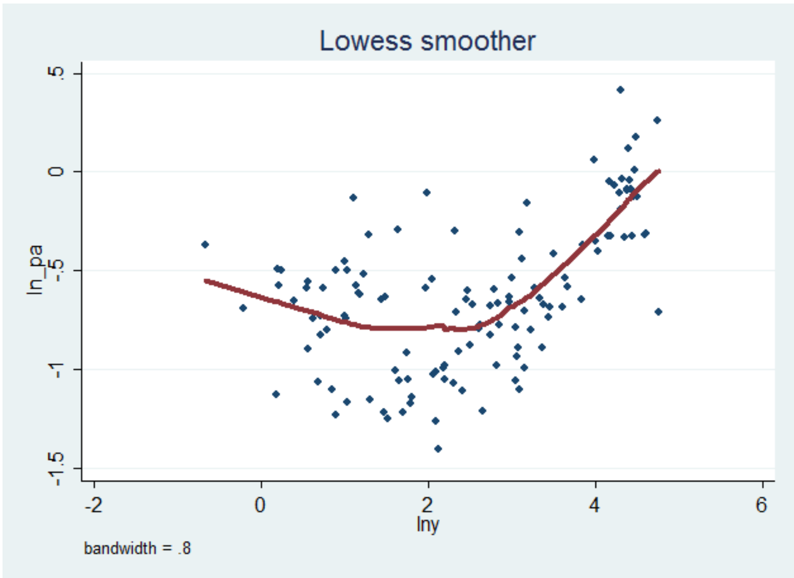

Figure 2.2: Price of Agriculture and Income: Non-Parametric Estimation

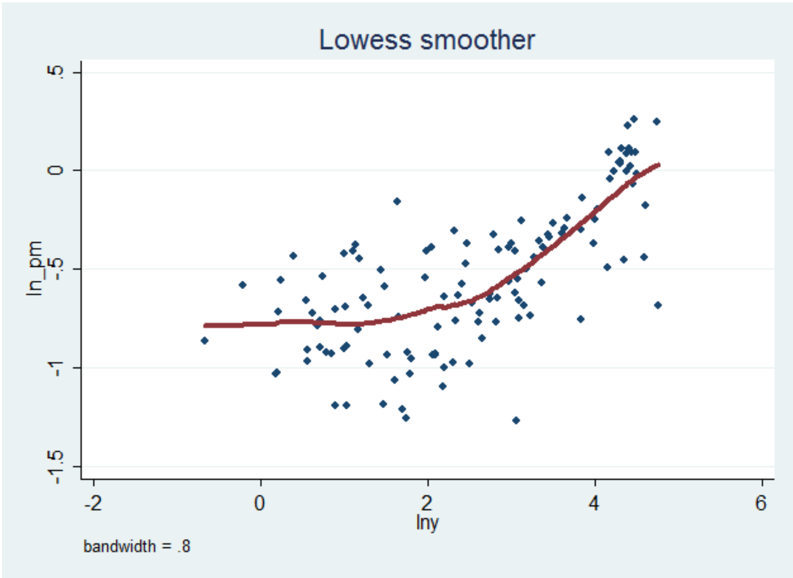

Figure 2.3: Price of Manufacturing and Income: Non-Parametric Estimation

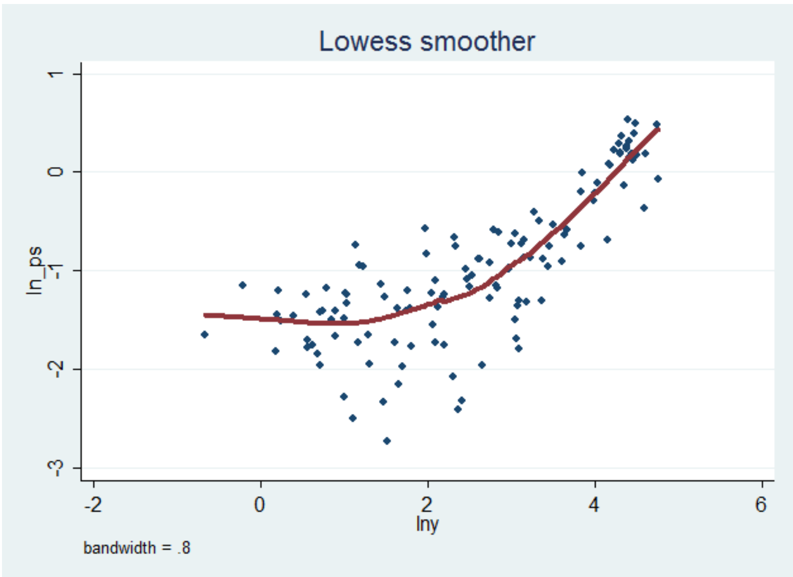

Figure 2.4: Price of Services and Income: Non-Parametric Estimation

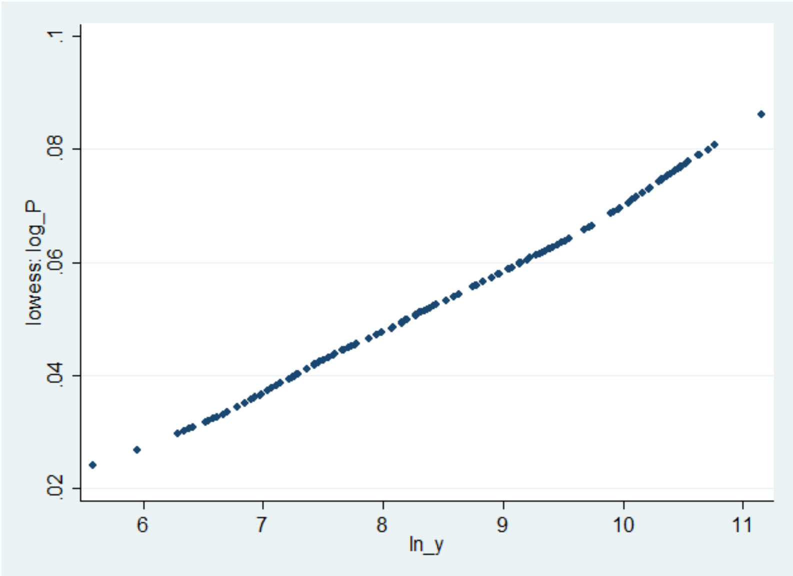

Figure 2.5: The price level in the Balassa-Samuelson hypothesis: non-parametric estimation of the price-income relationship, fitted values

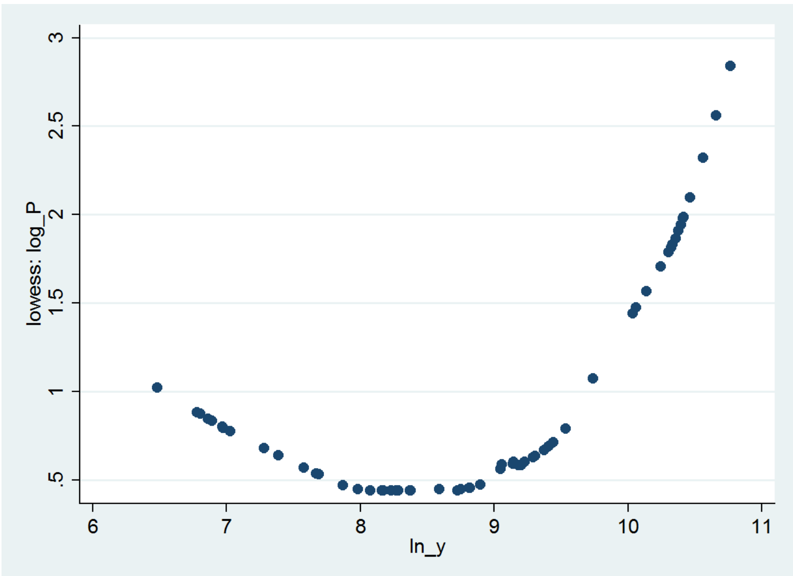

Figure 2.6: The price level in the Balassa-Samuelson+ hypothesis: non-parametric estimation of the price-income relationship, fitted values

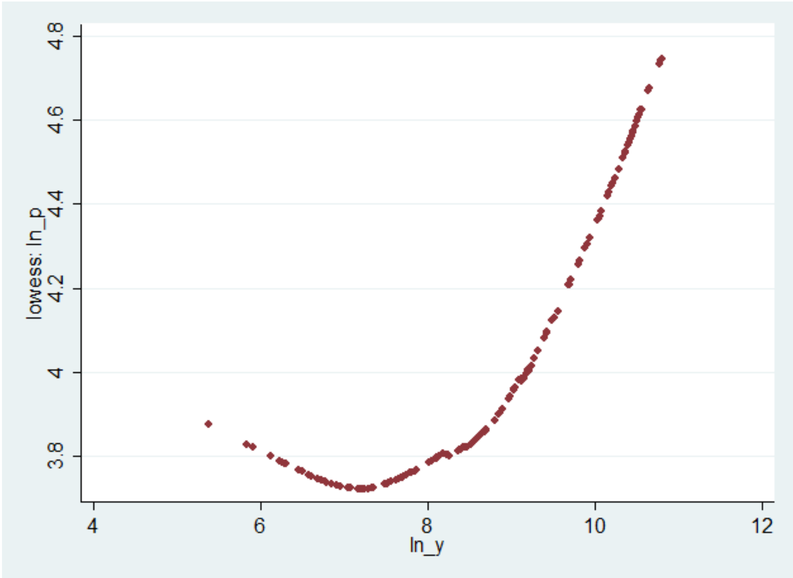

Figure 2.7: Penn World Table 7.0 (2005): non-parametric estimation of the price-income relationship, fitted values

Table 2.2: Data and models

	Data	BS+ Model	BS Model
Countries on the downward sloping path	22%	26%	0%
Price, Std. Deviation	0.41	1.02	0.02
Turning point	1,464 PPP$	3,070 PPP	-

Chapter 3

The price-income relationship in a multi sector Eaton-Kotum model of trade

3.1 Introduction

This chapter departs from the standard Balassa-Samuelson framework and takes the Eaton-Kortum model of trade as the main point of reference considering a multi-sectors extension. This allows to relax the assumptions of the previous model where agriculture is completely non-tradable. In this model we have endogenous tradability in both the agriculture and manufacturing sector, so that potentially all countries can trade in those two sectors, but if actual trade takes place it depends on trade costs and relative competitiveness.

The chapter shows that also within an Eaton-Kortum framework a non-monotonic pattern of the price-income relationship emerges. This is additional supporting evidence that the empirical results shown in chapter 1 are not spurious given that two different types of model can generate a non-monotonic relationship. Moreover the higher degree of flexibility of this model permits a better quantitative fit respect to the previous one.

Section 3.2 describes the set-up of the model; section 3.3 focuses on the price level implied by the model and on how the key parameters and variables are estimated in order to match moments of trade data; section 3.4 discusses the estimates of the model and analyses the price-income relationship implied by this framework; section 3.5 concludes.

3.2 Model set-up

Let's consider a world economy characterized by many countries $i = 1, ..., I$. Each country has three sectors: agriculture, manufacturing and services. Countries differ in terms of sectoral productivities and bilateral transport costs. Labor is the only factor of production, is immobile across countries, and is supplied inelastically with no disutility. Employment shares vary across sectors and countries because of exogenous productivity differences.

3.2.1 Preferences and technology

Preferences are assumed to be CES so that:

$$U_i = [\psi_{Ai}C_{Ai}^{\rho} + \psi_{Mi}C_{Mi}^{\rho} + \psi_{Si}C_{Si}^{\rho}]^{\frac{1}{\rho}}, 0 < \frac{1}{1-\rho} < 1 \tag{3.1}$$

We assume that there is a partial complementarity across goods from different sectors, so that the elasticity of substitution is smaller than one. Demand parameters ψ_{Ki} change across countries because of different real income and tastes.

The agriculture and the manufacturing sectors K are characterized by a continuum of differentiated varieties z produced with a linear technology:

$$y_{Ki}(z) = A_{Ki}(z)L_{Ki}(z) \tag{3.2}$$

As in Eaton-Kortum (2002), in each country technology is a random draw across products and sectors from a Frechet distribution:

$$Pr(A_{Ki}(z_K) \leq z) = F_{Ki}(z_K) = e^{-(x/A_{Ki})^{-\theta_K}} \tag{3.3}$$

where A_{Ki} is the scale parameter that governs the average productivity for each sector and country; the sectoral average productivity of each country is proportional to A^{θ}_{Ki} with the constant of proportionality not depending on the country. A higher A_{Ki} means that country i is more likely to draw a higher efficiency for each products of sector K. Variation in the productivity parameter A_{Ki} across sectors and countries determines the distribution of employment across countries within each sector. θ_K is the shape parameter that controls the dispersion of productivity across products and within each sector for the world economy. A higher θ_K implies less variability in productivity in sector K across countries and so a lower incentive to trade.

A domestic firm aggregates the varieties z of sector K, either imported or produced domestically, into a composite good through a CES technology with an elasticity of substitution $1/(1-\sigma)$:

$$Y_{Ki} = \left[\int_0^1 \tilde{y}^{1-1/\sigma}_{Ki(z)} dz\right]^{(\sigma/\sigma-1)} \tag{3.4}$$

The service sector is characterized by a non-tradable composite good produced with a linear technology such that:

$$Y_{Si} = A_{Si} L_{Si} \tag{3.5}$$

3.2.2 Prices and trade flows

Products within each sector are produced in a perfectly competitive environment. Output can be traded across countries subject iceberg trade costs $d_{Kij} > 1$ (from country j to country i). [1] Under this assumptions and the technology specified above, the cost to a consumer in country i of purchasing variety z of sector K from country j is:

$$p_{Kij}(z) = \frac{w_j}{A_{Kj}(z)} d_{Kij} \tag{3.6}$$

Given a homogeneous product, the representative consumer buys product z from the lowest cost supplier, so that:

$$p_{Ki}(z) = \min \{p_{Kij}(z); j = 1, ..., I\} \tag{3.7}$$

The distribution of price within sector K faced by a representative consumer in country i for goods sourced from country j is then:

$$G_{Kij}(p_K) = Pr[p_{Kij} \leq p_K] = 1 - F_{Kj}\left(\frac{w_j}{p_K} d_{Kij}\right) = 1 - e^{-A_{Kj}(w_j d_{Kij})^{-\theta_K} p_K^{\theta_K}} \tag{3.8}$$

Since goods are sourced from the lowest cost supplier, the distribution of prices within sector K in location i for the goods purchased is given by the

[1]The triangular inequality is assumed to hold so that $d_{Kij} < d_{Kin} d_{Knj}$

distribution of the minimum, so that:

$$G_{Ki}(p_K) = \Pr\left[\min\left\{p_{Ki1}, p_{Ki2}, ..., p_{KiI}\right\} \leq p_K\right] = 1 - \prod_{i=1}^{I}[1 - G_{Kij}(p_K)] = 1 - e^{\phi_{Ki} p_K^{\theta_K}} \quad (3.9)$$

where

$$\phi_{Ki} = \sum_{s=1}^{I} A_{Ks}(w_s d_{Kis})^{-\theta_K} \quad (3.10)$$

so the distribution of prices of goods actually purchased depends on productivity parameters, input costs, and trade costs across countries. If there were no geographic barriers, so that $d_{Kij} = 1$, ϕ would be the same across countries and the law of one price would hold for each good.

As in Eaton and Kortum (2002) The price distribution (3.9) has important implications for defining the trade flows and the price index:

- Goods are sourced from the lowest cost supplier; so the probability that country i purchases a good z from country j is :

$$\pi_{Kij} = \Pr\left[p_{Kij}(z) \leq \min\ p_{Kis}(h); s \neq j\right] \quad (3.11)$$

This probability can be expressed as:

$$\pi_{Kij} = \frac{A_{Kj}(w_j d_{Kij})^{-\theta_K}}{\sum_{s=1}^{I} A_{Ks}(w_s d_{Kis})^{-\theta_K}} \quad (3.12)$$

so that the share of expenditure of country i on products coming from country j depend on the relative competitiveness of country j and the trade costs between j and i.

- The distribution of prices in country i for products imported from any country j is independent of the identity of country j and equal to the distribution of prices in location i. In fact the distribution of prices in location i conditional on sourcing products from j is equal to the distribution of prices $G_{Ki}(p_K)$ given by the distribution of the minimum across countries:

$$\Pr[p_{Ki} \leq p_K \mid p_i = p_{ij}] = G_{Ki}(p_K) \tag{3.13}$$

The intuition is that a source country j with higher productivity, lower input and trade costs, takes advantage of this by expanding the extensive margin, the number of products supplied, up to the point where the distribution of prices that j sells to i is equal to the overall price distribution of i.

- The sectoral price index under a CES utility function is given by:

$$P_{Ki} = \left[\int_0^1 p_{Ki}(z)^{1-\sigma} dz \right]^{\frac{1}{1-\sigma}} \tag{3.14}$$

It can be shown that exploiting the properties of the Frechet distribution, the sectoral price can be written as:

$$P_{Ki} = \left[\Gamma \left(\frac{\theta_K + 1 - \sigma}{\theta_K} \right) \right]^{\frac{1}{1-\sigma}} \left[\sum_{s=1}^{I} A_{Ks} (w_s d_{Kis})^{-\theta_K} \right]^{-\frac{1}{\theta_K}} \tag{3.15}$$

where $\left[\Gamma \left(\frac{\theta_K+1-\sigma}{\theta_K} \right) \right]^{\frac{1}{1-\sigma}} \equiv \gamma_K$

The aggregate price index for the economy is then given by:

$$P_i = [\psi_A^{\kappa} P_{Ai}^{1-\kappa} + \psi_M^{\kappa} P_{Mi}^{1-\kappa} + \psi_S^{\kappa} P_{Si}^{1-\kappa}]^{\frac{1}{1-\kappa}} = \left\{ \sum_{Z\in(A,M,S)} \psi_Z^{\kappa} \gamma_Z^{1-\kappa} \left[\sum_{s=1}^{I} A_{Zs} (w_s d_{Zis})^{-\theta_Z} \right]^{-\frac{1}{\theta_Z}} \right\}^{\frac{1}{1-\kappa}} \tag{3.16}$$

3.2.3 Labor market clearing

Labor market clearing implies that for each sector payment to labor equals the sum of expenditures on goods produced in that sector and country.

Payment to labor in each sector is equal to the sum of expenditures across countries on goods produced in that sector and location:

$$w_j L_{Kj} = \sum_{i=1}^{I} \pi_{Kij} \lambda_{Ki} Y_i \tag{3.17}$$

Labor market clearing in each country implies that the total income received by workers equals the sum of payments to labor across sectors.

$$w_j L_j = \sum_{K\in(A,M,S)} \sum_{i=1}^{I} \pi_{Kij} \lambda_{Ki} Y_i \tag{3.18}$$

Dividing both sides 3.17by $w_j L_j$, sectoral labor shares can be written as:

$$\frac{L_{Kj}}{L_j} = \sum_{i=1}^{I} \pi_{Kij} \lambda_{Ki} \frac{Y_i}{Y_j} \tag{3.19}$$

where Y_i/Y_j, measures the relative income size

Finally, sectoral labor demand are an aggregation of labor demand for each variety $L_{Ki}(z)$, such that $L_{Ki} = [\int_0^1 L_{Ki}(z)dz]$. For each country the labor market must clear so that:

$$\sum_K L_{Ki} = L_i \tag{3.20}$$

3.3 Technology, trade, and the price level

In this section I investigate the price level implied by the model in equation (3.16). Parameters are calibrated either to reflect accepted values in the literature or to match key moments of trade data.

3.3.1 Parameters calibrated from the literature

Following Michaels et al. (2011), who refer to a vast literature in macroeconomics, I assume inelastic demand across sectors and set the elasticity of substitution across sectors ρ equal to 0.5. As in Tombe (2013) the elasticity of substitution across varieties σ is set such that $\gamma = 1$

Finally the parameters of the Frechet distribution that controls the dispersion of productivity across goods θ_K is set equal to 4. Simonovska and Waugh (2011) develop a simulated method of moments estimator to estimate this trade-cost elasticity from a large cross-country price and trade flows data. They find that $\theta = 4$ with a range between 2.5 and 5.5. [2] Moreover, θ is set to be the same in all sectors. Caliendo and Parro (2012) using trade flows between Canada, Mexico, and the US find no difference in θ between agriculture and manufacturing.

[2]This value is 50% lower than the original finding of Eaton-Kortum whose estimate is shown to suffer of a finite sample bias

3.3.2 Trade, import barriers, and competitiveness

In order to compute the price level implied by the model in (3.16) I need estimates for $A_{Ki}(w_i d_{Kij})$. Let's define the state of technology of country i adjusted by labor cost as country i competitiveness $T_{Ki} \equiv \frac{A_{Ki}}{w_i}$. Hence, using (3.15) and accounting for $\gamma = 1$ given the calibration defined above, country's i expenditure on goods imported from country j can be expressed as: This probability can be expressed as:

$$\pi_{Kij} = \frac{A_{Kj}(w_j d_{Kij})^{-\theta}}{\sum_{s=1}^{I} A_{Ks}(w_s d_{Kis})^{-\theta}} = P_{Ki}^{\theta} \left(\frac{T_{Kj}}{d_{Kij}} \right)^{\theta} \tag{3.21}$$

Similarly, country i expenditure on domestically produced goods is $\pi_{Kii} = P_{Ki}^{\theta} T_{Ki}^{\theta}$. So, normalizing (3.21) by the importer's home sales and taking logs, we have:

$$\ln \left(\frac{\pi_{Kij}}{\pi_{Kii}} \right) = \theta \ln(T_{Kj}) - \theta \ln(T_{Ki}) - \theta \ln(d_{Kji}) \tag{3.22}$$

Bilateral trade costs include distance between countries, use of common language, trade agreements, and sharing a border. The empirical specification of (3.22) then becomes:

$$\begin{aligned} \ln \left(\frac{\pi_{Kij}}{\pi_{Kii}} \right) = {} & \beta_{K1} \ln(\text{distance}_{ji}) + \beta_{K2} \text{Language}_{ji} + \beta_{K3} \text{Trade Agreement}_{Kji} + \\ & \beta_{K4} \text{Border}_{ji} + S_{Kj} + S_{Ki} + \epsilon_{Kji} \end{aligned} \tag{3.23}$$

where S_{Kj} is the exporter fixed effect, S_{Ki} is the importer fixed effect, and ϵ_{Kji} is the random component.

Data about trade costs is taken from the CEPII data set. Following Eaton-Kortum (2002) the share of imports from country j to country i is computed as:

$$\hat{\pi}_{Kij} = \frac{\text{Imports}_{Kji}}{\text{Sectoral Output}_{Ki} - \text{Exports}_{Ki} + \text{Imports}_{Ki}} \tag{3.24}$$

Sectoral output is computed from World Bank (WDI) sectoral shares grossed up by 0.9^-1 and by 0.5^-1 in manufacturing (Tombe, 2012) Data on trade flows are taken from WIT. Agricultural flows correspond to ISIC (Revision 3) 01, 02, and 05 digit codes. Manufacturing flows are the ones classified with an ISIC digit code from 10 to 40.

3.4 Estimation of the model and the price level

In this section I estimate the econometric specification (3.23) by OLS. Table 3.5 reports the results of the regressions. Distance has a significant negative effect on the trade shares between pairs of countries, while sharing a border, having a common language, and having a regional trade agreement have a positive effect.

The parameters of the model are then linked to the regression estimates by $\hat{T}_{Ki} = e^{\hat{S}_{Ki}/\theta}$ and $\hat{d}_{Kji} = e^{-(\hat{\beta}_{K1}\text{Dist}+\hat{\beta}_{K2}\text{Lang}+\hat{\beta}_{K3}\text{Trade Agr.}+\hat{\beta}_{K4}\text{Border})/\theta}$, which are then used to compute the price level (3.16). Table 3.2 reports some ranking of secotral competitiveness. It shows that developed and emerging countries have a higher absolute advantage in both sectors respect to low-income countries, which in turn tend to have a higher relative advantage in the agricultural sector.

Given the estimates obtained above the price level implied by the model is then:

$$P_i = \left\{ \sum_{K \in (A,M,S)} \psi_K^{\kappa} \left[\sum_{s=1}^{I} \left(\frac{\hat{T}_{Ks}}{\hat{d}_{Kis}} \right)^{\theta_K} \right]^{-\frac{1}{\theta_K}} \right\}^{\frac{1}{1-\kappa}} \tag{3.25}$$

I then run a non-parametric LOWESS estimation of the price-income relationship using the estimate of (3.25) and I compare the result with that implied by the Balassa-Samuelson + framework. In figure fig3.1 we can see that the multi-sector Eaton-Kortum model of trade can generate a non-monotonic pattern of the price-income relationship. Table 3.3 shows also an improvement of the quantitative fit. The standard deviation is 30% lower than in the previous model and the turning point is at a lower level of income.

3.5 Conclusions

This chapter shows that a multi-sector Eaton-Kortum model of trade can generate a non-monotonic pattern of the price-income relationship. This is a relevant result because it confirms that the non-monotonicity documented in the first chapter is not a spurious result, but a hitherto undocumented economic fact.

A further improvement of this analysis would be to account for the different contribution that trade costs, endogenous tradability, and technology have in generating the non-monotonic pattern that is observed. This extension can be carried through the standard counter-factual experiments that the Eaton-Kortum framework allows and it would improve our understanding of the determinants of the price-income relationship.

3. Figures and Tables

Table 3.1: Trade Regression

Dependent var: Normalized Import Share	**Agriculture**	**Manufacturing**
Ln-Distance	-1.45*** (-26.1)	-1.51*** (-30.7)
Shared border	1.08*** (7.6)	0.93*** (6.0)
Common Language	1.05*** (10.2)	1.28*** (16.0)
Trade Agreement	0.48*** (5.37)	0.59*** (6.9)
Exporter fixed effects	Yes	Yes
Importer fixed effects	Yes	Yes
No. of observations	7336	7863
R-squared	0.6	0.73

*** Significant at the 1% level; robust t-statistics in parenthesis.

Table 3.2: Countries' competitiveness

Top 10 Agriculture	**Top 10 Manufacturing**	**Top 10 Relative Agriculture**
United States	China	Ecuador
China	United States	Mauritania
Argentina	Japan	Namibia
Brazil	Germany	Uruguay
Thailand	Korea, Republic of	New Zealand
New Zealand	France	Chile
Canada	Italy	Senegal
Netherlands	United Kingdom	Colombia
France	Malaysia	Gambia
Germany	Brazil	Argentina

Bottom 10 Agriculture	**Bottom 10 Manufacturing**	**Top 10 Relative Manufacturing**
Rwanda	Rwanda	Japan
Niger	Gambia	Korea, Rep.
Albania	Lesotho	Kuwait
Nepal	Central African Republic	Hong Kong
Gabon	Sierra Leone	Sweden
Central African Republic	Niger	Finland
Kuwait	Mauritania	Saudi Arabia
Mali	Armenia	Malaysia
Botswana	Burkina Faso	Slovenia
Armenia	Botswana	Nigeria

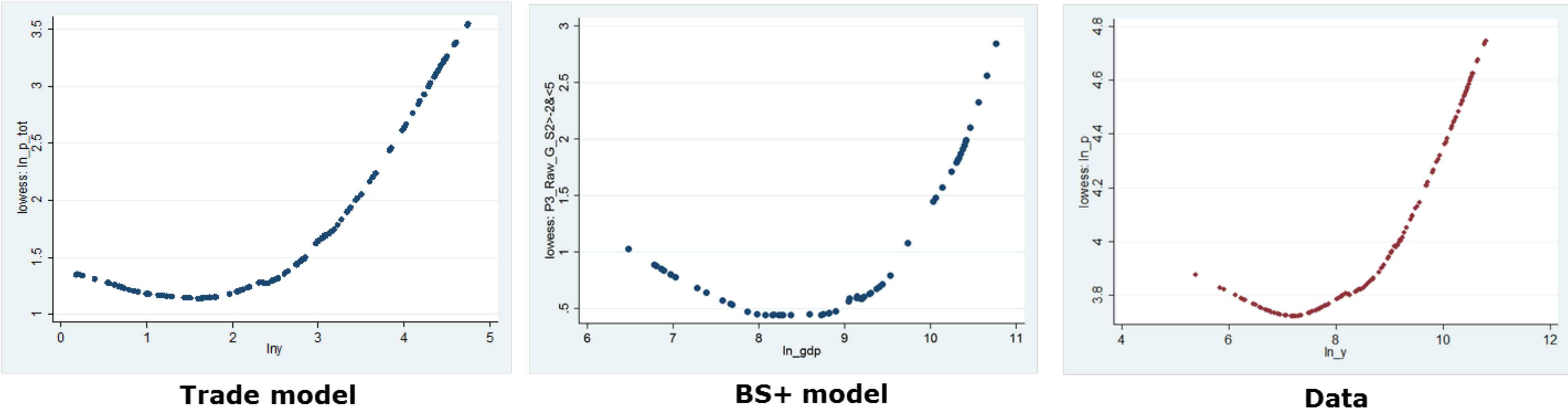

Figure 3.1: Price-income relationship in the model and in the data: Non-Parametric Estimation

Table 3.3: Data and models

	Trade model	BS+ Model	Data
Countries on negative path	26%	26%	22%
Price, Std. Deviation	0.74	1.02	0.41
Turning point	2,024 PPP$	3,070 PPP$	1,464 PPP$

Chapter 4

Foreign Capital Flows and Income Inequality in Emerging Markets: the interaction between the real exchange rate and the labor market

4.1 Introduction

One of the most important features of the current globalization process is the continuous strengthening of financial integration and the rise of capital flows. In the last twenty years the daily average Forex turnover has increased by seven fold in absolute terms and by almost three fold as percentage of World GDP[1]; and the de facto financial openness indicator of the IMF has more than doubled in all developing regions [2]

At the same time income inequality within countries has increased sharply. Galbraith (2007) shows that wage inequality in developing countries, after a stable trend between 1963 and 1980, has risen by almost 50% between 1980 and

[1]Elaboration on data from BIS and WDI

[2]See World Economic Outlook, 2007. The IMF indicator is the ratio of assets and capital liabilities over GDP.

2000. As Wade (2008) argues, this trend matters for the development process of poorer countries. There is suggestive evidence that higher income inequality within countries is associated with lower elasticity between growth and poverty reduction, and weaker public goods provision. Moreover, as Birdsall (2004) points out, income inequality undermines collective decision making and social institution critical to a sound and cohesive society.

The combination of large and fast rising capital flows, relative to GDP, and high and rising income inequality in most developing countries raises the question of the connection between the two trends. It is not hard to see some mechanisms linking them, but the subject has been almost completely neglected in the literature. One of the few exceptions is the study by Taylor (2000), who discusses the effects of the Washington Consensus on the functional distribution of income, stressing the role of capital account liberalization. However, it does not consider wage inequality and it discards the role of the labor market, which is the primary source of within-countries inequality as Goldberg and Pavcnik (2007) show.

The literature on globalization and inequality is surprisingly silent about the distributional effects of capital flows. The World Economic Outlook of the IMF (2007) acknowledges in passing that capital flows like equities, portfolio debt, cross-border banking lending can affect income inequality, but it makes no analysis of the connection; and the wider literature contains virtually no specific studies on this issue. The excellent survey of Goldberg and Pavcnik (2007) titled "Distributional Effects of Globalization in Developing Countries" represents well the status of the literature. The section "Capital Flows" is just one paragraph long and it is the shortest point in the section "The relationship between globalization and inequality". It quotes only two papers, yet neither of those papers has a primary focus on the distributional effects of capital flows.[3]

The aim of our work is to analyze the effects that foreign capital flows have on income inequality in emerging countries. If we want to sustain the upside of capital flows, or globalization in general, it is important to understand and manage its downsides. Rising income inequality can be one of the negative effects of capital flows and I want to investigate this unexplored connection. In the paper capital flows is the exogenous variable and the mechanism that links capital flows to income inequality is centered in the labor market. This is consistent with Calvo et alt. (1993) where financial shocks in the developed world are the cause of capital flows in developing countries; and with Goldberg and Pavcnik (2007) who find that in developing countries the labor market governs the overall distribution of income through unemployment and wage differential between skilled and unskilled workers.

We try to disentangle the effects of foreign capital flows on income inequality through a theoretical model which has the merit to connect in a general equilibrium framework the macroeconomic models on the dynamics of the balance of payments with the search and matching models of the labor market. This allows us to address a fresh and to our knowledge original issue: the effects of real exchange rate adjustment on the labor market as the link between foreign capital flows and income inequality. Section 4.2 presents the empirical motivation behind this paper; section 4.3 discusses the theoretical link between

[3] Cregg and Epelbaum (1996) analyze the increasing wage dispersion in Mexico due to an import-catalyzed technological change; they affirm that financial integration might have played a role by favouring the imports of cheaper capital goods. Behrman et alt. (2000) find that capital account liberalization had a strong negative impact on the relative log-wage of skilled and unskilled workers. However, the authors are more attentive to stress that its not trade liberalization that increased inequality rather than to analyze the mechanism that links capital account openness and inequality

capital flows and income inequality; section 4.4 introduces the analytical model and section 4.5 analyzes the general equilibrium effects of capital flows; finally section 4.6 concludes the paper discussing further developments of this work.

4.2 Empirical motivation

Since the '80s developing countries experienced a liberalization of trade and capital flows. This process was accompanied by an important change of income distribution within countries. This mainly refers to the experience of semi-industrial emerging countries like Argentina, Hungary, India, Malaysia, Mexico, Russia and others.

Figure 4.1 provides a good example of the economic patterns the paper wants to focus on. We can see that in Argentina, after the liberalization of the current and capital account in 1991, inequality sharply increased between 1993 and 2002, the years of the currency board. During this period the country was experiencing a net inflow of capitals around 4-5% of GDP and the Gini coefficient increased from 0.47 to 0.55. This is a very remarkable change, given the low range of variability that usually characterizes the Gini. An equally remarkable change is the rapid decrease of income inequality, from 0.55 to 0.48, once the convertibility ended and the country became an exporter of capitals. The purpose of the paper is to analyze the association between those two dynamics.

In order to verify how general the association between capital flows and income inequality is, I take a panel data set of 128 countries between 1980 and 2008 and run the following reduced form panel regression for the full sample and for emerging countries only. Table 4.1 reports the results of:

$$\begin{aligned} \text{Gini}_{it} = \beta_0 + \beta_1 \text{ Capital flows}_{it-1} + \beta_2 \text{ GDP per-capita growth}_{it-1} + \\ \beta_3 \text{ Government expenditure}_{it-1} + \gamma_i + \delta_t + u_{\ it} \end{aligned} \tag{4.1}$$

The dependent variable is the Gini coefficient (WDI data); the independent variable is capital flows measured as the net financial account, excluding reserve, in percentage of GDP (IMF data); the control variables are GDP growth per-capita (WDI) and government consumption as percentage of GDP (WDI). Moreover, a set of country and year dummies are added to control for the time-invariant characteristics of a country and for country-invariant variables that might have affected inequality in all countries in a given year. The independent and the control variables are taken with a one-year lag because a change in capital flows or in government expenditure is likely to require some time before showing any effect on income inequality. Whether GDP per-capita growth should be included with one lag or not is more questionable as economic growth can also have a contemporary effect on income inequality. However, the results of Table 4.1 barely change if GDP per-capita growth at time t substitutes or is added to its lagged value.

The results show that an increase in capital inflows is associated to a positive and significant rise in income inequality both in the full sample and in emerging countries where the correlation is stronger in magnitude. The effect of GDP per-capita growth is negative as it could be expected, but it is not statistically significant. Surprisingly, aggregate government consumption is associated to higher income inequality in the full sample; using social expenditure rather than aggregate expenditure would provide a better assessment, but unfortunately data availability on this is quite limited.

I have run regression (4.1) disaggregating the financial flows into foreign direct investments, financial derivatives, portfolio investmentss, and other investments; moreover, I have also considered reserve assets. The results in Table 4.2 show that, in the full sample, portfolio flows have a positive and significant effect (at the 10% level) on income inequality; whereas an increase in reserve assets is associated to a significant (at the 5% level) decrease income inequality. In emerging countries, the flow that is relevant is the one classified as "other investments"; this includes trade credits, loans, currency and deposits, and other assets and liabilities. I do not find any significant effect of foreign direct investments on the Gini coefficient. This is not necessarily in contrast with the literature that has found a positive effect of FDI on inequality. This literature, which focuses mainly on the case of Latin America, focuses on the stock of FDI rather than on the net flows.

According to our knowledge the association between net foreign capital flows and income inequality in emerging countries have not yet been documented. The results shown in this section suggest that a novel contribution to the literature can be made. The next parts of the paper try to identify from a theoretical point of view the causal mechanism that links capital flows to income inequality.

4.3 Theoretical explanation and key assumptions

This section rationalizes the link between capital flows and income inequality. Let's suppose that there is an exogenous shock coming from foreign capitals inflows. As in Calvo et alt. (1993) factors that can generate capital inflows are low international interest rates, development of the US balance of payments, US economic performance etc. This is consistent with the original idea of Diaz-Alejandro (1984) that in developing countries capital flows can be considered truly exogenous, as financial shocks in the center affect the periphery.

The inflow of capital generates an income effect that increases demand of both tradable and non-tradable goods. In order to satisfy the higher demand for non-tradables a shift of production resources from the tradable to the non-tradable sector is required. This can be achieved if the price of non-tradable goods increases; this implies an appreciation of the real exchange rate. As the real exchange rate appreciates and more domestic resources are targeted to the production of non-tradable goods, the higher demand for tradables is satisfied through imports. Therefore, the final effects of foreign capital inflows are: real exchange rate appreciation, increase in the relative supply of non-tradable goods, and current account deficit.

How do these effects influence the labor market, hence income inequality? How are unemployment and the wage gap between skilled and unskilled workers affected?

Wages in both sectors are subject to a supply and a demand effect. As the relative production of non-tradables increases, the demand effect makes wages rise in the non-tradable sector and decline in the tradable sector. However, as the number of workers in the non-tradable sector increases, the marginal product of labor diminishes pinning down the wage rate; the reverse occurs in the tradable sector. Thus, the supply effect on wages is negative in the non-tradable sector and positive in the tradable one.

In the case of the standard neo-classical model with full employment, supply and demand effects tend to cancel out. However, in the case of a search and matching model the supply effect tends to dominate as long as the ratio of the job-finding and separtion rates decreases. Under this scenario, as capitals flow in, the wage gap between the tradable and non-tradable sectors increases contributing to a higher level of income inequality.

Linking wages in the tradable and non-tradable sectors to skilled and unskilled wages is an important aspect of this analysis. The paper associates wages in the tradable sector to skilled workers and wages in the non-tradable sector to unskilled workers. This simplifying assumption is empirically motivated by the fact that emerging economies have a very large share of informal employment, which is unskilled, and that this is largely absorbed by the non-tradable sector.[4]

The effect of capital inflows on the job finding and separation rates is crucial for the results of the model. If the ratio of the finding/separation rate decreases, the wage gap between skilled and unskilled workers goes up. The paper presents a model of exogenous job destruction where an appreciation of the real exchange rate, that follows from capital inflows, decreases the job finding/separation rate in the tradable sector. As Pissarides (2000) points out, a change in relative prices reflect a demand shock, here coming from capital flows, that affects the separation and the finding rates. The assumption of a reduction of the job finding/separation ratio in the tradable sector is grounded

[4]In countries like Argentina, Brazil, and Mexico between 42% and 53% of the non-agricultural employment is informal and this share increases to a range of 70% - 82% for countries like Indonesia, India, and Philippines (ILO 2012). Fiess et al. (2009) show that the non-tradable sector absorbs 81% of the informal employment in Argentina, 84% in Brasil, 83% in Colombia, and 87% in Mexico; whereas La Porta and Shleifer (2008) document that 0.1% is the share of exports from sales of the informal economy. This evidence leads Fiess et al. (2009) to model the non-tradable sector as the informal one.

in Gourinchas (1998). He shows, for the US case, that a decrease in the relative price of tradables causes a contraction of the finding/separation ratio in the tradable sector. This happens because a lower relative price of tradables reduces the opportunity cost of non-market activities like reorganization and search and matching.

The effect of foreign capital flows on unemployment, the other important source of income inequality, is more ambiguous. The value function of unemployment is subject to both a reduction, due to a lower job finding/separation rate, and an increase due to higher wages in the tradable sector. As long as the first effect dominates, unemployment increases with capital inflows.

This model seems to provide a good representation of the dynamics that characterized developing countries during the Washington Consensus when countries with capital inflows and real exchange rate appreciation suffered an increase in income inequality (i.e. Argentina or Malaysia). The model is also consistent with the decline in income inequality, accompanied with capital outflows and real exchange rate depreciation that some countries experienced in the last years. For instance, if we look at the case of Argentina, during the '90s we observe capital inflows, real exchange rate appreciation, increasing relative production of non-tradables, expanding wage gap between the tradable and non-tradable sector, growing unemployment, and higher inequality; whereas the opposite dynamics characterizes the '00s when the country experienced capital outflows. Although the Argentinean experience might not be representative of all the developing world, it provides a quasi-natural experiment for observing the effects of capital flows on income inequality via real exchange rate variation and labor markets dynamics because a relatively long period of growth and capital inflows in the '90s was followed by a period of growth and capital outflows in the '00s. Nevertheless further empirical work and a quantitative analysis are required to evaluate the validity of the model.

4.4 Model set-up

4.4.1 Production technology

We consider an economy with a tradable and a non-tradable sector. We assume that labor is the only factor of production; this simplifies the tractability of the model and it allows us to focus on the labor market; future development of the model will include capital as a factor of production:

$$Y_t^{NT} = \left(L_t^{NT}\right)^{\beta}, \qquad 0 < \beta < 1 \tag{4.2}$$

and for the tradable sector it is:

$$Y_t^{T} = \left(L_t^{T}\right)^{\alpha}, \qquad 0 < \alpha < 1 \tag{4.3}$$

The value of the parameters α and β is fundamental for our result. We assume that there are decreasing returns to scale and that labor in the non-tradable sector has, on average, lower productivity than in the tradable sector. As discussed in the previous section, this is consistent with the high level of informality that characterize the non-tradable sector. A drawback of the model is to have a rigid sectoral division between skilled and unskilled workers. It is not clear why a skilled worker employed in the tradable sector should become unskilled if reemployed in the non-tradable sector. However, Gourinchas (1998) and Davis and Haltiwanger (2001) show that after a relative price shock most of the labor reallocation occurs within rather than between sectors. This empirical fact can mitigate and provide partial support for the assumption of the model.

4.4.2 Preferences and utility maximization

We assume that there is a continuum of households with a unitary measure. Each household consumes and supplies labor. According to the big family assumption in each households there are three types of members: employed in the non-tradable sector as well as unemployed and employed in the tradable sector. Over time individuals can switch between occupations, but the relative proportion of each type are fixed. Households maximize lifetime utility over the consumption of tradable and non-tradable goods. Utility is represented by a standard Constant Relative Risk Aversion (CRRA) function with Cobb-Douglas preferences:

$$U = \sum_{t=0}^{\infty} \phi^t \frac{1}{1-1/\sigma} \left\{ \left[\left(C_t^T\right)^{\gamma} \left(C_t^{NT}\right)^{1-\gamma} \right]^{1-1/\sigma} - 1 \right\} \tag{4.4}$$

where $0 < \phi < 1$ is the discount factor, $\sigma > 0$ is the intertemporal elasticity of substitution, and $0 < \gamma < 1$ is the preference parameter for the tradable goods. [5]

The utility maximization problem is solved as in Rebelo and Vegh (1995). We assume that the representative household directly operates the economy's technology and sell products in the goods market. We consider the tradable good as the numeraire and we define P_t as the relative price of non-tradable to tradable goods. Considering that consumers can borrow and lend in the international capital markets at the exogenous interest rate r^*, the budget

[5] At the optimized value, for a constant return to scale Cobb Douglas function, γ is the consumptions share of tradable goods.

constraint of the economy is:

$$Y_t^T + P_t Y_t^{NT} + B_{t-1}(1+r) = C_t^T + P_t C_t^{NT} + B_t \tag{4.5}$$

where B_t is the private net foreign asset holdings. We simplify our model with respect to Rebelo and Vegh (1995) by not considering government in our economy. The no-Ponzi game condition for the representative agent is:

$$\lim_{t\to\infty} \frac{B_t}{1+r} = 0 \tag{4.6}$$

I also assume that $\phi = (1+r)^{-1}$. In this case, a permanent change in output does not affect the current account; this implies that we can abstract from the presence of trend in the current account. [6]

The optimality condition of consumption derived from equation (4.2), (4.3), (4.5), and (4.6) is the standard one for CRRA functions:

$$\frac{1-\gamma}{\gamma} \frac{C_t^T}{C_t^{NT}} = P_t \tag{4.7}$$

where P_t represents also the RER which, as it is well renown, can be expressed as the relative price of non-tradable to tradable goods; an increase of P_t implies an appreciation of the RER (Obstfeld and Rogoff, 1996).

4.4.3 Domestic and external market clearing conditions

We assume that non-tradable goods are used only for consumption so that:

$$P_t C_t^{NT} = P_t Y_t^{NT} \tag{4.8}$$

[6] On this point see also Obstfeld and Rogoff (1996)

In an open economy the equilibrium for the market in tradable goods is:

$$C_t = Y_t^T - TB_t \tag{4.9}$$

where TB_t is the trade balance of our economy.

Private net foreign assets are then given by the identity:

$$\begin{aligned} B_{t+1} \equiv \left(Y_t^T + P_t Y_t^{NT}\right) - \left(C_t^T + P_t C_t^{NT}\right) + (1+r)B_t = \\ TB_t + (1+r)B_t \end{aligned} \tag{4.10}$$

According to the standard absorption approach to the balance of payments the current account is defined as:

$$CA_t \equiv B_{t+1} - B_t = r^* B_t + TB_t \tag{4.11}$$

From equations (4.10) and (4.11) we can see that capital outflows imply a current account surplus; vice versa a current account deficit reflects an excessive absorption of the country, and it entails an inflow of capitals.

4.4.4 The labor market

Following Pissarides (2000) and Davidson and Matusz (2004), we now elaborate a search and matching model to describe the labor market. We assume that the non-tradable sector offers jobs, which do not need many skills, are easy to find, and pay low wages; whereas, the tradable sector offers jobs that require higher skills, are harder to find, and pay relatively higher wages. The turnover rate differs between the two sectors. It is lower in the tradable sector, where the matching of firms and workers is harder because higher skills are required; thus, once a match has been created, the jobs tend to last longer. In the non-tradable sector, we assume that there is an instant matching between firms and workers; jobs do not last long, but they are very easy to find; thus, in this sector, there is never unemployment. This assumption simplifies the tractability of the model and allows to abstract from the effect of a change in the relative price on the job finding and separation rate in the non-tradable sector. This is justified by the finding of Gourinchas (1998) who show that a change in relative price does not cause a statistically significant change of the job finding and separation rates in the non-tradable sector. In the context of our model this can emerge because the presence of a large pool of unskilled and informal workers makes the opportunity cost of non market activities like reorganization, search and matching constantly very low in the non-tradable sector.

It is important to stress that the supply side of the factor market is analyzed according to the search and matching literature, as in Pissarides (2000). However, the demand side is derived through efficiency wages. As it becomes clear below, this kind of framework makes it possible to examine in more detail the connections between the goods and the factor market.

Demand side of the labor market

The demand side of the labor market is determined by the optimizing behavior of firms. In equilibrium, wages equal the value of the marginal product of labor. Taking the tradable good as the numeraire, this implies from (4.2) that:

$$w_t^{NT} = \beta \left(L_t^{NT}\right)^{\beta-1} P_t \tag{4.12}$$

$$L_t^{NT} = \left(\frac{w_t^{NT}}{\beta P_t}\right)^{\frac{1}{\beta-1}} \tag{4.13}$$

The economic intuition of equation (4.12) is that wages in the non-tradable sector decrease when L^{NT} rises ($\beta - 1$ is negative). This is not surprising since the marginal product of labor has a decreasing return to scale; thus, optimizing firms hire new workers only at a lower wage rate.

For the tradable sector, from (4.3) we obtain:

$$w_t^T = \alpha \left(L_t^T\right)^{\alpha-1} \tag{4.14}$$

$$L_t^T = \left(\frac{w_t^T}{\alpha}\right)^{\frac{1}{\alpha-1}} \tag{4.15}$$

When $\alpha > \beta$, we can observe that, as new workers are hired, wages in the tradable sector will decrease at a lower rate than in the non-tradable.

Supply side of the labor market

The supply side of the labor market is modeled in a search and matching framework. We think about employment and unemployment as if they were human capital assets. These assets are valued by arbitrage conditions. Therefore, the value of an employed worker must be equal to the present discounted value of his expected flows of income. In the non-tradable sector, income flows are w^{NT} plus a minimum wage z. [7] Thus, in the non-tradable sector the works value W^{NT} is given by:

$$rW_t^{NT} = w_t^{NT} + z \tag{4.16}$$

[7] We also assume that z is the same for both sectors and is granted also to unemployed workers.

where r is the interest rate.

In the tradable sector, the works value is determined by taking into account that there is a positive probability of becoming unemployed, as jobs break up at an exogenous rate b. [8] Therefore, the value of work in the tradable sector is given by:

$$rW_t^T = w_t^T + z + b(U_t^T - W_t^T) \tag{4.17}$$

where $(U_t^T - W_t^T)$ is a negative value.

The value of unemployment is determined by the minimum wage plus the eventual capital gain $(W_t^T - U_t^T)$ that is realized if the worker changes to the employed status:

$$rU_t^T = z + e(W_t^T - U_t^T) \tag{4.18}$$

where e is the rate at which jobs are created and we call it the job-finding rate.

Summing up equations (4.17) and (4.18) and solving W_t and U_t we can rewrite these expressions as:

$$rW_t^T = z + \frac{(r+e)w_t^T}{r+b+e} \tag{4.19}$$

$$rU_t^T = z + \frac{ew_t^T}{r+b+e} \tag{4.20}$$

In equilibrium the supply side of factors' market must satisfy two conditions:

1. In order for both goods to be produced, it must be that the value of a job in the non-tradable sector is equal to the value of unemployment in

[8] As in Pissarides (2000) the shocks that break up jobs can be caused by changes in the relative price due to structural shifts in demand.

the tradable sector:

$$W_t^{NT} = U_t^T \tag{4.21}$$

In fact, if $W_t^{NT} < U_t^T$, a worker would prefer to be unemployed in the tradable sector, rather than work in the non-tradable sector; in this case, non-tradable goods would not be produced. Whereas, if $W_t^{NT} > U_t^T$, a worker would choose to take a low paid job in the non-tradable sector. This would imply that once jobs break up in the tradable sector new jobs cannot be created because there are no unemployed workers; this cannot be equilibrium.

Combining equations (4.16) and (4.20), condition (4.21) is satisfied when:

$$w_t^{NT} = \frac{ew_t^T}{r+b+e} \tag{4.22}$$

2. We also need an equilibrium condition in the tradable sector for the flows of workers between unemployment and employment, so that:

$$bL_e^T = eL_u^T \tag{4.23}$$

where L_e^T and L_u^T are respectively the number of workers employed and unemployed in the tradable sector. Taking into account the fact that the total number of workers in the economy is $L = L^{NT} + L_e^T + L_u^T$, we can rewrite equation (4.23) as:

$$L_e^T = \frac{e}{b+e}\left(L - L^{NT}\right) \tag{4.24}$$

according to this condition, the number of employed workers in the tradable sector decreases when labor in the non-tradable sector rises, breakup rate goes up, and the finding rate decreases.

In the next section we analyze how foreign capital flows affect the equilibrium of the economy, in particular that in the labor market.

4.5 Capital flows and model's equilibrium

4.5.1 The goods market

The demand side of the goods market is represented by (4.7) $\frac{1-\gamma}{\gamma}\frac{C_t^T}{C_t^{NT}} = P_t$. We can see that there is a negative relation between the RER and the relative demand of non-tradable goods.

Since labor is the only factor of production, the supply side of the market is derived through the equilibrium conditions of the labor market. Therefore, substituting equation (4.22) in (4.13) [9] and then in (4.2) we can write the optimal supply of the non-tradable goods as:

$$Y_t^{*\ NT} = \left[\frac{(r+b+e)\beta P_t}{ew_t^T}\right]^{\frac{\beta}{1-\beta}} \tag{4.25}$$

It is important to notice that when wages in the tradable sector increase, the production of the non-tradable goods decreases. The intuition is that as w^T goes up, workers shift from the non-tradable to the tradable sector, causing a reduction of non-tradable goods output.

Similarly, the optimal supply of tradable goods can be obtained by substi-

[9] We remind the reader that (4.22) is the equilibrium of the supply side of the labour market and(4.13) is the equilibrium condition of its demand side.

tuting equilibrium condition (4.24) in (4.2) and then (4.3), so that:

$$Y_t^{*\ T} = \left\{ \frac{e}{b+e} \left[L - \left(Y_t^{*\ NT} \right)^{1/\beta} \right] \right\}^{\alpha} \tag{4.26}$$

The relative supply curve of the goods market is thus represented by:

$$S^* \equiv \frac{Y_t^{*\ NT}}{Y_t^{*\ T}} = f\left(P_t; L; e; r; b; w_t^T; \beta \right) \tag{4.27}$$

we can see that when the RER appreciates, the production of non-tradable goods increases, consequently by (4.26) that of the tradable goods decreases. Therefore, there is a positive relationship between the relative supply of non-tradable goods and the RER.

Let's now suppose that the economy experience an inflow of capitals. [10] This generates an expansion of credit, so that households want to consume a greater amount of both tradable and non-tradable goods. This can be represented by an upward shift of the demand curve in Figure 4.2, where the economy reaches a new equilibrium at point 2 characterized by a more appreciated real exchange rate.

The intuition is that in order to satisfy the demand for non-tradable goods it is necessary to shift resources from the tradable to the non-tradable sector. This is possible only if the price of non-tradables increase which implies an appreciation of the real exchange rate. As the real exchange rate appreciates and more domestic resources are targeted to the production of non-tradable goods, the higher demand for tradable goods is satisfied through imports.

[10] See Calvo et al. (1993) for a detailed description of the factors that generate capital inflows i.e. during the nineties. They identify low international interest rate, the balance of payments development of the US, and US economic performance. Thus, capital flows can be considered truly exogenous as in the idea of Diaz-Alejandro (1984) where financial shocks in the center affect the periphery.

Therefore, foreign capital inflows lead to a real exchange rate appreciation, a current account deficit, and to an increase of the relative supply of non-tradable goods.

Nevertheless, it is important to consider that, as stressed by Pissarides (2000), structural shifts in demand and changes in the relative price affect the break-up and the job-finding rate in the labor market. Because of the contraction in the tradable sector, we have a raise of the braking-up and a decrease of the job-finding rates. This would lead to an increase of the relative supply of non-tradable goods. In fact we can see that:

$$\frac{\partial Y^{NT}}{\partial b} = \frac{\beta}{1-\beta}\left(Y^{NT}\right)^{\frac{2\beta-1}{1-\beta}} \frac{\beta}{e}\frac{P}{w^T} > 0 \tag{4.28}$$

$$\frac{\partial Y^T}{\partial b} = \alpha\left(Y^T\right)^{\alpha-1}\left\{-\frac{e}{(b+e)^2}\left[L-\left(Y^{NT}\right)^{1/\beta}\right]+\frac{e}{b+e}\frac{1}{\beta}\left(Y^{NT}\right)^{\frac{1-\beta}{\beta}}\frac{\partial Y^{NT}}{\partial b}\right\} < 0 \tag{4.29}$$

$$\frac{\partial Y^{NT}}{\partial b} - \frac{\partial Y^T}{\partial b} > 0 \tag{4.30}$$

As more jobs break up in the tradable sector, more workers are available to be employed in the non-tradable sector, whose relative production can therefore increase. Similarly a higher job finding rate in the tradable sector decreases the number of workers that can be employed in the non-tradable sector so that the relative production of non-tradable goods decreases.

$$\frac{\partial Y^{NT}}{\partial e} = \frac{\beta}{1-\beta}\frac{(r+b)\beta P w^T}{(ew)^2}\left(Y^{NT}\right)^{2\beta} < 0 \tag{4.31}$$

$$\frac{\partial Y^T}{\partial e} = \alpha \left(Y^T\right)^{\alpha-1} \left\{ \frac{b}{(b+e)^2} \left[L - \left(Y^{NT}\right)^{1/\beta}\right] - \frac{e}{b+e}\frac{1}{\beta}\frac{\partial Y^{NT}}{\partial e} \right\} > 0 \quad (4.32)$$

$$\frac{\partial Y^{NT}}{\partial e} - \frac{\partial Y^T}{\partial e} < 0 \quad (4.33)$$

Therefore, the decrease of the job-finding breakup ratio (e / b) leads to a leftward shift of the supply curve so that the relative price of non-tradable goods decreases. Whether this supply effect counterbalances the demand effect depends on parameters and should be object of a quantitative analysis. In figure 4.3 we represent the case where the final equilibrium at point 3 has a higher real exchange rate than the initial case

4.5.2 The labor market - wage inequality

In this paragraph, we analyze how the new equilibrium in the good market affects wage inequality between different sectors. Combining equations (4.14) and (4.3), we can write the wage in the tradable sector as:

$$w^T = \alpha \left(Y^{*\ T}\right)^{\frac{\alpha-1}{\alpha}} \quad (4.34)$$

Combining equations (4.12) and (4.2), we can write the wage in the non-tradable sector as:

$$w^{NT} = \beta P \left(Y^{*\ NT}\right)^{\frac{\beta-1}{\beta}} \quad (4.35)$$

Combing (4.34) and (4.35) the relative wage of the non-tradable sector is:

$$\frac{w^{NT}}{w^T} = P\frac{\beta}{\alpha}\frac{\left(Y^{*\ T}\right)^{\frac{1-\alpha}{\alpha}}}{\left(Y^{*\ NT}\right)^{\frac{1-\beta}{\beta}}} \quad (4.36)$$

Where:

$$Y^{*\ NT} = \left(\frac{(r+b+e)\beta P}{ew^T}\right)^{\frac{\beta}{1-\beta}} \tag{4.37}$$

$$Y^{*\ T} = \left\{\frac{e}{b+e}\left[L - \left(Y^{*NT}\right)^{1/\beta}\right]\right\}^{\alpha} = \left\{\frac{e}{b+e}\left[L - \left(\frac{(r+b+e)\beta P}{ew^T}\right)^{\frac{1}{1-\beta}}\right]\right\}^{\alpha} \tag{4.38}$$

Taking logs equation (4.36) becomes:

$$\ln w^{NT} - \ln w^T = \ln\beta - \ln\alpha + \ln P + \left(\frac{1-\alpha}{\alpha}\ln Y^{*T} - \frac{1-\beta}{\beta}\ln Y^{*NT}\right) \tag{4.39}$$

substituting for Y^{*NT} we get:

$$\begin{aligned}\ln w^{NT} - \ln w^T = \ln\beta - \ln\alpha + \ln P + \frac{\beta}{1-\beta}\frac{\beta}{1-\beta}\,[\ln(r+b+e)+ \\ \ln\beta + \ln P - \ln e - \ln w^T + \frac{1-\alpha}{\alpha}\ln Y^{*T}\end{aligned} \tag{4.40}$$

Differentiating respect to the relative price

$$\begin{aligned}\frac{\partial(\ln w^{NT} - \ln w^T)}{\partial \ln P} = \frac{\partial\left(\ln e - \ln\alpha - \ln(r+b+e) + lnw^T + \frac{1-\alpha}{\alpha}\ln Y^{*T}\right)}{\partial \ln P} = \\ \frac{\partial \ln w^T}{\partial \ln P} + \frac{1-\alpha}{\alpha}\frac{\partial \ln Y^{*T}}{\partial \ln P}\end{aligned} \tag{4.41}$$

Lets now focus on the last term of this expression reminding that $\frac{\partial \ln Y^{*T}}{\partial \ln P} = \frac{\partial Y^{*T}}{\partial P}\frac{P}{Y^{*T}}$, so that by (4.38) we get that

$$\begin{aligned}\frac{\partial Y^{*T}}{\partial P}\frac{P}{Y^{*T}} = \alpha\left\{\frac{e}{b+e}\left[L - \left(\frac{(r+b+e)\beta P}{ew^T}\right)^{\frac{1}{1-\beta}}\right]\right\}^{\alpha-1} - \\ \frac{e}{b+e}\left(\frac{(r+b+e)\beta P}{ew^T}\right)^{\frac{\beta}{1-\beta}}\frac{(r+b+e)\beta ew^T - (r+b+e)\beta Pe\frac{\partial w^T}{\partial P}}{(ew^T)^2}\frac{P}{Y^T}\end{aligned} \tag{4.42}$$

Rearranging we can get:

$$\frac{\partial \ln Y^{*T}}{\partial \ln P} = \alpha \frac{\left(\frac{(r+b+e)\beta P}{ew^T}\right)^{\frac{1}{1-\beta}}}{L - \left(\frac{(r+b+e)\beta P}{ew^T}\right)^{\frac{1}{1-\beta}}} \left(\frac{\partial \ln w^T}{\partial \ln P} - 1\right) < 0 \tag{4.43}$$

From 4.26 and 4.25 we know that $\frac{\partial Y^T}{\partial P} < 0$, as the relative price of non-tradables increase the supply of tradable decreases. Using (4.34) this implies that $\frac{\partial \ln w^T}{\partial \ln P} < 1$; hence 4.43 is negative. Going back to (4.41) and substituting for (4.43) we get:

$$\begin{aligned}\frac{\partial(\ln w^{NT} - \ln w^T)}{\partial \ln P} &= \frac{\partial \ln w^T}{\partial \ln P} + (1-\alpha) \frac{\left(\frac{(r+b+e)\beta P}{ew^T}\right)^{\frac{1}{1-\beta}}}{L - \left(\frac{(r+b+e)\beta P}{ew^T}\right)^{\frac{1}{1-\beta}}} \left(\frac{\partial \ln w^T}{\partial \ln P} - 1\right) = \\ &\frac{\partial \ln w^T}{\partial \ln P} + (1-\alpha)\frac{e}{b+e}\frac{(Y^{*NT})^{1/\beta}}{(Y^{*T})^{1/\alpha}}\left(\frac{\partial \ln w^T}{\partial \ln P} - 1\right)\end{aligned} \tag{4.44}$$

we know that $\frac{\partial \ln w^T}{\partial \ln P} < 1$. So the key question is if $\left|(1-\alpha)\frac{e}{b+e}\frac{(Y^{*NT})^{1/\beta}}{(Y^{*T})^{1/\alpha}}\right| \gtreqless 1$

This is a numerical issue that depends on parameters and the relative supply of non-tradable goods. As long as $\frac{(Y^{*NT})^{1/\beta}}{(Y^{*T})^{1/\alpha}} \gg 1$, which given $\beta < \alpha$ requires that $Y^{*NT} > Y^{*T}$, this relationship is greater than one. Therefore, it is likely that the real exchange rate appreciation triggered by capital inflows increases the wage gap between skilled and unskilled workers, contributing to the overall rise of income inequality.

As we have seen in the previous section, one of the consequences following capital flows is the rise of the breakup rate and the reduction of the job-finding rate. This has a positive effect on the wage gap between the tradable and non-tradable sector. In fact: [11]

$$\frac{\partial w^T}{\partial b} = \frac{\alpha(1-\alpha)(1-\beta)e(w^T)^2\Phi^{\alpha-2}\left\{\frac{e}{e+b}\left[L-\Gamma^{\frac{1}{1-\beta}}\right]+\frac{\beta}{1-\beta}\frac{P}{w^T}\Gamma^{\frac{\beta}{1-\beta}}\right\}}{(1-\beta)(b+e)(ew^T)^2+\alpha\beta(1-\alpha)(r+b+e)eP\Gamma^{\frac{\beta}{1-\beta}}\Phi^{\alpha-2}} > 0 \tag{4.45}$$

the intuition is that when more jobs breakup in the tradable sector, the wage increases because of the diminishing returns to labor. Whereas in the non-tradable sector we can see that:

$$\frac{\partial w^{NT}}{\partial b} = \frac{e}{r+b+e}\frac{\partial w^T}{\partial b} - \frac{ew^T}{(r+b+e)^2} < \frac{\partial w^T}{\partial b} \tag{4.46}$$

So that the overall effect on the wage gap is positive:

$$\frac{\partial w^T}{\partial b} - \frac{\partial w^{NT}}{\partial b} = \left(1-\frac{e}{r+b+e}\right)\frac{\partial w^T}{\partial b} + \frac{ew^T}{(r+b+e)^2} > 0 \tag{4.47}$$

Similarly, the effect of a change in the job-finding rate is such that:

$$\frac{\partial w^T}{\partial e} = \frac{\alpha(\alpha-1)(1-\beta)e(w^T)^2\Phi^{\alpha-2}\left\{\frac{b}{e+b}\left[L-\Gamma^{\frac{1}{1-\beta}}\right]+\frac{\beta}{1-\beta}\frac{P}{w^T}\Gamma^{\frac{\beta}{1-\beta}}\left(\frac{r+b+e}{e}-1\right)\right\}}{(1-\beta)(b+e)(ew^T)^2+\alpha\beta(1-\alpha)(r+b+e)eP\Gamma^{\frac{\beta}{1-\beta}}\Phi^{\alpha-2}} < 0 \tag{4.48}$$

the intuition is that an increase in the job-finding rate increases the number of workers employed in the tradable sector, because of diminishing marginal returns this implies a reduction of wages. Whereas, the overall effect on the wage in the non-tradable sector is going to be smaller, in fact:

$$\frac{\partial w^{NT}}{\partial e} = \frac{r+b}{r+b+e}w^T + \frac{e}{r+b+e}\frac{\partial w^T}{\partial e} > \frac{\partial w^T}{\partial e} \tag{4.49}$$

So that combining (4.48) and (4.49) the overall effect of a change in the job-

[11] In order to save notation we define $\Phi = \frac{e}{b+e}\left[L-\left(\frac{(r+b+e)\beta P}{ew^T}\right)^{\frac{1}{1-\beta}}\right]$ and $\Gamma = \frac{(r+b+e)\beta P}{ew^T}$

finding rate on the wage gap is negative:

$$\frac{\partial w^T}{\partial e} - \frac{\partial w^{NT}}{\partial e} = \left(1 - \frac{e}{r+b+e}\right)\frac{\partial w^T}{\partial e} - \frac{r+b}{r+b+e}w^T < 0 \tag{4.50}$$

In this section we have analyzed the effects that foreign capital inflows have on the wage gap between the tradable and non-tradable sector through a real exchange rate appreciation and a decrease of the $\frac{e}{b}$ ratio. We have seen that a decrease of the $\frac{e}{b}$ ratio leads to a higher wage gap between skilled and unskilled workers; while the effect of the real exchange rate appreciation depends on parameters, but it is more likely to increase the gap as long as the non-tradable sector is larger than the tradable one. Therefore, capital inflows lead to higher income inequality because of a wider wage gap between skilled and unskilled workers.

4.5.3 The labor market - unemployment

In this section we analyze the effects of foreign capital inflows on unemployment which is one of the key determinants of inequality in developing countries. The labor force is divided into employed in the non-tradable sector, employed in the tradable sector, and unemployed in the tradable sector:

$$L = L^{NT} + L_e^T + L_u^T \tag{4.51}$$

Therefore, we firstly need to find the equilibrium allocation of the labor force between the non-tradable and the tradable sector; then, we have to define the repartition between employed and unemployed workers within the tradable sector.

In figure 4.4 (panel A), we consider the value equations of employment in the tradable sector and of unemployment in the tradable sector. On the left axis, we measure $rW^{NT} - z = w^{NT}$, while, on the right axis, $rU^T - z = \frac{e}{r+b+e} w^T$. The length of the horizontal axis is equal to the total number of workers. The intersection between the two curves represents the equilibrium allocation of labor between the tradable and non-tradable sectors, such that the equilibrium condition $W^{NT} = U^T$ is satisfied. [12]

Figure 4.4A allows to determine the division of workers between the non-tradable and tradable sector, but we cannot distinguish between employed and unemployed workers in the tradable sector. Combining equation (4.51) with the equilibrium condition (4.23) the total number of unemployed workers is going to be given by:

$$L_u^T = \frac{b}{b+e}\left(L - L^{NT}\right) \tag{4.52}$$

We can see that unemployment is influenced by the number of workers allocated in the non-tradable sector and by the breaking and job-finding rates of the search and matching model. Thus, in diagram B of figure 4.4 the downward sloping curve shows all the combinations of L_e^T and L_u^T that sum to $L - L^{NT}$, as determined in 4.4A. Whereas, the upward sloping curve shows all the combinations of L_e^T and L_u^T that satisfy the equilibrium condition $bL_e^T = eL_u^T$.

We can now examine the impact of capital flows on unemployment by analyzing the effects of both real exchange rate appreciation and raise of the finding/breakup rate ratio. When the real exchange rate appreciate the job-value curve of the non-tradable sector shifts up as from (4.39) we know that:

$$\frac{\partial\left(W^{NT} - z\right)}{\partial P} = \frac{\partial w^{NT}}{\partial P} > 0 \tag{4.53}$$

[12]Since the marginal product of labor is decreasing in both sectors, the two curves are downward sloping in labor. However, since in the tradable sector the productivity of labor is higher than in the non-tradable sector the w^T curve is flatter than the w^{NT} curve

The unemployment-value curve moves up as well since from (4.36):

$$\frac{\partial\left(U^{T}-z\right)}{\partial P}=\frac{\partial\left(\frac{e}{r+b+e}w^{T}\right)}{\partial P}>0 \tag{4.54}$$

However, the elasticity of W^{NT} respect to the real exchange rate is higher than the elasticity of U^{T}, in fact combining (4.31) and (4.32) we can see that:

$$\frac{\partial w^{NT}}{\partial P}\frac{P}{w^{NT}}=\frac{\partial w^{T}}{\partial P}P>\frac{\partial w^{T}}{\partial P}\frac{P}{w^{T}}\frac{e}{e+r+b} \tag{4.55}$$

where the term at the right hand side of the inequality is the elasticity of $(U^{T}z)$ respect to P.

This implies that the overall effect of real exchange rate appreciation is to shrink the number of workers in the tradable sector to point 2 in panel A of figure 4.4. As a consequence, in figure 4.5 the L^{T} curve shifts in and we reach a temporary new equilibrium at point 2 characterized by lower unemployment.

Nevertheless, we need to take into account also the contraction of the (e/b) ratio. As (e/b) decreases the equilibrium curve $L_{e}^{T}=\frac{e}{b}L_{u}^{T}$ rotates downwards so that the economy reaches an equilibrium with a higher unemployment level.

However, in order to assess the final effect of foreign capital flows on unemployment we should also consider how the new finding/breakup rate ratio affects the job-value equation in the non-tradable sector and the unemployment-value equation in the tradable sector. We can see that:

$$\frac{\partial(U^{T}-z)}{\partial e}=\frac{\partial\left(\frac{e}{r+b+e}w^{T}\right)}{\partial e}=\frac{r+b}{(r+b+e)^{2}}w^{T}+\frac{e}{r+b+e}\frac{\partial w^{T}}{\partial e}\gtreqless 0 \tag{4.56}$$

$$\frac{\partial(U^{T}-z)}{\partial b}=\frac{\partial\left(\frac{e}{r+b+e}w^{T}\right)}{\partial b}=\frac{e}{(r+b+e)^{2}}w^{T}+\frac{e}{r+b+e}\frac{\partial w^{T}}{\partial b}\gtreqless 0 \tag{4.57}$$

These derivatives are equal to the sum of a positive and a negative term. Thus, the effects of a change in the e and b on the value of unemployment is indeterminate and it depends on the numerical value of the functions. The reason is that two opposite effects are taking place. From one side, because of the reduction (increase) in the job finding rate (break-up rate), it becomes harder to find a job and it is easier to lose it so that the value of unemployment diminishes. From the other side, as there are less workers employed in the tradable sector (Y^T decreased) the wage in this sector increases raising the value of unemployment. Looking at equations (4.46) and (4.49) we can see that the same indeterminacy characterizes the value function of employment in the non-tradable sector.

Therefore, the contraction of the (e/b) ratio can lead either to a rise or to a reduction of the workers employed in the non-tradable sector. In the latter case the overall effect of foreign capital inflows would be an increase of the unemployment equilibrium. In the former case the final result would depend on whether the effect of a change in (e/b) on $L_e^T = \frac{e}{b} L_u^T$ is stronger than the effect on the value of unemployment in the tradable sector and of employment in the non-tradable sector.

4.6 Conclusions and further developments

This paper fills a gap in the literature on globalization and income inequality. It shows that there is a significant positive association between net capital flows and the Gini coefficient, in particular in emerging countries. The paper then disentangles the theoretical mechanisms of this link through an analytical model that connects in a general equilibrium framework the macroeconomic models on the dynamics of the balance of payments with the search and matching models of the labor market.

In the model capital inflows lead to an increase in the relative production and relative price of non-tradable goods. This generates an adjustment process in the labor market, where employment in the tradable sector decreases. Part of the workers previously employed in this sector are absorbed by the non-tradable sector, but part of them remain unemployed. Because of the lower productivity in the non-tradable sector respect to the tradable one, the relative wage of the tradable sector increases during this adjustment process. The increase in unemployment and in the relative wage of skilled workers lead to an overall increase of income inequality.

The paper lays the ground for further theoretical and empirical research on this subject. From a theoretical and point of view the next steps would be to endogenize the break-up and job-finding rates to changes in the relative price. Moreover the welfare implications of this model need to be assessed. Finally, a more quantitative test of the model and a numerical analysis would contribute to a better understanding of the link between capital flows and income inequality.

4. Figures and Tables

Table 4.1: Panel regression of income inequality on capital flows 1980-2008

Dependent var: Gini coefficient	**Full sample**	**Emerging countries**
Financial Account	0.07**	0.15**
Lag 1 (% GDP)	(2.59)	(2.47)
GDP per-capita growth	-0.06	-0.05
Lag 1 (% GDP)	(-1.1)	(-0.76)
Government Consumption	0.17**	0.07
Lag 1 (% GDP)	(2.16)	(0.6)
Country, fe	Yes	Yes
Time dummies	Yes	Yes
No. of countries	128	24
No. of observations	683	246

*** Significant at the 1% level; ** significant at the 5% level; robust t-statistics in parenthesis. Emerging countries (IMF definition):Argentina, Brazil, Bulgaria, Chile, China, Estonia, Hungary, India, Indonesia, Latvia, Lithuania, Malaysia, Mexico, Pakistan, Peru, Philippines,Poland, Romania, Russian Federation, South Africa, Thailand, Turkey, Ukraine, Venezuela.

Table 4.2: Panel regression of income inequality on different categories of capital flows 1980-2008

Dependent var: Gini coefficient	**Full sample**	**Emerging countries**
Portfolio	0.07*	0.06
	(1.75)	(0.5)
Derivatives	-0.8	0.07
	(-0.96)	(0.03)
FDI	0.07	-0.04
	(1.14)	(0.31)
Other Investments	0.04	0.20***
	(1.32)	(2.97)
Reserve Assets	-0.11**	-0.06
	(-2.23)	(-0.47)

*** Significant at the 1% level; ** significant at the 5% level; robust t-statistics in parenthesis. Emerging countries (IMF definition):Argentina, Brazil, Bulgaria, Chile, China, Estonia, Hungary, India, Indonesia, Latvia, Lithuania, Malaysia, Mexico, Pakistan, Peru, Philippines,Poland, Romania, Russian Federation, South Africa, Thailand, Turkey, Ukraine, Venezuela.

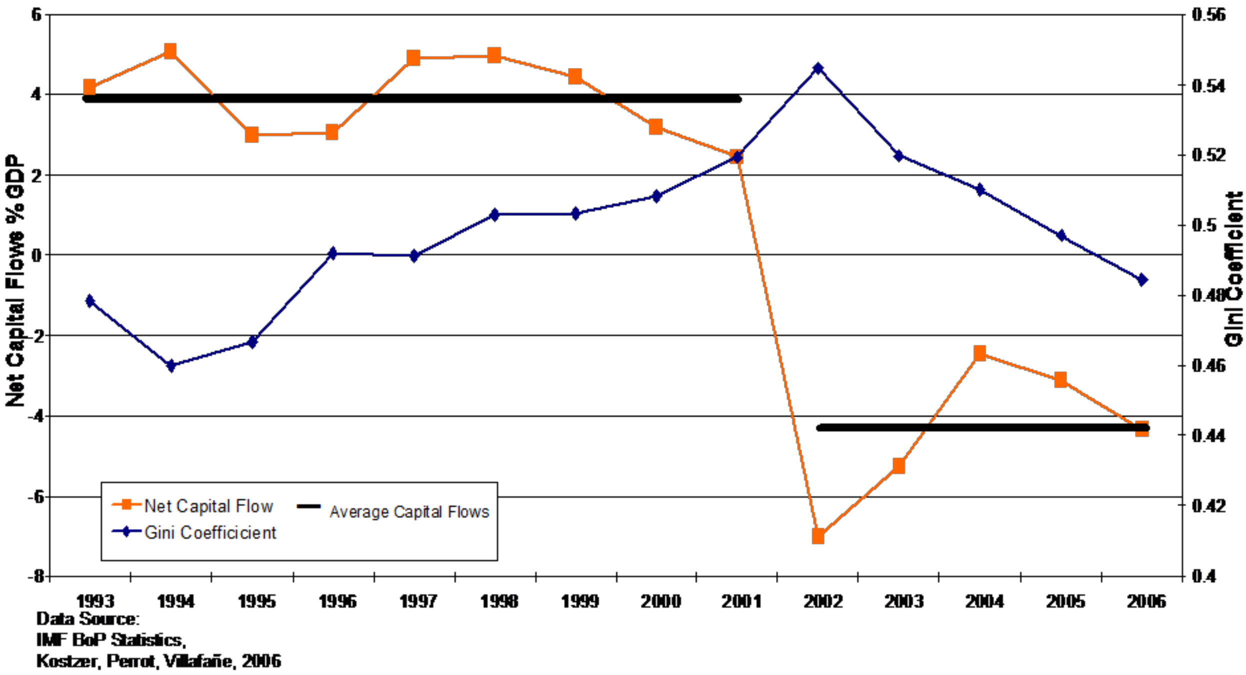

Figure 4.1: Foreign capital flows and income inequality - Argentina

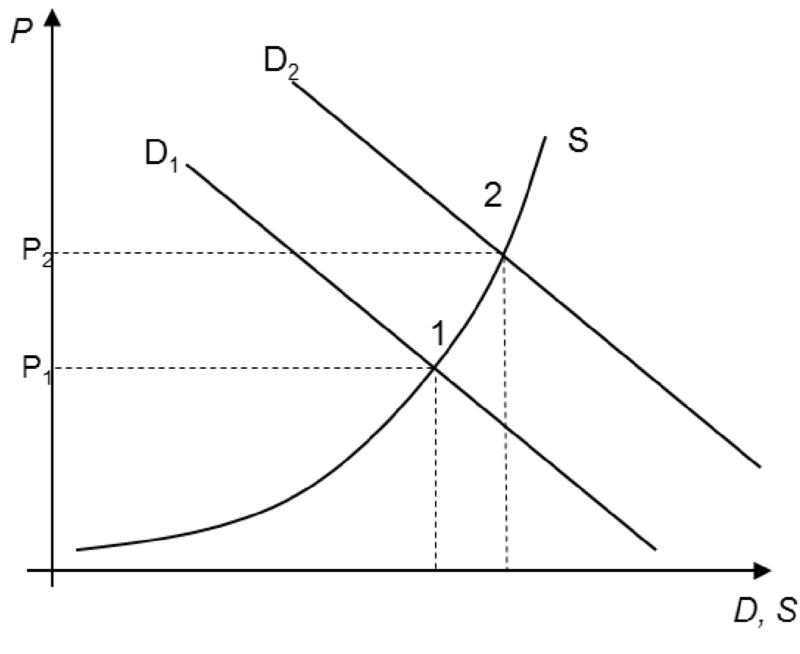

Figure 4.2: Demand effect of foreign capital flows

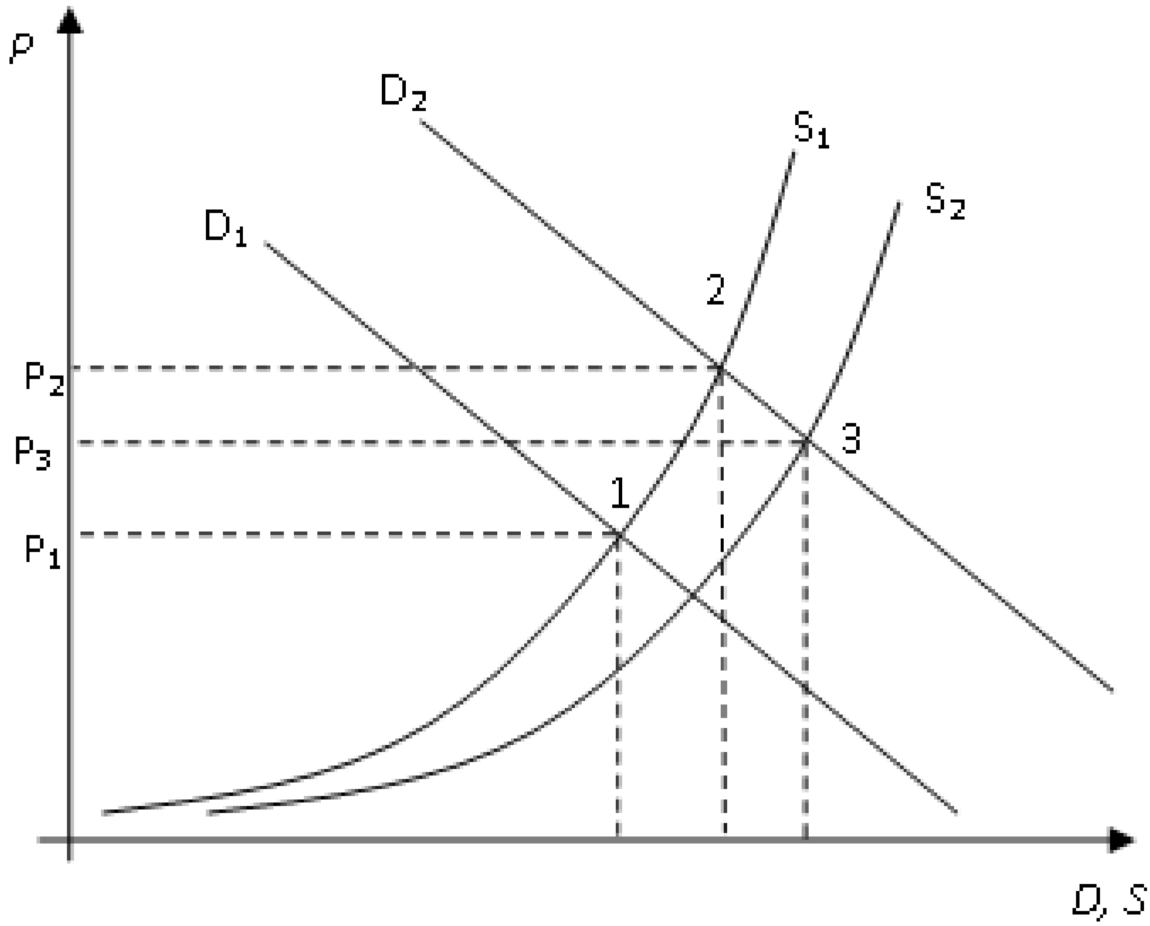

Figure 4.3: Supply effect of foreign capital flows

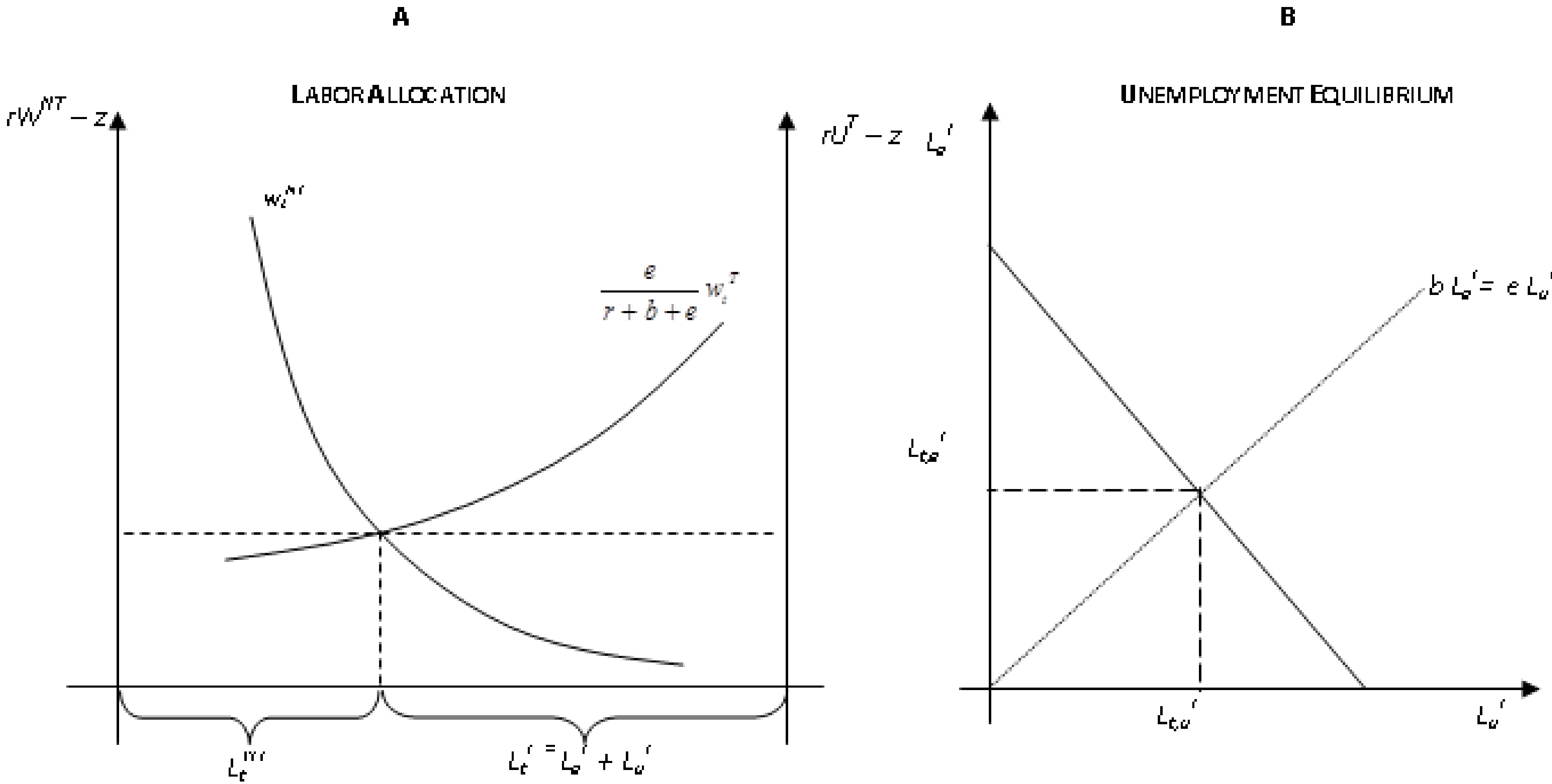

Figure 4.4: Equilibrium in the labor market

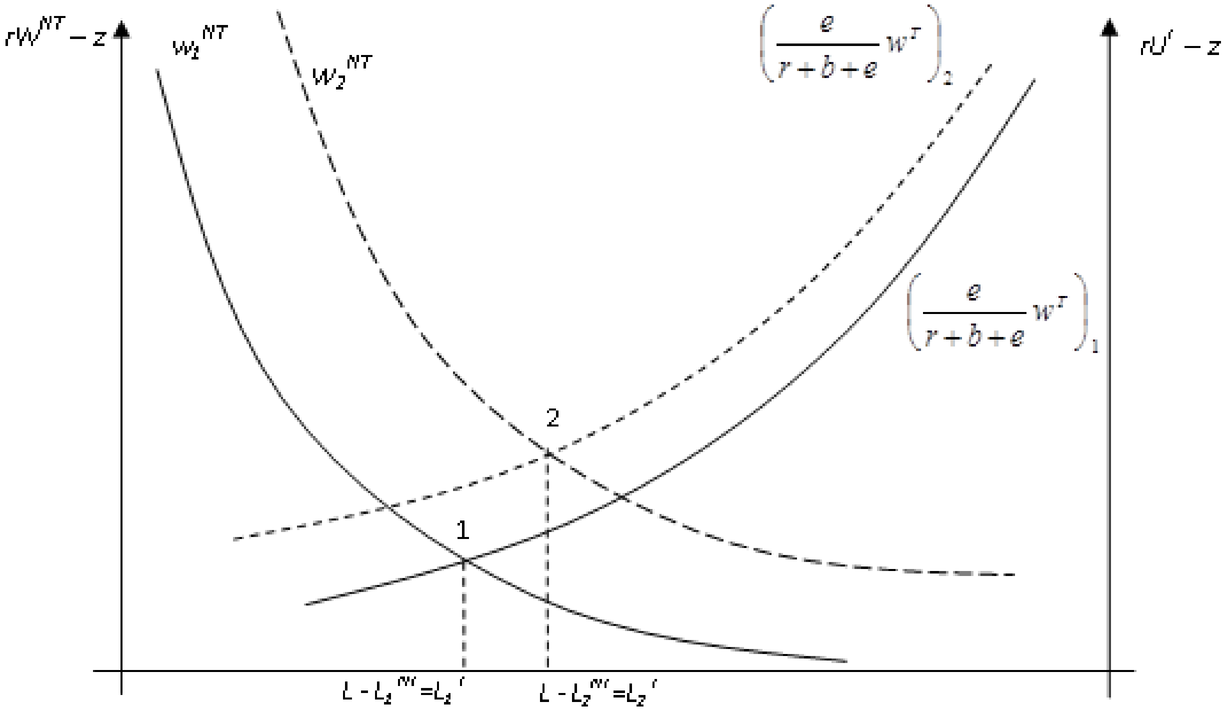

Figure 4.5: RER appreciation and labor allocation

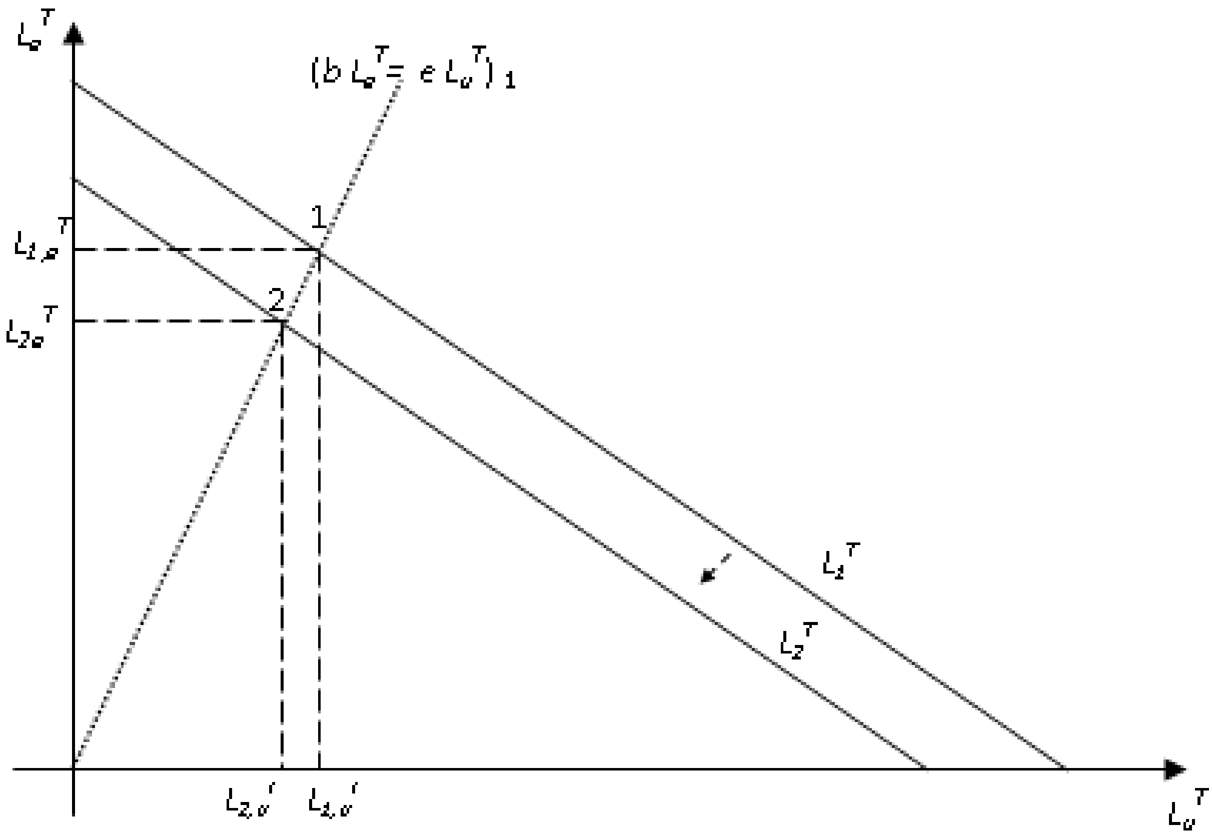

Figure 4.6: Real exchange rate appreciation and unemployment equilibrium

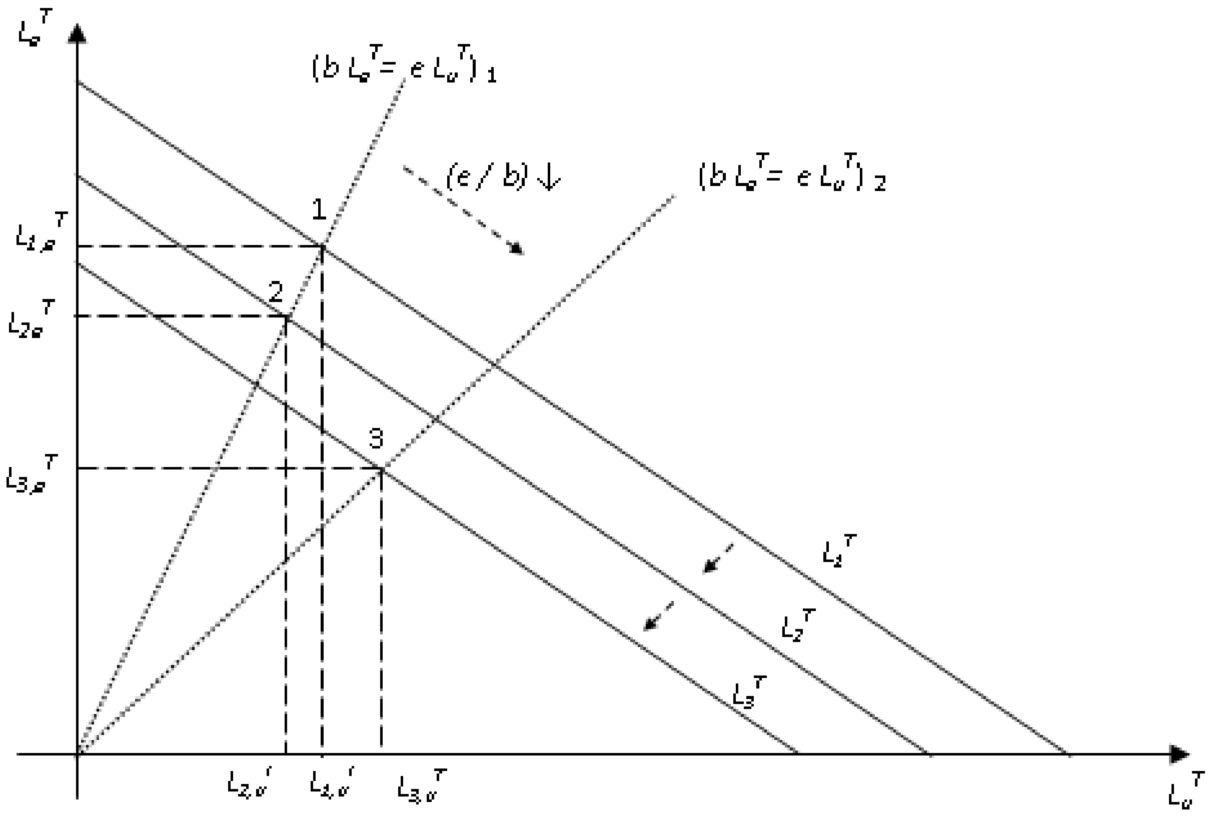

Figure 4.7: (e/b) contraction and unemployment equilibrium

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