LOWER PRICES IN POOR COUNTRIES:
TECHNOLOGY, EXCHANGE RATE RISK AND CAPITAL MOBILITY
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1. Introduction

The strong correlation between countries' price levels and their per capita income is widely known since Balassa (1964). The purpose of the present paper is to investigate this correlation (hereinafter, B-correlation) when international capital mobility is introduced. At odds with the results of the traditional models, it is shown that neutral and homogeneous technological differences à la Hicks can affect both the cost of living and relative prices, when capital mobility is present. Additionally, the model explains the role of exchange risk premia and constraints to capital mobility in price and real wage differences between poor and rich countries.¹

The B-correlation suggests that economic growth can be associated with a real exchange rate appreciation. This issue is particularly important to countries that face an economic integration and a catching-up process. As shown in Figure 1, in general, the B-correlation also holds for EU

¹ Several empirical papers [Samuelson (1964), Kravis, Heston and Summers (1983) and Kravis and Lypsey (1983, 1987)] argue for the B-correlation. These papers show that price levels are also correlated with other variables, namely with the openness of the country and their natural resources endowment.
country members. If one of the aims of European movement is some form of welfare convergence, then there are reasons to suspect that the eventual welfare catching-up process of the lagging countries will be coupled with a real appreciation\(^2\). Hence, given the euro participation, any attempt to assure an inflation convergence may be unachievable in a sustainable way. This depends on how wide the gap is and how quickly the catching-up process is taking place. Inasmuch as it reflects a real convergence process, over the medium term an inflation rate alignment is neither possible nor desirable.

Figure 1
EU countries 2000, EU=100

![Graph showing EU countries 2000, EU=100](image)

Source: Eurostat

\(^2\) Two different approaches to quantify the real appreciation for the Portuguese economy are in Brufio and Correia (2000) and Costa (2001).

This issue is even more important to accession countries that will join the European Union by 2004, given that income and price level differences are much more pronounced (see Figure 2).

![Figure 2: Candidate countries vs EU 1999, EU=100](image)

Source: Eurostat

Our paper stresses these points and gives an alternative rationale for the possible conflict between these two policy objectives: nominal convergence (price level and exchange rate stability) and real convergence.

The theoretical fundamentals of the empirical studies mentioned above, related with the B-correlation, remain largely unknown\(^3\). Bhagwati (1984) makes an important

\(^3\) The approaches here in referred to are based on aggregated macro data. Other related literature uses micro data and usually

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contribution in that direction using a Heckscher-Ohlin framework, while categorising alternative explanations in two groups.\footnote{An alternative justification based on household preferences was presented in Bergstrand (1991). However, his justification is less related to our paper.}

(i) Productivity level hypothesis.\footnote{This approach corresponds to the formalisation of an idea presented early in Balassa (1964), Samuelson (1964) and Kravis, Heston and Summers (1983). This approach is also implicit in the Scandinavian model, although only in explaining the real exchange rate movements [see, Officer (1976), Hsieh (1982) and Marston (1987)].} Assuming that poor countries have a lower productivity level in tradable sectors, if these differences are homogeneous and neutral à la Hicks, international trade will equalise relative factor rewards. Furthermore, if the non-tradable sector has the same technology as the developed country, then the price of this commodity will be lower in the poor country, the cost of living (or the price level) is also lower and the Balassa correlation is explained.\footnote{If we assume neutral technological differences à la Hicks in all sectors, price equalization between the two countries is warranted as in Komvia (1967). Both results can be seen as extensions of Flay and Grubert (1959).}

However, as argued in Bhagwati (1984), the productivity hypothesis is not a reasonable one. First, it is unlikely that the technological inferiority of poor countries will mainly be in the tradable sector. Moreover, this hypothesis leads to two unrealistic consequences in the observed differences between developed and poor countries: equalisation of relative factor returns and equalisation of sectorial capital intensities.

emphasises border effects and price stickiness. Engel, C. and J. Rogers (1996, 2001) are two recent examples of this other route.

(ii) Factor endowment hypothesis. This approach is suggested in Bhagwati (1984) and assumes no technology differences among countries, overcoming the previous criticism. Alternatively, it assumes that the poor country has a relative scarcity of capital. If this relative factor endowment difference is large (i.e. the two countries do not remain inside the McKenzie-Chipman diversification cone), the free trade equilibrium implies that the poor country will be completely specialised in the production of the least capital-intensive tradable good (within the tradable sector goods) and as a result it will enjoy a lower (relative and real) wage. Even without technology differences, a lower wage leads to a price of the labour-intensive non-tradable good lower in the poor country.

The value added of this paper is its explicit consideration of the role of capital mobility, which is particularly relevant due to the actual increasing mobility of factors and to the substitution between international trade and international factor mobility.\footnote{See Mundell (1957)} In contrast to the traditional results, this paper shows that Hicks neutral and homogeneous technological differences across (tradable and non-tradable) sectors can affect both the cost of living and relative prices, when international capital mobility is introduced. Countries with a lower technological level will have a lower cost of living and a lower real wage. Furthermore, the productivity level hypothesis is reintroduced, but the unrealistic asymmetric technological difference is not assumed, as in previous papers. It is also stressed that the exchange risk premium and the constraints to capital mobility can also explain price and real wage differences between poor and rich countries.
The paper is organised as follows. Section 2 presents the relation between price and real wage levels in a CRS-two-sector model. Section 3 analyses the consequences of international capital mobility. Section 4 derives the main results: lower productivity in all sectors, positive exchange rate risk premium or constraints to international capital inflows simultaneously explain lower prices and lower real wages. Finally, Section 5 summarises the main results and their policy implications.

2. Price and Real Wage Levels in the Model

The model assumes two economies and two goods, where \( PT \) is the price of the tradable good and \( PN \) is the price of the non-tradable good or service. Cobb-Douglas preferences are assumed to be identical, implying that the price index or the cost of living index \( (P) \) for both economies can be written as

\[
P = PT^p PN^{1-p}
\]

(1)

And

\[
P' = PT'^p PN'^{1-p}
\]

(2)

where the "*" indicates the foreign country and "p" and "\( (1-p) \)" are the consumption shares. The tradable good market is completely integrated in the international market, thus

\[
PT = E.PT'
\]

(3)

where \( E \) stands for the exchange rate\(^a\). Using expressions

\(^a\) It is implicitly assumed that transport costs are negligible.

\[
\frac{P}{E.P'} = \left( \frac{PN}{E.PN'} \right)^{\frac{1}{1-p}} \left( \frac{PN'/P'}{PN'}/P' \right)^{\frac{1}{p}}
\]

(4)

As usual, it is assumed that both the tradable good \( QT \) and non-tradable good \( QN \) are produced with CRS technologies using capital \( (K) \) and labour \( (L) \). For simplicity, we further assume a Cobb-Douglas representation in both cases

\[
QT = \tau K^{\alpha} L^{1-\alpha}, \quad 0 < \alpha < 1
\]

(5)

\[
QN = \nu KN^\beta LN^{1-\beta}, \quad 0 < \beta < 1
\]

(6)

As usual, the non-tradable good is assumed to be labour-intensive, implying that \( \beta < \alpha \). Other variables have the usual interpretation. Equivalently, for the foreign country the production functions are

\[
QT' = \tau' K^{\alpha} L^{1-\alpha}, \quad 0 < \alpha < 1
\]

(7)

\[
QN' = \nu' KN^\beta LN^{1-\beta}, \quad 0 < \beta < 1
\]

(8)

The differences in technologies between countries are exogenous and assumed to be homogeneous and Hicks neutral, that is

\[
\frac{\tau}{\tau'} = \frac{\nu}{\nu'} = \theta
\]

(9)

For illustrative purposes, we will consider throughout that the domestic country is less efficient (that is, \( \theta < 1 \)).
Conditions of profit maximisation in both sectors and expressions (4) through (9) allow us to relate the price and real wage levels as below:

$$\frac{P}{E.R^*} = \left(\frac{W/R}{W'/R'}\right)^{(\alpha-\beta)(1-p)}$$ (10)

$$\frac{W/P}{W'/P'} = \theta \left(\frac{W/R}{W'/R'}\right)^{\phi+\beta(1-p)}$$ (11)

Equation (10), with $>$, shows that an increase in the relative cost of labour increases the price of the non-tradable good. This is reminiscent of the Bhagwati model.

The present paper investigates the links between equations (10) and (11) without resorting to Bhagwati’s assumption of large factor-endowments differences between countries. Instead, the assumption of international capital mobility is introduced. This is a more palatable assumption when we envisage countries that are not very different, but nevertheless welfare and cost of living differences are still relevant.  

3. International Capital Mobility

Assuming the tradable good as the capital good with constant physical depreciation rate and denoting the nominal interest rate in each country by $i$, we can express the nominal rental cost of capital ($R$) as

$$R = iPT + \delta PT - \left(\frac{dPT}{dt}\right)^\gamma$$ (12)

$$R^* = i^*PT^* + \delta PT^* - \left(\frac{dPT^*}{dt}\right)^\gamma$$ (13)

where the superscript "e" stands for the expected value of the variable and $dX/dt$ for the time derivative of $X$. The above expressions state that $R$ can be decomposed into: (a) a purchasing cost; (b) a nominal cost of physical depreciation; (c) the expected capital gains.

Capital mobility implies interest rate parity in international financial operations. Assuming that the exchange rate risk premium ($\pi$) and the transaction costs of international capital mobility ($\epsilon$) are exogenous, the following financial condition holds:

$$i = i^* + \left(\frac{dE}{E}\right)^\gamma + \pi + \epsilon$$ (14)

The parameter quantifies the international capital mobility constraints as a transaction cost, which explains the differences between domestic and off-shore interest rates. Hence, is positive if the economy is an importer of capital. Again, for illustrative purposes, we consider the case of the domestic economy being the riskier country and the importer of capital.

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9 Details can be seen in the Annex.
10 In other words, we do not have in mind a comparison between India and the US, but rather, one between European economies, for instance.
To warrant the consistency of economic agents’ forecasts, from equation (3) the following must hold

\[
\left( \frac{dPT}{PT} \right) = \left( \frac{dE}{E} \right) + \left( \frac{dPT^*}{PT^*} \right)
\]  

(15)

Using equations (12) through (15) and the optimality conditions for production, we can express the wage-rental as

\[
\frac{W}{R} = \left( \frac{1}{\theta + \frac{1}{1+\pi + \epsilon}} \right)^{\frac{1}{1-\alpha}}
\]  

(16)

The home country, with the lower technological level ($\theta < 1$) and a positive exchange rate risk premium ($\pi > 0$), will have a lower relative cost of labour. Likewise, constraints to capital inflows ($\epsilon > 0$) will also induce a lower cost of labour in the home country.

Finally, considering expression (16), equations (10) and (11), which explain price and real wage levels, can be rewritten as

\[
\frac{P}{EP^*} = \left( \theta + \frac{1}{1+\pi + \epsilon} \right)^{\frac{\alpha - \beta (1-p)}{1-\alpha}}
\]  

(17)

\[
\frac{W}{P} = \left( \frac{1}{\theta + \frac{1}{1+\pi + \epsilon}} \right)^{\frac{\alpha + \beta (1-p)}{1-\alpha}}
\]  

(18)

It should be underscored that our assumption of only one tradable good is not as restrictive as it seems at first sight. In fact, two tradable goods would generate pressure towards relative factor cost equalisation (Komyia 1967)). However, international capital mobility with technological differences leads necessarily to a lower relative cost of labour in the domestic country and hence towards a complete specialisation as in Bhagwati (1984).

4. Links Between Real Wages and Price Levels

The model is reduced to equations (17) and (18), which can easily be solved making use of Figure 3. First, note that the exponents of the above expressions are all positive, and furthermore

\[
\frac{1 - \alpha + \alpha \epsilon + \beta (1-p)}{\alpha \epsilon + \beta} > 1
\]

In Figure 3, we define two curves: R1 and R2. The former is defined such that the real exchange rate is equal to one, i.e., expression (17) is equal to one; R2 is defined such that real wages are identical in both countries, that is, expression (18) is equal to one. To the left (right) of line R1, the domestic price is lower (higher) than the foreign price level; to the left (right) of line R2, the domestic real wage is lower (higher) than the foreign price level. These two lines define four areas that will be analysed below.

Clearly, if the two countries are identical, there are no differences between price and real wage levels, then

\[(\theta = 1) \wedge (\pi + \epsilon = 0) \Leftrightarrow (P = EP^*) \text{ and } \left( \frac{W}{P} = \frac{W^*}{P^*} \right)\]

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This is depicted by point V in Figure 3.

The following propositions are also illustrated in Figure 3, where the numbering of the four areas defined by those two lines follows the numbering of the propositions below.

The case we have been analysing, where the domestic country is poorer, capital importer and riskier, can be seen as a point in a region north-west of point V. It is a particular case of Region I where the price level is also lower. Region II represents the symmetric case, where the domestic country has a higher cost of living and is more developed, in the sense of having a higher real wage. More formally,

**Proposition 1**

\[
(1 + \pi + \epsilon > \theta) \land (1 + \pi + \epsilon > \theta \quad \text{or} \quad \beta(1 - \rho)) \quad \Leftrightarrow \quad (P < EP') \quad \text{and} \quad \left(\frac{W}{P} < \frac{W'}{P'}\right)
\]

**Proposition 2**

\[
(1 + \pi + \epsilon < \theta) \land (1 + \pi + \epsilon < \theta \quad \text{or} \quad \beta(1 - \rho)) \quad \Leftrightarrow \quad (P > EP') \quad \text{and} \quad \left(\frac{W}{P} > \frac{W'}{P'}\right)
\]

Regions III and IV are less plausible to occur. A country in the latter region has a low cost of living coupled with high real wages, due to a particular mix of technological advantage and a positive risk premium cum capital mobility costs.\(^{13}\) Region III represents the symmetric case.

\[^{13}\] This could illustrate the case of Argentina after the 2001 currency board collapse, where the risk premia outweighed the technological advantage relative to other neighbouring countries.

A necessary but not sufficient condition for higher prices in countries with lower real wages is that the opposite financial markets elements overcompensate the productivity differences. This is stated for each country in the following two propositions.

**Proposition 3**

\[
(1 + \pi + \epsilon < \theta) \land (1 + \pi + \epsilon < \theta \quad \text{or} \quad \beta(1 - \rho)) \quad \Leftrightarrow \quad (P > EP') \quad \text{and} \quad \left(\frac{W}{P} < \frac{W'}{P'}\right)
\]

**Proposition 4**

\[
(1 + \pi + \epsilon > \theta) \land (1 + \pi + \epsilon < \theta \quad \text{or} \quad \beta(1 - \rho)) \quad \Leftrightarrow \quad (P < EP') \quad \text{and} \quad \left(\frac{W}{P} > \frac{W'}{P'}\right)
\]

In general, for a given level of technology in both countries, the riskier the home country is, the likelier it is that it will be in Region I, with a low real wage and a low cost of living. The same holds for capital mobility costs. Furthermore, for a given level of risk premium cum capital mobility costs, the lower the technological level in the domestic country is, the likelier it is that it will lie in Region I.
At variance with the traditional analysis without capital mobility, homogeneous and Hicks' neutral technological differences affect the relative prices between two economies. Capital mobility anchors the real cost of capital, and lower productivity implies a lower capital-labour ratio in both the traded sector and the non-traded sector. Therefore, the relative cost of labour will be lower in the foreign country, as well as a lower wage-rental ratio leading to a lower price in the non-traded sector and a lower price level than in the rich country.

On the other hand, other things being equal a positive risk premium or constraints to capital inflows increases the interest rate, and so, the real cost of capital, leading to lower capital-labour ratios in both sectors. Again, the lower wage-rental ratios explain the lower non-traded sector price and the lower real wage. The conclusion follows.

In areas III and IV of Figure 3, the differences between price and real wage levels have opposite signs because the productivity levels and the financial market parameters play in opposite directions. However, these two areas are only interesting from a theoretical standpoint. If a country has lower productivity, it is reasonable to assume that exchange rate risks or capital transaction costs go in the same direction. Furthermore, the poor country is usually an importer of capital. Thus, we conclude that the poor country is likely to be in area I, namely to the north-west of point V.

5. Conclusions

This paper investigates the links between price levels and real wage levels, in a conventional model, with one tradable good and one non-tradable good, while allowing for international capital mobility, exchange rate risk and productivity differences. The first conclusion stresses that, contrary to what is suggested in the traditional analysis without international capital mobility, homogeneous and neutral technological differences à la Hicks affect relative prices. A country with lower productivity, positive exchange rate risk premium or constraints to international capital inflows has a lower relative cost of labour. Therefore, in such a country the non-tradable good price and the real wage are lower.

It is widely accepted that the Purchasing Power Parity (PPP) hypothesis even in first differences, does not hold. Our results may also be seen as a contribution to a macro explanation of that puzzling empirical result.

The results of the paper also have important policy implications, namely for accession countries to the EU. An eventual convergence of lower income economies should be coupled with a real appreciation of their currencies. With a pegged nominal exchange rate, any attempt to assure a quick inflation convergence is doomed to fail. Furthermore, the paper shows that the already recognised technological catching-up that leads to real appreciation is compounded by the simultaneous liberalisation of the capital account and reductions in risk premia due to convergence plays that are already taking place in those economies. All of this calls for accession countries to design their exchange rate strategies maintaining some degree of flexibility for the coming years, even following full membership.
References


Annex

Profit maximisation in both sectors implies that capital and labour real prices are equal to their marginal productivities.

\[
\begin{align*}
(i) \quad \frac{R}{PT} &= \tau (1 - \alpha) \left( \frac{KT}{LT} \right)^{\alpha - 1} \\
(ii) \quad \frac{W}{PT} &= \tau \alpha \left( \frac{KT}{LT} \right)^{\alpha} \\
(iii) \quad \frac{R}{PN} &= v (1 - \beta) \left( \frac{KN}{LN} \right)^{\beta - 1} \\
(iv) \quad \frac{W}{PN} &= v \beta \left( \frac{KN}{LN} \right)^{\beta} \\
\end{align*}
\]

Combining these expressions for each sector, it is possible to express the relative cost between labour and capital as:

\[
\begin{align*}
(v) \quad \frac{W}{R} &= \frac{KT}{LT} \frac{1 - \alpha}{\alpha} \\
(vi) \quad \frac{W}{R} &= \frac{KN}{LN} \frac{1 - \beta}{\beta} \\
\end{align*}
\]

Dividing (ii) by (iv) and using the two previous equations, the relative prices between the two sectors could be expressed as:

\[
\begin{align*}
(vii) \quad \frac{PN}{PT} &= v \left( \frac{W}{R} \right)^{\gamma - \beta} \frac{\alpha^\alpha (1 - \alpha)^{1 - \alpha}}{\beta^\beta (1 - \beta)^{1 - \beta}} \\
\end{align*}
\]

Considering the correspondent expression for the foreign country and equation (4), equation (10) comes immediately.

On the other hand, considering consumer basket weights, the real wage could be written as:

\[
\begin{align*}
(viii) \quad \frac{W}{P} &= \left( \frac{W}{PT} \right) \left( \frac{W}{PN} \right)^{\gamma - \sigma} \\
\end{align*}
\]

Using equations (ii) and (iv), and expressions (v) and (vi), it is easy to express real wage as:

\[
\begin{align*}
(ix) \quad \frac{W}{P} &= \alpha^\alpha \beta^{1 - \gamma} \left( \frac{\alpha}{1 - \alpha} \right)^{\gamma} \left( \frac{\beta}{1 - \beta} \right)^{\beta (1 - \gamma)} \tau \left( \frac{W}{R} \right)^{\gamma - \sigma} \\
\end{align*}
\]
Equation (11) is easily obtained considering the corresponding equation for the foreign country and remembering that $\theta = \tau / \tau' = u / \delta$.

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Resumo

Preços mais baixos nos países pobres: tecnologia, risco de taxa de câmbio e mobilidade do capital

Este trabalho desenvolve um modelo que explica a correlação de Balassa, pela qual ráveis de vida mais elevados estão associados com custos de vida também mais elevados. O modelo segue uma abordagem de outros modelos e na linha das diferenças tecnológicas entre países, mas mostra que diferenças tecnológicas uniformes e neutras à Hicks podem explicar essa correlação bem como o comportamento relativo dos salários quando é introduzida a mobilidade internacional do capital. São sublinhados o papel do prêmio de risco e a relevância das restrições à mobilidade do capital. Neste contexto, chama-se igualmente a atenção para o possível conflito entre estabilidade cambial e baixa inflação para um país em crescimento acelerado. Este problema já foi importante no caso ibérico, mas está a ressurgir para os países candidatos à União Europeia, para os quais a preservação de alguma flexibilidade cambial pode ser importante.

Palavras-chave: apreciação real; inflação; convergência; diferenças de tecnologia; mobilidade do capital.

Abstract

An open-economy model is developed to explain that countries with a lower technological level will have a lower cost of living or price level. In contrast to previous models, it is shown that homogeneous Hicks neutral technological differences can affect price levels when capital mobility is introduced. Moreover, the exchange risk premium and the constraints to capital mobility play an important role in explaining price and real wage differences between poor and rich countries. At last, it becomes apparent that both low inflation and exchange rate stability may not be sustainable for a fast
growing economy. This is particularly important to the design of exchange rate strategies for countries facing an economic integration process, namely the accession countries to the European Union.

Keywords: real appreciation; inflation; convergence, differences in technology; international capital mobility.