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The Relative Price of Non-traded Goods in an Imperfectly Competitive Economy: Empirical Evidence for G7 Countries.*

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Abstract

In this paper, we consider the role of imperfect competition in explaining the relative price of non-traded to traded goods within the Balassa-Samuelson framework. Under imperfect competition in the two sectors, relative prices depend on both productivity differentials and mark-up differentials. We test this implication using a panel of sectors for the seven major OECD countries. The empirical evidence suggests that relative price movements are well explained by productivity and mark-up differentials. Unlike the original Balassa-Samuelson model, aggregate demand could affect the real exchange rate by changing the mark ups. The empirical results show that aggregate demand fluctuations lead to changes on the mark-ups.

Keywords: Balassa-Samuelson hypothesis, real exchange rate, relative prices, imperfect competition.

J.E.L. Classification: F31, F36, C23.

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1 Introduction

The relative prices of non-traded to traded goods are important in explaining real exchange rate movements and price convergence among countries. In this paper, we study the determinants of these relative prices in an economy with imperfect competition. The existing theory on this topic is based on Balassa (1964) and Samuelson (1964). In the Balassa-Samuelson framework, prices are determined only by marginal costs under the perfect competition assumption; so, variations in the relative price of the non-traded goods have to be explained by differences in productivity between sectors. At the same time, variations in aggregate demand, such as changes in fiscal policy, would not affect the relative price of non-traded goods.

In this paper, we take a closer look at the determinants of relative prices by considering the presence of market power in both traded and non-traded sectors. Unlike the Balassa-Samuelson model, in an economy with imperfect competition, prices are determined both by marginal costs and mark-ups. Hence, variations in mark-ups could amplify or dampen the effect of the variation in productivity on prices. Besides, different authors have shown that variations in aggregate demand lead to variations in mark-ups (e.g., Schmitt-Grohé (1997) and Rotermberg and Woodford (1999)), thus, the mark-up fluctuations provide a channel through which aggregate demand variations could affect the relative price of non-traded goods.

The empirical literature (e.g., De Gregorio, Giovannini and Wolf (1994), De Gregorio, Giovannini and Krueger (1994), Froot and Rogoff (1991, 1995), Canzoneri et. al. (1999), and Kakkar (2003)) has corroborated that changes in productivity in the non-tradable and tradable sectors are correlated with relative price variations. However, the empirical evidence has also indicated that variations in aggregate demand, such as changes in public expenditure, are an important determinant of relative price variations. This empirical finding cannot be explained within the Balassa-Samuelson hypothesis. However, in our model, movements in relative prices may be generated by changes in relative productivity and/or in relative mark-up. Thus, we investigate whether the effect of a shift in aggregate demand on the relative price of non-traded goods could be explained by variations in mark-ups.

To account for the empirical relevance of imperfect competition in explaining relative price movements, we study relative prices using a panel data for the G-7 economies during the1970-90 period. Our empirical results indicate that there exists a positive correlation between relative prices and relative mark-ups in the non-traded and traded sectors. An increase in the non-traded sector mark-up relative to the traded sector mark-up raises the relative price of the non-traded goods. Also, as in the previous literature (e.g., Bergstand (1991), De Gregorio, Giovannini and Wolf (1994), Muscatelli and F. Spinelli (1999), and DeLoach (2001)), we find evidence of the Balassa-Samuelson effect: an increase in the difference between productivity in the traded and non-traded sectors increases the relative price of non-traded goods

Engel (1999) shows that the relative price of non-traded goods to traded goods accounts for a small amount of the total real exchange variations in U.S. However, Betts and Kehoe (2006) found that movements in the relative price of the non-traded goods are closely related with the movements in the real exchange rate in the U.S. and the statistical measures of this relationship depend on several factors, such as the choice of the price series or the trade partner. The relationship is stronger the more important is the intensity of trade between the U.S. and trade partner.[1]. Recently, the existence of inflation differentials in the European Monetary Union has highlighted the relevance of the different evolution of prices in traded and non-traded sector (see European Central Bank (1999)). The inflation in the traded sector (manufacturing) tends to converge as a consequence of the introduction of the Euro and the single market. Inflation in the non-traded sector (services) tends to be different among countries. The Balassa-Samuelson theory suggests that these variations in inflation are explained by the gap in productivity between the traded and non-traded sector (supply-side factors), but, demand factors, such as changes fiscal policy, business cycles etc., are not so relevant. However, there is uncertainty about the extent to which the inflation differences are caused by productivity (European Commission 2002). Our results indicate that the different mark-up behaviour in services and manufacturing could be considered as important determinant of the inflation differentials. Assessing the sources of inflation differentials is crucial to macro-policy (e.g., Blanchard (2001) and Sinn and Ruetter (2001). Since demand factors could influence the mark-ups, we also analyze the role of different macroeconomic variables that could affect the relative prices through variations in mark-ups. We show that relative productivity is correlated with relative mark-ups, thus, the evolution of the mark-ups dampens the Balassa-Samuelson effect. Moreover, we estimate the effect of aggregate demand proxies, like inflation and

[1] According to Betts and Kehoe (2001) fluctuations in relative prices of nontraded goods explain around one-third of the variation of the bilateral real exchange rate in a sample of 52 countries.

public spending, on relative mark-ups, we show that a fiscal expansion could affect relative prices by changing relative mark-ups.

The paper proceeds as follows. In Section 2, we introduce imperfect competition in the Balassa-Samuelson framework and discuss the effect of variations in productivity and mark-ups on the real exchange rate. In Sections 3 and 4, we describe the data and the empirical framework underlying our later empirical results. In Section 5, we report regression results for relative prices, productivity and market power, and the macroeconomic effects of fiscal expenditure and output fluctuations on the mark-ups. Finally, Section 6 concludes the paper.

2 Relative prices, productivity and mark-ups

We consider a small open economy that produces traded (T) and non-traded goods (N). Movements in the real exchange rate (q) can be decomposed into two components: deviation in the law of one price in the traded sector and variation in the relative price of non-traded goods. We consider the log of the real exchange rate

$$\log q = s + p^* - p, \tag{1}$$

where s is the log of the nominal exchange rate, p is the log of the price index, and "$*$" refers to foreign variables. We define the price index as a weighted average of traded and non-traded good prices: $p = (1-\phi)\log P_T + \phi \log P_N$. Thus, the real exchange rate is divided in two components:

$$\log q = s + \log P_T^* - \log P_T + \phi^*(\log P_N^* - \log P_T^*) - \phi\,(\log P_N - \log P_T)\,. \quad (2)$$

In the paper, we focus on the determinants of variations in the relative price of non-traded goods. In the existing literature, some authors test the Balassa-Samuelson effect on real exchange rates (e.g., Canzoneri, Cumby and Diba (1999) and Muscatelli and Spinelli (1999)), while other authors consider only the relative price for non-traded goods (e.g., Bergstrand (1991), De Gregorio, Giovannini and Wolf (1994), DeLoach (2001) and Kakkar (2003)). We prefer this second approach since the relationship between mark-up, productivity and relative prices could be obscured by other factors that affect the real exchange rate, such as fluctuations in the nominal exchange rate, which, according to Engel (1999), are predominant. Moreover Betts and Kehoe (2006) show that relation between is real exchange rate and relative price of non-traded goods is affected by several factor like: the method to detrend the variables, the prices index used etc.[2].

According to Balassa (1964) and Samuelson (1964), the relative price of non-traded goods is only explained by variations in the relative marginal cost, generated by variations in productivity. Here, we keep the basic Balassa-Samuelson assumptions, but we introduce imperfect competition in both sectors. Our results do not depend on the way in which imperfect competition is introduced. We use a general model of imperfect competition,

[2] Imbs, Mumtaz, Ravn and Rey (2002) offer an explanation for the persistent deviation of the law of one price found by Engel (1999). They observe a higher heterogeneity among the traded goods than among the nontraded goods. This heterogeneity induces an aggregation bias that accounts for the observed higher persistence in the relative price of the traded good and its dominant role in explaining the exchange rate variability.

where firms in both sectors have market power to fix prices over marginal cost. The mark-ups could be affected by different factors: changes in market concentration, elasticity of demand, etc. However, the key point is that firms in the non-traded sector only face demand from the domestic market and they are sheltered from international competition, while firms in the traded sector also face demand from abroad and they experience the international competition. Thus, we should expect mark-ups to evolve differently in each sector. At the same time, mark-ups will react differently to macroeconomic shocks. For instance, in the case of an increase in aggregate demand, it will be easier for firms in the non-traded sector to collude in order to raise prices.

As in the original Balassa-Samuelson model, firms in both sectors produce output through a constant returns to scale production function

$$y_i = A_i F_i(K_i, l_i), \qquad i = T, N, \tag{3}$$

where the subindex T refers to the traded sector, and N refers to the non-traded sector. The term A_i represents the total factor productivity. Capital (K) and labour (l) can move freely across sectors. Therefore, firms across sectors pay the same wage, w. Finally, the real interest rate, r, is determined in the international capital market, given that the economy is small and there is international capital mobility. However, we depart from the basic Balassa-Samuelson conditions since firms in each sector have market power to fix their prices. Firms set their prices, p_j, over marginal cost, $C(w, r)$.

$$p_i = \mu_i C(w, r). \tag{4}$$

The mark-up μ_i is defined as the ratio of price over marginal cost[3]. Since firms use a constant returns technology, the marginal cost is independent of the level of production. Using cost minimization, the marginal cost is represented as a function of input costs and the marginal productivity of capital and labour.

$$C(w,r) = \frac{r}{f_i'(k_i)} = \frac{w}{\big(f(k_i) - k_i f_i'(k_i)\big)}. \tag{5}$$

Here, we have used the constant returns to scale property of the production function to write the marginal productivity of capital and labour in terms of the capital labour ratio k_i and per worker production function $f(k_i)$. Then, we use the profit maximization condition, equation (4), to derive the factor market equilibrium in the economy:

$$p_N A_N f_N'(k_N) = \mu_{_N} r, \tag{6}$$

$$p_N A_N \left(f_N(k_N) - k_N f_N'(k_N) \right) = \mu_{_N} w, \tag{7}$$

$$p_T A_T f_T'(k_T) = \mu_{_T} r, \tag{8}$$

$$p_T A_T \left(f_T(k_T) - k_T f_T'(k_T) \right) = \mu_{_T} w. \tag{9}$$

This set of equations ((6), (7), (8) and (9)) alone determines the relative price in the non-traded sector to the trade sector. Therefore, the relative price of

[3]For instance, if we consider monopolistic competition, following Dixit-Stiglitz (1977), where each industry consists of many monopolistic competitors, which produce symmetric varieties, the mark-up would be determined by the elasticity of demand.

the non-traded good is only determined by the mark-ups and the marginal costs. The proof is simple, from equation (8) we solve the capital labour ratio in the traded sector, k_T, as a function of the international interest rate and the mark-up in this sector. After that, we compute the wage w as function of the international interest rate and mark-up in the traded sector by substituting k_T in equation (9). Given the wage as a function of r, μ_T and p_T, we can solve for k_N and p_N from equations (6) and (7). Thus, we express the evolution of the relative price of the non-traded sector as a function of the mark-ups in the traded and non-traded sector. For the case of perfect competition ($\mu_N = \mu_T = 1$), this result was obtained by Balassa (1964) and Samuelson (1964). According to the Balassa-Samuelson hypothesis, the variations in the relative price of non-traded goods should be explained by variations in total factor productivity. However, under imperfect competition the variation in the mark-up is an important determinant of the real exchange rate. From the above equilibrium conditions (equations (6), (7), (8) and (9)), we can compute the effect of a variation in the mark-ups and productivity on the relative price of the non-traded good as

$$\frac{\Delta p_N}{p_N} - \frac{\Delta p_T}{p_T} = \left(\frac{\alpha_N}{\alpha_T} \frac{\Delta A_T}{A_T} - \frac{\Delta A_N}{A_N} \right) - \left(\frac{\alpha_N}{\alpha_T} \frac{\Delta \mu_T}{\mu_T} - \frac{\Delta \mu_N}{\mu_N} \right), \tag{10}$$

where $\alpha = \frac{F_L L}{F}$ denotes the labour-output elasticity in each sector. Note that variations in mark-ups and productivity have an opposite effect on the relative price of the non-traded sector. An increase in the mark-up in the non-traded sector increases the price of the non-traded good. We have to take into account that variations in markups produce changes in prices as long as the movement in the mark-up in one sector is not offset by the movement in the markup in the other sector. The effect of an increase in the mark-up in the traded sector depends on the capital labour ratio in each sector. Since an increase in traded sector mark-up reduces real wages, the effect on the relative price is going to be bigger when the non-traded sector is labour intensive.

In the original Balassa-Samuelson framework ($\mu_N = \mu_T = 1$), as productivity grows faster in the traded sector, relative prices increase, since greater wages raise marginal costs in the non-traded sector over the ones in the traded sector that simply match productivity growth with wage growth. At the same time, variations in aggregate demand (like changes in fiscal policy) cannot affect relative prices[4]. However, in our model, relative prices also depend on the different evolution in mark-ups in each sector. Therefore, variations in demand can affect the relative price of non-traded goods by changing the mark-ups.

A satisfactory theory to explain the evolution of the relative price of the non-traded good cannot neglect the effect of the variation in the mark-up on prices. At the same time, it has to distinguish between the effect of a variation in productivity and a variation in the mark-up on prices. Our first objective is the estimation of equation (10), so that we can distinguish between the effect of variation in productivity and mark-ups on the relative prices. Secondly, as we can be seen in this equation, changes in mark-ups

[4]In a model with perfect competition, it is possible to have demand shocks affecting the relative price of non-traded goods, but we need to departure from the Balassa-Samuelson assumptions and to consider imperfect capital mobility (e.g., Rogoff (1992) and De Gregorio, Giovannini and Wolf (1994))

only change relative prices when they follow different paths in each sector. It is then important to analyze the reasons that could explain the different evolution in the mark-up in the traded and non-traded sector.

There are several reasons why mark-ups can change as a consequence of demand or productivity shocks[5] For instance, an increase in aggregate demand can induce firm entry, therefore increasing competition. Moreover, since firms in the traded sector have to compete in the international market, we should expect different types of shocks to have different effects on traded and non-traded sector mark-ups. Thus, mark-ups in the traded sector are more affected by the external demand and the competition in international market than by domestic factors. Although it could be difficult to identify the different factors that could affect the mark-up, it worth noting that if demand or productivity shocks have different effects in each sector, they would produce changes in mark-up differentials. Therefore, the mark-ups variations will transmit the shock to the relative price of non-traded goods.

Finally, our model offers an alternative explanation for the observed positive relationship between the increase in public spending and non-traded sector prices (e.g., De Gregorio, Giovannini and Wolf (1994), Froot and Rogoff (1991), Chinn and Johnston (1997), and Strauss (1999)). Variations in mark-ups generated by a fiscal expansion could affect relative price of non-traded good, we aim to study whether the mark-ups variations could explain this observed positive relationship .

[5] Rotermberg and Woodford (1999) summarize the recent empirical literature on mark-ups. These authors show that the mark-ups in U.S. tend to be procyclical.

3 Data

The data used in the empirical analysis come from the OECD International Sectoral Database for G-7 countries from 1970 to 1990. The annual dataset includes output in nominal and real terms, gross capital stock at constant prices in home currency and in dollars, and the number of labour hours for a set of sectors. Sectoral prices are computed as implicit deflators. We follow De Gregorio, Giovannini and Wolf (1994), and Canzoneri et. al. (1999)[6] to group manufacturing and agriculture into the traded category and the service sectors into the non-traded category. Also, the data set includes information about public spending and inflation coming from OECD Annual National Accounts.

4 Empirical framework

In order to consider the empirical relevance of market structure and productivity in explaining relative prices for the G-7 economies, we use the following panel data to test equation (10).

$$P_{k,t} = \lambda_k + \beta_1 R_{k,t} + \beta_2 M_{k,t} + \varepsilon_{k,t} \tag{11}$$

[6] We consider following traded sectors: Agriculture, hunt., for. & fishing (AGR), Mining and quarrying (MID), Food, beverages and tobacco (FOD), Textiles, wearing app. & leather (TEX), Wood & wood prod., incl. furniture (WOD), Paper & paper prod., print. & pub. (PAP), Chemicals & chemical petroleum, ...(CHE), Non-metallic mineral products, ... (MNM), Basic metal industries (BMI), Fabricated metal products, ... (MEQ), Other manufacturing industries (MOT). The nontraded sectors are: Electricity, gas and water (EGW), Construction (CST), Transport, storage & communication (TRS), Finance, ins., real est., bus. ser (FNI), Community, social & personal serv. (SOC)

where k denotes country, t refers to time, and $P_{k,t} = \Delta\ln(P_t^N) - \Delta\ln(P_t^T)$, $R_{k,t} = \frac{\alpha_N}{\alpha_T}\Delta\ln A_t^T - \Delta\ln A_t^N$, $M_{k,t} = \frac{\alpha_N}{\alpha_T}\Delta\ln\mu_t^T - \Delta\ln\mu_t^N$, $\varepsilon_{k,t}$ is a stochastic i.i.d. term and λ_k is a country specific effect on relative prices[7]. The empirical significance of the common coefficients across countries β_1 and β_2 could support or not the Balassa-Samuelson hypothesis under imperfect competition. To estimate the model, we need to compute these variables from our data set.

First, we need to measure the productivity and markup in each sector. Hall (1988) showed, that under imperfect competition, we cannot use the Solow residual to measure productivity. The reason is that marginal productivity is not equal to wages (see equation (7)). Therefore, we cannot use the labour share in income to compute the labour-output elasticity. To illustrate this point, the Solow residual (SR) is equal to $SR = \ln Y - s_L\ln(K/L)$, where s_L denotes the labour share. From equation (7), the labour-output elasticity (α) is equal to $\alpha = \mu s_L$, so the Solow residual is only an accurate productivity measure when there is perfect competition, $\mu = 1$. Otherwise, the Solow residual includes the following error: $SR = \ln A + (\mu - 1)s_L\ln(K/L)$[8]. Based on this equation, Hall (1988) proposed a method to estimate the markup and to measure productivity. However, Hall's method only allows the estimation of constant mark-up or the effect of other variables, like business cycles fluctuations (e.g., Rotemberg and Woodford (1999)) on the mark-ups.

[7]Temporal effects could also be included in the model specification, but they are not statistically significant with our data set.

[8]Moreover, the Solow residual, under imperfect competition is affected by variations in output generated by variations in demand. Therefore, the Solow residual is not suitable to test the Balassa-Samuelson effect since it cannot be used to distinguish the effect of variations in demand or productivity on prices.

However, to test our model we need mark-up variations along time. Then, to compute productivity and mark-ups for each country, we first specify a constant returns Cobb-Douglas production function for every sector in each country producing tradable or non tradable goods at time t as

$$Y_{j,t} = A_{j,t} L_{j,t}^{\alpha_i} K_{j,t}^{(1-\alpha_i)} \qquad 0 < \alpha_i < 1, \tag{12}$$

the subindex j refers to the different sectors within the traded or non-traded group, and $Y_{j,t}$, $K_{j,t}$ and $L_{j,t}$, denote real output, real value of capital stock, and labour hours, respectively. $A_{j,t}$ represents total factor productivity for sector j at period t, and α_i denotes the elasticity of output with respect to labour for tradable or non tradable goods if $i = T$ or $i = N$, respectively[9].

Changes in the productivity of sector j at time t can be easily obtained from the production function

$$\Delta \ln A_{j,t} = \Delta y_{j,t} - \alpha_i \Delta l_{j,t}, \tag{13}$$

where $y_{j,t} = \ln\left(\frac{Y_{j,t}}{K_{j,t}}\right)$ and $l_{j,t} = \ln\left(\frac{L_{j,t}}{K_{j,t}}\right)$. However, before constructing changes in productivity from equation (13), it is necessary to have an estimation of the output-labour elasticity for tradable and non tradable goods, α_i. We estimate the output-labour elasticity from the production function instead of using labour share to compute total factor productivity. The production function is estimated for tradable and non tradable goods from a panel data of sectors included in each of the two categories for each country. We assume that the log form of total factor productivity for any sector j at

[9] The output elasticity is assumed constant over sectors included in the same category (tradables or non-tradables) because of short length of time series available for each sector.

time t follows the following AR(1) process

$$\ln(A_{j,t}) = \delta_j + u_{j,t}, \tag{14}$$

$$u_{j,t} = \rho u_{j,t-1} + \eta_{j,t} \quad 0 < \rho \leq 1,\ \eta_{j,t} : i.i.d. \tag{15}$$

where δ_j is a specific effect on productivity for a sector j included in anyone of the two categories.

In order to compute the mark-ups, we use the firms' profit maximization condition (equations (7) and (9)) for the Cobb-Douglas production function[10]

$$P_{j,t}\alpha_i \left(\frac{Y_{j,t}}{L_{j,t}}\right) = \mu_{j,t} w_{j,t}, \tag{16}$$

where $P_{j,t}$, $\mu_{j,t}$, and $w_{j,t}$ are respectively the price, the markup and the wage level for sector j at time t. From this equilibrium condition, we can calculate how mark-ups change over time for sector j as

$$\Delta \ln \mu_{j,t} = \Delta \ln(P_{j,t}) + \Delta \ln \left(\frac{Y_{j,t}}{L_{j,t}}\right) - \Delta \ln(w_{j,t}). \tag{17}$$

To test our model, we need to construct an aggregate series of productivity and mark-up variations for traded and non-traded sectors. With this aim, we use as aggregation criteria the sector output share, $s_{j,t}$

$$s_{j,t} = \frac{Y_{j,t}}{\sum_{j=1}^{H} Y_{j,t}}, \tag{18}$$

[10]Note that the other equilibrium condition states that the value of the marginal product of capital equals the mark-up multiplied by the cost of capital. We do not use this second condition because the estimation of the cost of capital for each sector is more inaccurate than the wage estimation, which is given by the database.

where H is the number of sectors producing traded or non-traded goods. For instance, changes in the productivity level for the non-traded sector for any country are obtained by aggregating the sectoral productivity changes as $\Delta \ln A_{j,t}$

$$\Delta \ln A_t^N = \sum_{j=1}^{H} s_{j,t} \Delta \ln (A_{j,t}) \quad (19)$$

Finally, we measure the price in each sector j in the database by GDP deflator. To obtain the aggregate price changes for the traded and non-traded sector, we use the same aggregation criteria than for productivity and markups.

5 Results

Estimates of the output labour elasticities (α_i) from the production function (12) for traded and non-traded sectors in each country are presented in the first two columns of Table 1. Both coefficients are significant and indicate that the non-traded output labour elasticity is for most of the countries above the traded output labour elasticity, which reflects the relatively well-known fact that service industries are more labour intensive than manufacturing industries. Using the output labour elasticities, we can obtain the changes in productivity for the two sectors and the relative productivity changes. Average values for relative changes in productivity, mark-ups and prices are presented in columns (3)-(5) of Table 1. Figure 1 plots the growth rate of relative prices and the (weighted) growth rates of the relative productivity and relative markup variables for all countries during the sample period. A first glance at the data suggests a positive relationship between the (weighted) growth rate of the relative productivity and relative prices, and a negative relationship between the (weighted) growth rate of the relative markups and relative prices.

INSERT TABLE 1 HERE

INSERT FIGURE 1 HERE

In Table 2, we report the estimates for the relative prices equation (11)[11]. One concern in the estimation of equation (11) is that variations in mark-ups are correlated with price changes at the sector level by construction of equation (17). This problem of simultaneity would mean that OLS estimates would be biased. To address this problem, we have used a GMM estimator using the set of instruments suggested by Arellano and Bond (1991, 1998). First, we present empirical evidence in columns (1)-(3) obtained by OLS and assuming that λ_k remains constant for all countries. The estimates indicate that both relative changes in productivity and demand are important in explaining relative price movements and have the expected sign. The effect of relative productivity, taking it independently of demand conditions, regression in column (3), has a similar size to that in De Gregorio, Giovannini and Wolf (1994). Likewise, the coefficient on productivity and on mark-up differentials increases when the two effects on relative prices are taken together. Moreover, the serial correlation tests suggest that the estimates in columns (1) and (3) are well specified. Assuming that λ_k takes a different value for each country, we reach similar conclusions using the within-groups estimator

[11] Augmented Dickey-Fuller and Phillips-Perron unit root test for the series in the relative prices regression reject the null hypothesis of a unit root for each country. Also, KPSS test is unable to reject the null hypothesis of stationarity. Therefore, the series in our regression equation are stationary.

in column (4), although the m1 statistic indicates an autocorrelation problem in the residuals

On the other hand, columns (5) and (6) report GMM estimates of the relative prices equation corresponding to the one-step Arellano-Bond (1991,1998) procedure. We treat the two explanatory variables as endogenous and instrument them using t-1 and t-1 to t-3 lags of these variables to address the simultaneity problem. Comparing the GMM with the OLS results in column (1) we can check that the estimated coefficients are quite similar, even though the OLS estimates of the coefficients are a little upwards biased . The Sargan and serial correlation test provide no evidence of bad specification. For the sake of robustness, we present estimates of the relative prices equation in first differences using OLS and GMM in columns (7)-(9). Column (7) reports the OLS estimates of the equation in differences, which are very similar to the ones in column (1), except for the productivity coefficient which is larger. Columns (8) and (9) report GMM estimates which are in agreement with those of the OLS estimator. Thus, empirical evidence in columns (5) and (6) supports the hypothesis that productivity differentials have a positive and significant effect on the relative prices. On the contrary, mark-up differentials have a significant but negative effect on the relative price of non-traded goods.

To summarize, the results of the empirical application of the Balassa-Samuelson hypothesis under imperfect competition for G-7 countries suggest that the relative prices of non-traded to traded goods are explained by both productivity and mark-ups. Increases in the traded sector productivity relative to non-traded sector productivity raise the relative prices of non-traded goods. Also, increases in non-traded relative to traded sector mark-ups increase the relative prices of non-traded goods, although in a lower proportion than an increase in relative productivity[12].

INSERT TABLE 2 HERE

5.1 Mark-up fluctuations

In this section, we study the empirical determinants of the relative mark-ups ($M_{k,t} = \frac{\alpha_N}{\alpha_T} \Delta \ln \mu_t^T - \Delta \ln \mu_t^N$) for each country. The Balassa-Samuelson hypothesis implies that variations in aggregate demand cannot affect relative prices. However, under imperfect competition, since aggregate demand can affect the mark-ups, variations in aggregate demand can affect the relative price. We focus our analysis mainly on macroeconomic variables that could affect the relative price of the non-traded sector through variations in mark-ups. With this aim, we use the following panel data model

$$M_{k,t} = \omega_k + \theta_1 R_{k,t} + \theta_2 (G/Y)_{k,t} + \theta_3 \Pi_{k,t} + \theta_4 y_{k,t} + \epsilon_{k,t} \tag{20}$$

where k denotes country, $R_{k,t} = \frac{\alpha_N}{\alpha_T} \Delta \ln A_t^T - \Delta \ln A_t^N$ is the relative productivity, $(G/Y)_{k,t}$ represents the ratio of public spending relative to GDP, $\Pi_{k,t}$ is the rate of inflation, $y_{k,t}$ is the output growth and $\epsilon_{k,t}$ is a stochastic i.i.d. term. As $\Pi_{k,t}$ and $y_{k,t}$ are non stationary, we take these variables in first differences. The empirical results are presented in Table 3.

[12] The estimation for each country of the relative prices equation by GMM using one and two period lagged values of the independent variables as instruments leads to similar conclusions. However, we do not present individual country results because the short length of the series for each country does not guarantee the robustness of the results, in contrast to the panel data evidence.

INSERT TABLE 3 HERE

To understand the results, we should have in mind that an increase in the relative mark-up $M_{k,t}$, will reduce the relative price of nontradables, the coefficient associated to $M_{k,t}$ in regression (11) is negative.

First, we consider the effect of productivity on the mark-up in each sector. Under imperfect competition, firms will not always pass all reductions in costs, as a result of higher productivity, into prices. Therefore, the evolution of mark-ups could reinforce or compensate the Balassa-Samuelson effect. In Table 3, we observe that differences in productivity have a positive and significant effect on the differences in mark-ups between sectors. Thus, the evolution in the mark-up dampens the effect of differences in productivity on prices. The reason is that large differences in productivity between sectors are associated with large differences in the rate of variation of the mark-ups between these sectors, $M_{k,t}$, which tend to reduce prices. Then, the evolution of the mark-up compensates the effect of productivity differentials on prices.

We consider the effect of fiscal policy on the relative mark-up. Different authors have shown that an increase public spending raises prices in the non-traded sector relative to the traded sector. (e.g., Froot and Rogoff (1991) and De Gregorio, Gionannini and Wolf (1994)). As we have said, this effect cannot be explained within the original Balassa-Samuelson framework. Our model suggests that variations in public spending could affect prices by changing mark-ups. Our empirical result indicates that public spending tends to increase the difference in mark-ups between the traded and non-traded sectors $M_{k,t}$, and thus reduces relative prices. Therefore, an expansion in government spending tends to reduce the relative price of non-tradables by changing the mark-ups, so the variations in the mark-up tend to dampen the upward pressure of a fiscal expansion on the relative price of the non-traded sector.

The inflation rate and output growth could be considered as a proxy for the evolution of aggregate demand (De Gregorio, Gionannini and Wolf (1994) show that there is positive correlation between inflation and the relative price of nontradables). Several authors have shown that inflation itself affects the mark-ups. Bénabou (1992) argues that inflation lowers the mark-up, since inflation leads to greater consumer search which increases competition. Also, empirical studies show that there is a negative relationship between mark-up and inflation (e.g., Bénabou (1992) and Banerjee and Russell (2000)). However, we find that the rate of inflation and output growth do not have a significant effect on the relative mark-up.

6 Conclusion

In this paper, we have introduced imperfect competition in the standard Balassa-Samuelson framework. We have shown that the relative price of traded to non-traded goods is determined by both productivity and the mark-ups.

We have also estimated the effect of a variation in productivity and mark-ups on the relative prices. We have shown that differences in productivity and mark-ups have significant and opposing effects on the relative price of the non-traded sector. Faster growth in productivity in the traded sector, relative to productivity growth in the non-traded sector, increases the relative price in the non-traded good. At the same time, our results support the hypothesis that the mark-ups in the traded and the non-traded sectors follow different paths, generating variations in the relative prices of non-traded goods

Besides, we have analyzed the reasons for the variation in mark-ups in each sector. Variations in mark-ups constitute a new channel through which variations in aggregate demand could affect the real exchange rate. We have shown that demand side variables, like government spending, have a significant effect on mark-ups in the traded and non-traded sector. Moreover, changes in mark-ups dampen the effect of a variation in productivity on prices since a higher difference in productivity is associated with a higher difference in mark-ups.

These results suggest a number of future lines of research. It could be interesting to study the role of the mark-ups in the propagation of business cycle fluctuations since the mark-ups could amplify or reduce the effect of shocks in productivity on prices. It would also be interesting to analyze the reasons for the variation in mark-ups in each sector in more detail. In addition, one could consider different measures for the variation in fiscal policy. Finally, one could study if the evolution in the mark-ups explains how different inflation rates in the service sector could generate differential inflation rates among countries in Euroland.

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TABLE 1

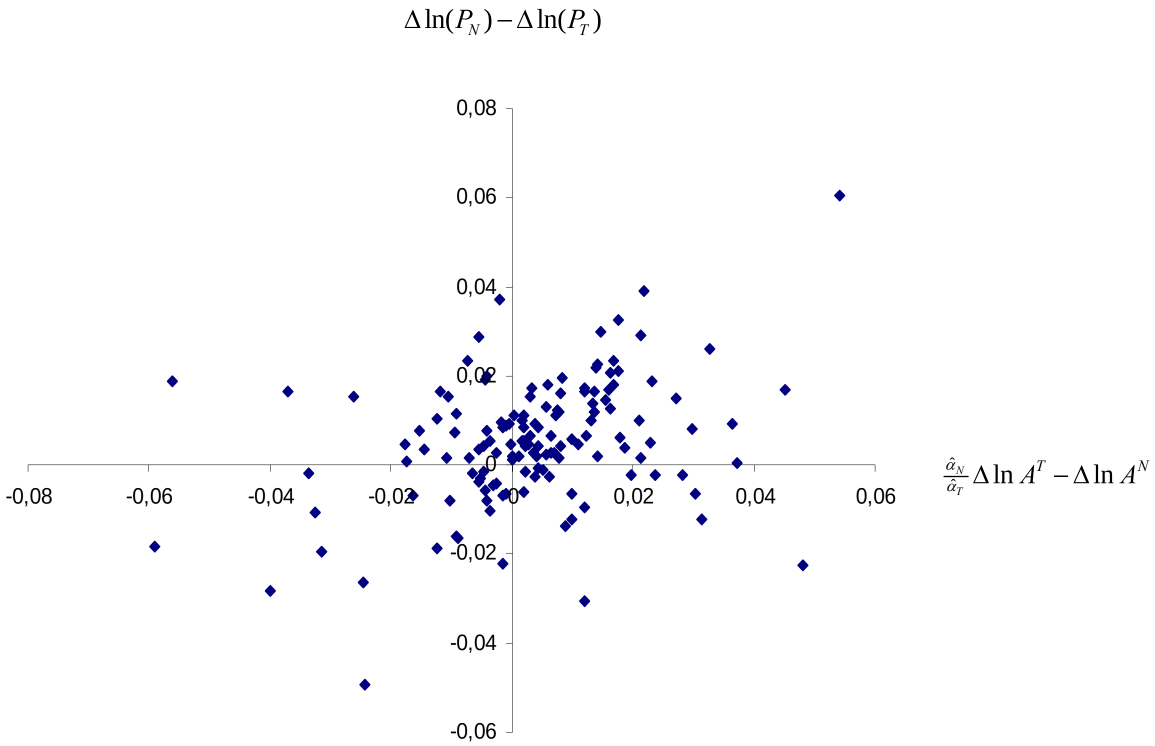
Estimates of elasticities and relative productivities, markups, and prices

	$\hat{\alpha}_T$	$\hat{\alpha}_N$	$\frac{\hat{\alpha}_N}{\hat{\alpha}_T}\Delta\ln A^T - \Delta\ln A^N$	$\frac{\hat{\alpha}_N}{\hat{\alpha}_T}\Delta\ln\mu^T - \Delta\ln\mu^N$	$\Delta\ln(P_N) - \Delta\ln(P_T)$
US	0.7333	0.7694	0.008289	0.004515	0.005861
	(11.03)	(11.73)	(0.0144)	(0.0090)	(0.0158)
CANADA	0.4953	0.5360	0.001619	0.007602	-0.002912
	(9.03)	(9.46)	(0.0229)	(0.0281)	(0.0192)
JAPAN	0.4130	0.7310	0.001198	0.000283	0.011777
	(7.28)	(20.08)	(0.0240)	(0.0181)	(0.0071)
GERMANY	0.3983	0.4088	0.001689	-0.002285	0.002494
	(5.27)	(6.02)	(0.008)	(0.0090)	(0.0061)
FRANCE	0.7175	0.2315	-0.001881	-0.001705	0.003441
	(53.22)	(2.92)	(0.0060)	(0.0064)	(0.0070)
ITALY	0.4550	0.5628	0.010027	-0.000180	0.011032
	(5.06)	(6.86)	(0.0128)	(0.0151)	(0.0105)
UK	0.3566	0.5268	0.002876	0.002238	0.005282
	(8.02)	(4.79)	(0.0196)	(0.0303)	(0.0194)

NOTE: The first two columns show the estimation of the output labour elasticities from the production function (9) for tradable and non tradable sectors for G-7 countries using a panel date of traded and non-traded sectors for the period 1970 to 1990. T-statistics in parentheses are robust to heteroskedasticity. Columns (3) to (5) report time average values for (weighted) growth rates of the relative productivity, (weighted) growth rate of the relative markups, and growth rates of the relative prices (in parentheses standard deviations).

FIGURE 1

Price differentials vs. productivity and markup differentials.



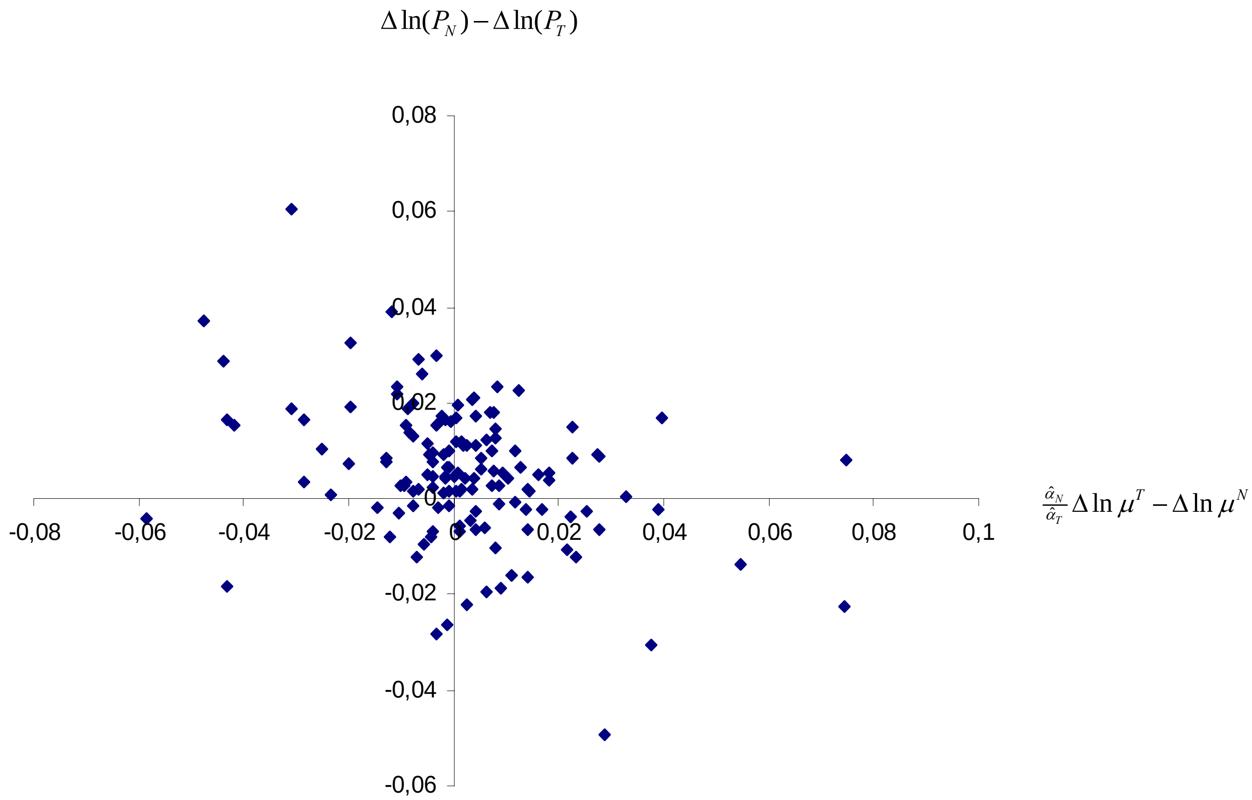


TABLE 2

Estimates of the relative prices equation: $P_{k,t} = \lambda_k + \beta_1 R_{k,t} + \beta_2 M_{k,t} + \varepsilon_{k,t}$

	OLS			Within-groups	GMM (all variables in levels)		GMM (all variables in first differences)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Instruments					(t-1)	(t-1)-(t-3)	OLS	(t-1)	(t-1)-(t-3)
λ	0.0038 (2.55)	0.0056 (3.28)	0.0040 (2.24)		0.0039 (2.34)	0.0039 (2.52)			
$R_{k,t}$	0.5584 (6.59)		0.2983 (2.49)	0.5407 (6.23)	0.5266 (3.94)	0.5446 (6.09)	0.6027 (7.78)	0.6006 (5.67)	0.6019 (8.14)
$M_{k,t}$	-0.5033 (-4.12)	-0.2720 (-5.18)		-0.4881 (-4.33)	-0.4822 (-3.86)	-0.4937 (-4.11)	-0.5091 (-4.18)	-0.4917 (-4.68)	-0.4814 (-3.64)
Sargan test					0.089	0.163		0.032	0.188
df					36	106		34	100
Wald test	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
m1	0.069	0.038	0.073	0.152	0.070	0.070	0.052	0.061	0.051
m2	0.439	0.587	0.930	0.344	0.463	0.443	0.263	0.309	0.306

NOTE: The sample period for the G-7 countries begins in 1970 and ends in 1990, given a total of 20 annual observations of changes in relative prices, productivity and markups for each country. All regressions are estimated using DPD98. T-Statistics in parentheses are robust to general cross-section and time series heteroskedasticity. The Sargan statistic tests the validity of overidentifying restriction for GMM estimators. df are the degrees of freedom of the Sargan test. The Wald statistic is a test for the joint significance of the independent variables under the null of no relationship. m1 and m2 are the p-values from tests for first and second order serial correlation robust to heteroskedasticity. (See Arellano and Bond (1991, 1998) for further explanations).

TABLE 3

Estimates of the variations in mark-ups:

$$M_{k,t} = \omega_k + \theta_1 R_{k,t} + \theta_2 (G/Y)_{k,t} + \theta_3 \Delta\Pi_{k,t} + \theta_4 \Delta y_{k,t} + \varepsilon_{k,t}$$

	(1)	(2)	(3)	(4)
$R_{k,t}$	0,5587	0.5528	0.5254	0.4870
	(6,60)	(4.28)	(3.77)	(3.47)
$(G/Y)_{k,t}$	0.3795	0.4294	0.4258	0.4404
	(2.12)	(2.29)	(2.12)	(2.27)
$\Delta\Pi_{k,t}$		0.0572		0.1816
		(0.38)		(1.43)
$\Delta y_{k,t}$			0.1193	0.2222
			(0.85)	(1.59)

NOTE: The sample period for the G-7 countries begins in 1970 and ends in 1990, given a total of 20 annual observations of changes in relative productivity, markups, public expending to GDP, rate of inflation and output growth for each country. T-Statistics in parentheses are robust to general cross-section and time series heteroskedasticity.

FIGURE 2

(Weighted) growth rates of the relative productivity vs. (weighted) growth rate of the relative markups