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Purchasing Power Parity and New Trade Theory

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Abstract

This paper theoretically derives and empirically tests the implications of a new trade theory framework for the systematic movements in the real exchange rate. It focuses on the effect of imperfect substitutability of tradables and on the importance of competitiveness, for which we construct an original proxy. Using a panel dynamic OLS estimation of nine bilateral US dollar real exchange rates, we derive long-run coefficients for relative productivity and competitiveness in the tradable and non-tradable sectors, controlling for standard macroeconomic variables. The implications of imperfect substitutability of tradables fit the data better than the standard neoclassical assumption of price equalization. Our new measure of competitiveness is statistically significant in explaining deviations from PPP.

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Keywords: New trade theory, real exchange rates, purchasing power parity, productivity differentials, the PPP puzzle

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I. Introduction

This paper stresses that some implications of new trade theory are relevant in improving our understanding of the long run behavior of the real exchange rate and of deviations from purchasing power parity (PPP). In particular, we focus on the role of: (1) imperfect substitutability of internationally traded goods and (2) different levels of competitiveness (or of economies of scale) in different countries. We first develop a "new" trade theory model with different productivities and elasticities of substitution in each of the tradable and non-tradable sectors of two countries. We then test the implications of our model for the impact on the real exchange rate of the levels of productivity and competitiveness in each sector. A new measure of competitiveness is constructed on the basis of our model.[2]

The failure of PPP is neatly summarized by the so-called PPP puzzle (Rogoff (1996)) which indicates that the mean reversion evidenced in CPI-based real exchange rates is too slow to be consistent with PPP. Empirical work has shown that macroeconomic variables, such as the relative real interest rate and relative net foreign assets positions, as well as relative productivity levels in the tradables and non-tradables sectors (the so called Balassa-Samuelson effect) are important in explaining deviations from PPP.[3] For example, the Balassa-Samuelson effect suggests that in the presence of price equalization of tradables, productivity of tradables appreciates the real exchange rate via its positive impact on wages—and prices of non-tradables—while productivity of non-tradables depreciates the real exchange rate via its negative impact on prices of non-tradables. Hence, it suggests that changes in the real exchange rate should be accounted for by changes in the internal price ratio (that is, the domestic price ratio of traded to non-traded goods, relative to the one in the foreign country).

However, Engel (1993,1999) has demonstrated that the source of systematic movements in real exchange rates seems to come from movements in the relative price of traded goods, rather than the internal price ratio (see also Engel and Rogers (1996)). There are a number of theoretical explanations for the persistence of the deviations of relative prices of traded goods across countries. One is in terms of the frictions introduced into international trade by transactions costs (see Obstfeld and Rogoff (2000)), such as transportation costs, tariffs and non-tariff barriers, and some empirical support has been offered for this interpretation (see for example Obstfeld and Taylor (1997)). Another explanation for this persistence is in terms of the pricing to market behavior of multinational firms, particularly when they engage in local

[2] In "new" trade theory models, the higher the demand elasticity of susbstitution, the lower the markup and the economies of scale, in equilibrium. We denote such enviroment as more competitive.

[3] For recent contributions, see, *inter alia,* Lane and Milesi Ferretti (2000), Obstfeld and Rogoff (1996), De Gregorio, Giovannini and Wolf (1994), Chinn (1997), Chinn and Johnson and (1999) and MacDonald and Ricci (2001).

currency pricing (see, for example, Betts and Devereux (1996) and Devereux and Engel (1998)). In this regard the firms mark-up is seen as a crucial variable in absorbing nominal exchange rate movements and driving a wedge between it and relative prices. We also highlight the role of the mark-up in explaining why the real exchange rate movements might be expected to be systematic.

In this paper, we propose taking the "new" trade theory approach (see for example Helpman and Krugman, 1985), based on the seminal contribution of Dixit and Stiglitz (1977), as our point of departure in trying to understand systematic movements in real exchange rates. This serves two main purposes. First, it allows us to show that imperfect (as opposed to perfect) substitutability of tradables across countries induces different implications for the way in which the productivity of tradables and non-tradables affects the real exchange rate, relative to the standard Balassa-Samuelson framework based on perfect substitutability of tradables and price equalization. Second, the model provides another dimension along which to investigate price determination. As is standard in 'new' trade theory models, a higher demand elasticity of substitution among different varieties of a given sector induces—in equilibrium—firms to charge a lower mark-up over marginal cost, generating lower economies of scale (as proxied by the average over the marginal cost), thus characterizing a **more competitive** market structure. Such aspects of price determination have not—to our knowledge—been used before in explaining systematic movements of the real exchange rate, and we provide a first attempt to bridge this gap.

The outline of the remainder of this paper is as follows. In the next section we develop the model. Section 3 contains a brief description of the data set and methodology employed and Section 4 summarizes our results. A final section provides some conclusions.

II. A "NEW" TRADE THEORY MODEL: THE IMPACT OF PRODUCTIVITY AND COMPETITIVENESS ON THE REAL EXCHANGE RATE

The model encompasses two countries (1 and 2), each with a tradable (T) and a non-tradable sector (N). Each of these sectors is composed of many varieties, which enters the utility function in a Dixit-Stiglitz (1977) form. Each variety is produced by a different firm under increasing return to scale with a fixed cost and a constant marginal cost, both in terms of labor. Trade is assumed to be free. Labor mobility within countries ensures domestic wage equalization across sectors. International labor immobility prevents agglomeration effects.[4] Preferences are similar across countries: Cobb-Douglas in tradables and non-tradables, CES between domestic and foreign tradables, and CES of the Dixit-Stiglitz type among varieties of each sector.

[4] See Ricci (1999) for an economic geography model investigating the relation between agglomeration effects and comparative advantage (based on different productivities across countries and sectors).

The choice of assumptions reflects the following objectives. In order to inspect the impact on the real exchange rate of different productivities and competitiveness across sectors and countries, the elasticity of substitution and the marginal labor input requirement are chosen to be specific to each sector in each country. In order to allow for imperfect substitution of tradables and its impact on relative prices, the utility function is assumed to be CES between tradables and non-tradables. Within each sector of each country, firms have identical production functions, as is standard in new trade theory models.

A. Consumer maximization problem

A representative individual of country k (k=**1**, **2**) maximizes the following preferences:

$$U_k = \left(\delta \left(\sum_{i=1}^{n_{Tk}} \left(c_{Tki}^{k} \right)^{\theta_{Tk}} \right)^{\frac{\theta}{\theta_{Tk}}} + (1-\delta) \left(\sum_{j=1}^{n_{Tk'}} \left(c_{Tk'j}^{k} \right)^{\theta_{Tk'}} \right)^{\frac{\theta}{\theta_{Tk'}}} \right)^{\frac{1-\gamma}{\theta}} \left(\sum_{h=1}^{n_{Nk}} \left(c_{Nkh}^{k} \right)^{\theta_{Nk}} \right)^{\frac{\gamma}{\theta_{Nk}}}$$

Subject to:

$$\sum_{i=1}^{n_{Tk}} p_{Tki}^{k} c_{Tki}^{k} + \sum_{j=1}^{n_{Tk'j}} p_{Tk'j}^{k} c_{Tk'j}^{k} + \sum_{h=1}^{n_{Nk}} p_{Nkh}^{k} c_{Nkh}^{k} = w_k L_k$$

where $\{ c_{Tki}^{k},\ c_{Tk'j}^{k},\ c_{Nkh}^{k} \}$ are, respectively, the consumption from the part of the representative consumer of country k of the $\{i^{th}, j^{th}, h^{th}\}$ variety of the {tradables produced in country k , tradables produced abroad—i.e. in country k′ —, and non-tradables produced in country k}. Similarly $\{ p_{Tki}^{k},\ p_{Tk'j}^{k},\ p_{Nkh}^{k} \}$ are the prices in location k of the varieties as respectively listed above. Prices of foreign varieties will equal foreign prices multiplied by the nominal exchange rate, *e*.[5] the labor supply and the wage rate of location k are denoted by L_k and w_k, respectively.

The relative weights of domestic and foreign tradables are assumed to be such that, *ceteris paribus* (i.e. if prices were identical), expenditure on domestic goods would be at least as large as expenditure on foreign goods ($0<1-\delta \leq \delta <1$). This introduces an expenditure bias on domestic tradables to the extent that $\delta >1-\delta$. [6] It is important to remark that the expenditure bias

[5] We introduced the notation of the nominal exchange rate for convenience in order to facilitate comparison with the literature on the real exchange rate. In this model, however, the nominal exchange rate is a redundant variable and can be set to one so that each variety has the same price in both locations.

[6] Note that in our framework the expenditure bias is assumed via the choice of δ. However, it may also be derived endogenously via the introduction of the trade costs, as in many economic geography models.

due to preferences (associated with δ) is identical across countries. Hence, such bias does not imply that the CPI weigths for domestic and imported goods should be different across countries.[7]

The parameters θ_{T1}, θ_{T2}, θ_{N1}, θ_{N2} allow for the elasticity of substitution of demand to differ across sectors and countries.

The Consumers' maximization problem implies that consumers will spend a share γ and 1-γ of their income on non-tradable and tradable goods, respectively. Within tradable goods, the relative expenditure between domestic and foreign tradables will depend on the relative (domestic versus foreign) prices as well as on the expenditure bias towards domestic goods. Within each of the three sub-utility consumption baskets (domestic tradables, foreign tradables, and non-tradables), expenditure will be allocated equally among varieties, as the latter are all symmetric. Formally, the optimal expenditure functions of the representative consumer of country k on the typical varieties of domestic tradables (c_{Tk}^{k}), foreign tradables ($c_{Tk'}^{k}$), and domestic non-tradables (c_{Nk}^{k}) are given by:

$$c_{Tk}^{k} = \frac{1}{n_{Tk}} \frac{\left(n_{Tk}\right)^{\frac{\theta}{\theta-1}\frac{\theta_{Tk}-1}{\theta_{Tk}}} \left(p_{Tk}^{k}\right)^{\frac{1}{\theta-1}} \left(\delta\right)^{\frac{1}{1-\theta}}}{\left(n_{Tk}\right)^{\frac{\theta}{\theta-1}\frac{\theta_{Tk}-1}{\theta_{Tk}}} \left(p_{Tk}^{k}\right)^{\frac{\theta}{\theta-1}} \left(\delta\right)^{\frac{1}{1-\theta}} + \left(n_{Tk'}\right)^{\frac{\theta}{\theta-1}\frac{\theta_{Tk'}-1}{\theta_{Tk'}}} \left(p_{Tk'}^{k}\right)^{\frac{\theta}{\theta-1}} \left(1-\delta\right)^{\frac{1}{1-\theta}}} \left(1-\gamma\right) E_k ,$$

$$c_{Tk'}^{k} = \frac{1}{n_{Tk'}} \frac{\left(n_{Tk'}\right)^{\frac{\theta}{\theta-1}\frac{\theta_{Tk'}-1}{\theta_{Tk'}}} \left(p_{Tk'}^{k}\right)^{\frac{1}{\theta-1}} \left(1-\delta\right)^{\frac{1}{1-\theta}}}{\left(n_{Tk}\right)^{\frac{\theta}{\theta-1}\frac{\theta_{Tk}-1}{\theta_{Tk}}} \left(p_{Tk}^{k}\right)^{\frac{\theta}{\theta-1}} \left(\delta\right)^{\frac{1}{1-\theta}} + \left(n_{Tk'}\right)^{\frac{\theta}{\theta-1}\frac{\theta_{Tk'}-1}{\theta_{Tk'}}} \left(p_{Tk'}^{k}\right)^{\frac{\theta}{\theta-1}} \left(1-\delta\right)^{\frac{1}{1-\theta}}} \left(1-\gamma\right) E_k ,$$

$$c_{Nk}^{k} = \frac{1}{n_{Nk}\, p_{Nk}^{k}} \gamma E_k .$$

B. Firms maximization problem

The labor input (l_{sk}) required to produce x_{sk} units of a typical variety in sector ***s (T, N)*** in country ***k (1,2)*** is given by:

$$l_{sk} = \alpha + \frac{x_{sk}}{\pi_{Tk}},$$

[7] The actual shares of expenditure on—and hence the CPI weights of—domestic and foreign goods are also influnced by relative prices and can therefore differ across countries if prices differ.

where π_{sk} represent the marginal productivity of labor in the respective sector of each country. The firm's profit maximization implies the usual mark-up pricing. Within each sector, all firms face the same wage, the same productivity, and the same elasticity of demand. Hence, the optimal price in domestic currency of the representative firm of sector s of country k is given by:

$$p_{sk}^{k} = \frac{w_k}{\pi_{sk}\theta_{sk}}.$$

As is usual in the Dixit-Stiglitz framework, θ_{sk} (a parameter of the utility function) equals the inverse of the optimal mark-up, and we will refer to it as a measure of competitiveness in the respective sector.[8] The zero-profit condition associated with monopolistic competition implies the following equilibrium output and employment for the typical firm:

$$x_{sk} = \alpha\pi_{sk}\frac{\theta_{sk}}{1-\theta_{sk}} \quad , \quad l_{sk} = \alpha\frac{1}{1-\theta_{sk}}.$$

Note that in each sector of each country, the ratio of variable employment to total employment equals the corresponding θ_{sk} parameter:

$$\frac{\textit{variable employment}}{\textit{total employment}} \equiv \frac{\frac{x_{sk}}{\pi_{sk}}}{\alpha + \frac{x_{sk}}{\pi_{sk}}} = \theta_{sk}$$

This relationship will turn out to be useful when we move to the empirical estimation.

C. Equilibrium

Equilibrium in the goods and labor market require the following conditions hold:

$$L_{Nk} = n_{Nk}l_{Nk} = \gamma L_k \quad , \quad L_{Tk} = n_{Tk}l_{Tk} = (1-\gamma)L_k \quad , \quad L_{Nk} + L_{Tk} = L_k$$
$$w_k L_{Tk} = n_{Tk}p_{Tk}^{k}x_{Tk} = n_{Tk}p_{Tk}^{k}\left(c_{Tk}^{k} + c_{Tk}^{k'}\right)$$
$$w_k L_{Nk} = n_{Nk}p_{Nk}^{k}x_{Nk} = n_{Nk}p_{Nk}^{k}c_{Nk}^{k}$$

where L_{sk} is employment in sector s of country k and L_k is the labor supply of country k.

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[8] The parameter θ_{sk} is directly related to the elasticity of substitution of demand for the respective variety (which equals $1/(1-\theta_{sk})$) and inversely related to the equilibrium economies of scale (as proxied by the ratio of average cost, equal to the optimal price, and marginal cost) in the respective sector.

Equilibrium in the tradable sector implies the following trade balance equilibrium condition:

$$n_{Tk} p_{Tk}^{k} c_{Tk}^{k'} = n_{Tk'} p_{Tk'}^{k} c_{Tk'}^{k}$$

which provides a non-linear solution for the equilibrium relative wage:

$$w = \frac{N_{T1} L_2}{N_{T2} L_1} \frac{\left(N_{T1} \left(\frac{w}{\theta_T \pi_T} \right)^{\frac{\theta}{\theta - 1}} (v)^{\frac{1}{1-\theta}} + N_{T2} \right)}{\left(N_{T1} + N_{T2} \left(\frac{\theta_T \pi_T}{w} \right)^{\frac{\theta}{\theta - 1}} (v)^{\frac{1}{1-\theta}} \right)},$$

where

$$N_{Tk} \equiv (n_{Tk})^{\frac{\theta}{\theta - 1} \frac{\theta_{Tk} - 1}{\theta_{Tk}}} \quad , \quad w = \frac{w_1}{e w_2} \quad , \quad \theta_s = \frac{\theta_{s1}}{\theta_{s2}} \quad , \quad \pi_s = \frac{\pi_{s1}}{\pi_{s2}} \quad , \quad v = \frac{\delta}{1 - \delta} \geq 1$$

By linearising the model around this equilibrium we can determine, via a comparative static exercise, the percentage changes in the real exchange rate associated with changes in the parameters of interest: π_T, π_N, θ_T, θ_N; that is, respectively, the relative productivity in tradables and non-tradables, as well as the relative competitiveness in tradables and non-tradables.

D. Initial equilibrium

For simplicity, we characterize the initial equilibrium as symmetric. We are in fact interested in the impact on the real exchange rate of changes in the above parameters rather than characterizing the patterns of trade, production, and location. We leave for future work the investigation of the impact of the second order effects of such different cross country patterns of changes in productivities and competitiveness would have on the real exchange rate.

We therefore initially assume that countries have the same overall labor supply, the same productivities and competitiveness in the respective sector s (a subscript 0 denotes an initial value):

$$L_1 = L_2 = L \quad , \quad \pi_{s1} = \pi_{s2} = \pi_{s0} \quad , \quad \theta_{s1} = \theta_{s2} = \theta_{s0}$$

This is sufficient to generate an equilibrium, where in each sector, prices, output, employment, the mark-up, and the number of varieties is identical across countries; and the wage is identical across countries.

$$L_{T1} = L_{T2} = L_{T0} = (1-\gamma)L\ ,\ L_{N1} = L_{N2} = L_{N0} = \gamma L\ ,\ n_{s1} = n_{s2} = n_{s0} = L_{s0}(1-\theta)/\alpha$$
$$e = 1 \quad , \quad w_1 = w_2 = w_0 \quad , \quad p^1_{s1} = p^2_{s2} = p_{s0}$$

Note that even if prices are initially identical across countries, the model does not imply that law of one price holds in general. If productivity and competitiveness differ across countries, so do prices.

The expenditure bias would be identical across countries, so that trade would be balanced. For future reference we identify the initial expenditure bias towards domestic goods as the difference in the initial shares of expenditures on domestic and foreign goods:

$$z = \frac{n_{Tk} p^k_{Tk} c^k_{Tk} - n_{Tk'} p^k_{Tk'} c^k_{Tk'}}{n_{Tk} p^k_{Tk} c^k_{Tk} + n_{Tk'} p^k_{Tk'} c^k_{Tk'}} = \frac{v^{\frac{1}{1-\theta}} - 1}{v^{\frac{1}{1-\theta}} + 1} \geq 0, \quad if \quad \delta \geq 1-\delta$$

E. The real exchange rate

The real exchange rate, q, - the ratios of the true price indexes of the two countries - is given by[9]:

$$q = \left(\frac{(n_{N1})^{\frac{\theta_{N1}-1}{\theta_{N1}}}}{(n_{N2})^{\frac{\theta_{N2}-1}{\theta_{N2}}}} \frac{w}{\theta_N \pi_N} \right)^{\gamma} \left(\frac{\left(N_{T1} \left(\frac{w}{\theta_T \pi_T} \right)^{\frac{\theta}{\theta-1}} (v)^{\frac{1}{1-\theta}} + N_{T2} \right)}{\left(N_{T1} \left(\frac{w}{\theta_T \pi_T} \right)^{\frac{\theta}{\theta-1}} + N_{T2} (v)^{\frac{1}{1-\theta}} \right)} \right)^{\frac{(1-\gamma)(\theta-1)}{\theta}}$$

As one can see, in the absence of an expenditure bias (i.e. if v=1), the real exchange rate would depend only on the relative price of non-tradables. By differentiation, we can therefore derive the following expression in terms of percentage changes:

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[9] Using an empirically based real exchange rate, such as a geometric average of the prices of tradables and non-tradables (with weights given by the relative expenditures on the two components), would yield a simpler expression, and similar conclusions to those in Section 2.6 would be obtained.

Equation 1

$$\hat{q} = \left(\gamma + (1-\gamma)z\right)w - (1-\gamma)z\hat{\pi}_T - \gamma\,\hat{\pi}_N - (1-\gamma)z(1-y_T)\hat{\theta}_T - \gamma\,(1-y_N)\hat{\theta}_N$$

$$\text{where } y_S = 1 + \frac{\ln(n_{S0})}{\theta_{S0}} \quad , \quad for\; s = T, N$$

The parameter y_s captures the impact on the real exchange rate due to the change in the number of varieties induced by the change in competitiveness (or in the parameter of the utility function associated with it); for convenience we will separate this effect from the effect of competitiveness directly on prices of individual varieties.

By differentiating the trade balance equilibrium we can derive the following expression for the percentage change in the relative wage:

$$\hat{w} = \frac{2v^{\frac{1}{1-\theta}}\frac{\theta}{1-\theta}}{1+v^{\frac{1}{1-\theta}}+2v^{\frac{1}{1-\theta}}\frac{\theta}{1-\theta}}\left((1-y_T)\hat{\theta}_T+\hat{\pi}_T\right).$$

By substituting the expression for the wage in equation 1, the final expression for the percentage change in real exchange rate can be defined as:

Equation 2

$$\hat{q} = \phi_{\pi T}\,\hat{\pi}_T + \phi_{\pi N}\,\hat{\pi}_N + \phi_{\theta T}\,\hat{\theta}_T + \phi_{\theta N}\,\hat{\theta}_N$$

where, recalling the definition of v,

$$\phi_{\pi T} = \frac{\gamma\left(\left(\frac{\delta}{1-\delta}\right)^{\frac{1}{1-\theta}}\left(\frac{1+\theta}{1-\theta}\right)-1\right)+1-\left(\frac{\delta}{1-\delta}\right)^{\frac{1}{1-\theta}}}{\left(\left(\frac{\delta}{1-\delta}\right)^{\frac{1}{1-\theta}}\left(\frac{1+\theta}{1-\theta}\right)+1\right)},$$

$$\phi_{\pi N} = -\gamma \quad , \quad \phi_{\theta T} = (1-y_T)\phi_{\pi T} \quad , \quad \phi_{\theta N} = -\gamma\,(1-y_N).$$

F. Implications of the model for the real exchange rate

Equation 2 provides several implications for the behavior of the real exchange rate.

1) The impact on the real exchange rate of the relative productivity in tradables is smaller than that of the relative productivity in non-tradables.

- It can be easily shown that: $\phi_{\pi T} < \gamma$. This differs from the usual Balassa-Samuelson theoretical result, often calculated in a neoclassical framework with homogenous commodities and price equalization (where the coefficients are identical, and equal to the share of expenditure on non-tradables, γ). In fact, the imperfect substitutability of tradables implies that the productivity of tradables also has a direct negative impact on the prices of tradables in addition to the indirect positive impact — via wages — on the price of non-tradables. To the extent there is an expenditure bias towards domestic tradables, the direct negative impact would produce a depreciation of the real exchange rate (as domestic prices fall more than foreign ones). Such an effect would go against the usual positive impact on the real exchange rate of the indirect effect (via the wage) of the productivity of tradables.

2) The overall impact of the productivity of tradables on q is positive, unless the share of expenditure on non-tradables is very small:

- $\phi_{\pi T} > 0$, only if γ is not too small.[10] If the share of expenditure on non-tradables were to be too small, the direct negative impact of productivity of tradables on the real exchange rate can be larger than the indirect positive impact via wages. (As we discuss later, we find empirically that $\phi_{\pi T} > 0$).

3) The impact of relative competitiveness in the tradable (non-tradable) sector on the real exchange rate is similar to the impact of relative productivity in the tradable (non-tradable) sector, if we neglect the price effect of changes in the number of varieties of tradables (non-tradables) captured by y_T (y_N).

- If we neglect y_T and y_N, then $\phi_{\theta T} = \phi_{\pi T}$ and $\phi_{0N} = -\gamma$. Neglecting the price effect of changes in the number of varieties makes sense if the objective is to derive an expression that can be empirically estimated with Consumer Price Index data, which

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[10] The exact condition being: $\gamma > \dfrac{\left(\dfrac{\delta}{1-\delta}\right)^{\frac{1}{1-\theta}} - 1}{\left(\dfrac{\delta}{1-\delta}\right)^{\frac{1}{1-\theta}} \dfrac{1+\theta}{1-\theta} - 1}$

do not properly — or at all — capture such an effect. Then, the model provides the intuitive result that competitiveness affects prices — and hence the real exchange rate — in a similar way to productivity. For example, consider the case of an increase in θ_{T1} (and hence of θ_T) and assume $\phi_{\theta T}>0$ (as is empirically the case). This induces the mark-up in tradables of country 1 to drop (that is, higher competitiveness), which both lowers the prices of varieties of tradables and increases the relative wage of country 1. The net effect on the real exchange rate is identical to that of an increase in productivity of tradables, which is discussed above.[11]

We conclude this section by stressing that the effect on the real exchange rate of the relative productivity in tradables, net of its indirect impact via the wage, is negative, as is visible from Equation 1. The intuition has already been provided in the discussion to point 1 above: the direct effect is to reduce the relative price of domestic tradables. To the extent that there is an expenditure bias towards domestic tradables, such a reduction of the price of domestic tradables would reduce the overall domestic price level more than the foreign one and this generates a depreciation of the real exchange rate. It is useful to remember that in the standard neoclassical Balassa-Samuelson setup, the effect of productivity of tradables on the real exchange rate operates exclusively via its positive impact on wages, hence its coefficient would become zero once we net out wage adjustments. In both our framework and that of Balassa-Samuelson, the productivity of non-tradables does not operate via wages, hence its coefficient is identical when we net out wage adjustments.[12]

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[11] If we consider y_T and y_N, then $\phi_{\theta T} = -(\ln(n_{T0})/\theta_{T0})\phi_{\pi T}$ and $\phi_{\theta N} = \gamma\ (\ln(n_{N0})/\theta_{N0})$. To illustrate the intuition of the price effect of the change in the number of varieties consider the same example as in the text (an increase in θ_{T1} when $\phi_{\theta T}>0$). In addition to the effect mentioned in the text (a reduction in the mark up for T1), the number of firms that can survive the stiffer competition within the T1 sector is reduced, so that every firm can produce a larger output and recover the same fixed cost despite the lower mark-up. However, due to the peculiar nature of the Dixit-Stiglitz utility functions (and its "love for variety" property), a reduction in the number of firms increases the true price index of T1, thus inducing an opposite set of effects to a drop in mark-up. It turns out that the price effect of the change in the number of varieties dominates the mark up effect, so that an increase in θ_{T1} (hence an increase in competitiveness of tradables of 1) would depreciate the real exchange rate of country 1.

[12] We focus on the relative productivity, as competitiveness was not present in the Balassa-Samuelson framework. However, also for competitiveness, the direct impact of on the real exchange rate of the relative competitiveness in tradables has the opposite sign than the overall effect.

III. Data Sources, Variable Definitions, and Econometric Methods

This Section presents a brief discussion of the construction of the data set, relegating a more complete description of the construction of the variables to the data appendix. Ten countries feature in our analysis: Belgium (BEL), Denmark (DNK), Finland (FIN), France (FRA), Italy (ITA), Japan (JPN), Norway (NOR), Sweden (SWE), West Germany (WGR), and the United States (USA).[13] Variables for each of the first nine countries are defined relative to the USA, bringing the cross sectional dimension of our panel to nine. Annual data are used for the period 1970 to 1992. Both the cross sectional and time series dimensions of the panel were determined by the availability of consistent data for all the variables. The correlation among variables, conditional on fixed effects (i.e. the correlation among the residuals of the regression of each variable on fixed effects) are presented in Table 1.

The key dependent variable in our study is the logarithm of the real exchange rate (LRER), which is CPI-based: an increase in LRER of country *j* corresponds to an appreciation of the real exchange of *j* versus the USA. We first condition the LRER term on two macro-economic control variables: the relative size of net foreign assets to GDP ratios and a relative real interest rate term. The theoretical and empirical importance of these variables has been assessed in various contributions, as discussed in the introduction. Hence, we introduce them as control variables even if they are not present in our theoretical framework.

We then add productivity in tradables and non-tradables (we introduce them both separately and jointly, the latter being the usual way to analyze the Balassa-Samuelson effect). All of these variables, apart from the productivity terms, are from the IFS, OECD, World bank, and WEO macroeconomic databases. The relative productivity in tradables and non-tradables are calculated by drawing from the OECD International Sectoral database. Similar to De Gregorio, Giovannini, and Wolf (1994) and Cheung, Chinn, and Fujii (1999) we classify agriculture, manufacturing, and transportation sectors as tradables; and utilities, construction, and social services sectors as non-tradables.[14]

We then introduce into the regressions variables capturing the competitiveness terms (θ_{sk}). In "new" trade theory models such as ours, θ_{sk} equals the equilibrium ratio of variable employment to total employment, as shown before. We build a proxy for θ_{sk} by calculating for

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[13] Data refer to West Germany only, even for the period after German reunification.

[14] De Gregorio, Giovannini, and Wolf (1994) define as tradable those sectors for which the export share in total production is larger than 10 percent. A similar classification was used by Stockman and Tesar (1995). Following MacDonald and Ricci (2001) we exclude the distribution sector from the non-tradable sector. Mining was not included in the tradable sector for lack of data for Belgium and Italy. The financial sector was not included in the non-tradable sector for lack of data for Belgium, Italy, and Netherlands.

each sector the ratio of employees to total employment from the OECD ISD database. As with the Balassa-Samuelson effect, the competitiveness terms for tradables and non-tradables are entered both separately and jointly. Finally, by introducing different measures of the aggregate wage in industrial activity (again from the OECD International Sectoral database), we are able to analyze how the Balassa Samueslon and competitiveness terms get transmitted into the real exchange rate.

The relatively small available time series samples for each country necessitates using panel methods to improve the power of our tests (data on productivity, for example, are only available at an annual frequency). Recent developments in the econometrics of panel data sets has sought to address the potential nonstationarity of the series entering the panel. In particular, McKoskey and Kao (1998), Pedroni (1997) and Phillips and Moon (1998) have proposed panel equivalents to the single equation fully modified estimator, while McKoskey and Kao (1998) and Mark and Sul (1999) have proposed using a panel dynamic OLS (DOLS) estimator. Since Kao and Chiang (1999) have demonstrated that the panel DOLS procedure exhibits less bias than the panel OLS and panel fully modified estimators and Mark and Sul (1999) have emphasized the tractability of the estimator, we employ a panel DOLS estimator for all our regressions. This has the following form:

Equation 3

$$y_{it} = \theta_{1i} + \theta_{2t} + \theta_3 x_{it} + \sum_{j=-p}^{+n} \theta_{4j} \Delta x_{it+j} + \omega_{it} ,$$

where y_{it} is a scalar, x_{it} is a vector with dimension k, θ_{1i} is an individual fixed effect, θ_{2t} is a time effect, θ_3 represents a cointegration vector, p is the maximum lag length, n is the maximum lead length and ω is a Gaussian vector error process. The leads and lags of the difference terms are included to ensure that the error term is orthogonalized. Our representation of the Panel DOLS estimator assumes that the dynamics are the same across individuals. The estimator can address potential cross sectional dependence by the inclusion of time dummies, and that is accomplished here by removing the cross-sectional mean of each variable.[15]

Pedroni (1997) has noted that the residuals from an equation like (3) will have the same distribution as the raw data and hence it is possible to use a standard unit root test to check for the existence of cointegration amongst the variables in the vector of interest. We therefore use the Levin and Lin (1993) panel unit root statistic to test for cointegration:

[15] The inclusion of the time dummies neutralizes the role of the reference country (USA): measuring the real exchange rate with respect to different reference countries (say Germany as opposed to USA) would yield different coefficients in the absence of time dummies. Our results on the adjustment speed do not depend on time dummies.

Equation 4

$$\Delta\omega_{it} = \delta\omega_{it-1} + \sum_{j=1}^{n} \theta_{4i} \Delta\omega_{it-j} + u_{it},$$

where -δ represents the adjustment speed[16] and the t-ratio on this term, denoted "PUR test" in the empirical section of this paper, denotes the significance of the adjustment speed.[17] The null hypothesis that each time series of residuals has a unit root is rejected if δ is significantly negative; that is, in the current application there is panel cointegration. As Levin and Lin demonstrate, under the null hypothesis that δ=0 the PUR test diverges to minus infinity. However, they propose a simple adjustment to this statistic that produces a test statistic, which has a standard normal distribution, and it is this adjusted t-statistic, which we use in this paper.

IV. Empirical Results

In Table 2 we present our base line set of results with the macro variables. The simplest model in which the real exchange rate is conditioned on NFA and the real interest differential indicates that both these variables are correctly signed and statistically significant. They contribute to reducing the half-life of a deviation from PPP from 3.3 years to 2.1 years. In column 3, the introduction of a traditional Balassa-Samuelson term—i.e. the ratio of relative productivity in tradables and non-tradables— into such an equation, produces a significant coefficient and a sign, which is consistent with the traditional Balassa-Samuelson effect. This is a common result in the literature on real exchange rates. However the results in column 4 indicate that the restriction that the coefficient on productivity in tradables and nontradables be equal and opposite is easily rejected using a 5 per cent significance level. In fact, consistent with our model, the coefficient of the productivity of tradables is, in absolute terms, significantly lower than the coefficient of the productivity of non-tradables.

We now inspect the channel of influence of the difference in productivities on the real exchange rate. In the final three columns of the table we introduce three different measures of the relative wage: the wage in the tradable sector, the overall industry wage, and the wage in manufacturing. According to the standard Balassa-Samuelson framework, the wage is the only channel through which improvements in productivity in the tradable sector gets transmitted to the CPI based real exchange rate, and including the wage in our regression should make the

[16] Equation (3) represents the reparameterization of a levels autoregression for ω, and therefore δ represents the difference between the sum of the levels autoregressive coefficients and one.

[17] We use the adjustment proposed by Levin and Lin (1993) for the case of a constant terms as we employed fixed effects in the original regression that generated the residuals.

coefficient on tradable productivity become zero (since the wage would capture all of the effect of the productivity of tradables). However, in all of the regressions which include the wage, the coefficient on the productivity of tradables becomes statistically negative, which is consistent with our model.

Both of the new results above (the significantly lower effect of the productivity of tradables versus the effect of non-tradables and the reverse in sign of the productivity of tradables when the wage enters the regression) can be ascribed to the imperfect substitutability of tradables in the presence of a home expenditure bias. As discussed in Section 2, in this case, productivity of tradables would not only directly and positively affect the aggregate wage (and hence indirectly and positively the overall price index and RER) but also directly and negatively the price of tradables (and hence indirectly and negatively the price index and the RER). The Balassa-Samuelson result would still hold if the first effect dominates, although once we control for the wage effect, only the second effect would be ascribed to the productivity of tradables. In other words, in the presence of imperfect substitutability of goods and expenditure bias towards domestic tradables, both productivity in tradables and non-tradables would have a direct negative impact on the real exchange rate once we control for the indirect effect via the wage channel.

Note also that the coefficient of productivity of non-tradables drops, in absolute terms, when the wage enters the regression. Our model (as well as the standard Balassa-Samuelson framework) cannot account for such an effect. However, one possible explanation for this result is that some components of non-tradables might indirectly be traded. It is in fact easy to conceive that services (such as the utilities) normally classified as non-tradable may constitute intermediate inputs for tradable goods. Productivity in these components would thus behave as productivity of tradables, so that the overall coefficient would be the average of two factors: pure non-tradables whose impact is unchanged when accounting for the wage, and spurious non-tradables, whose impact would become lower or negative when accounting for the wage. The net result would be a reduction of the coefficient when accounting for the wage effect.

Regarding the adjustment speeds, note that the introduction of the productivity terms dramatically reduces the half-lives of deviations of the real exchange rate to 1.2-1.3 years, which is the end point for the PPP puzzle (1 year). [18]

In Table 3 the two competitiveness terms – in tradables and in non-tradables - are introduced instead of the productivity terms. Our discussion in section 2 suggests that the coefficients on these terms should have opposite signs. Their signs should also mirror those of the productivities (positive for tradables and negative for non-tradables) to the extent the CPI-based real exchange rate cannot capture the effect of changes of the number of varieties on the

[18] The last 3 columns do not report an adjustment speed as the equation is deliberately overspecified.

true price index (i.e. the price of one unit of marginal utility); otherwise, these signs should be the reverse of those for productivities.

The first column shows that when both competitiveness in the tradables and non-tradables enters the regression, their signs are, respectively, significantly positive and negative (similarly to the signs of productivities); NFA is now insignificant. However, when the competitiveness term are entered separately (column 2 and 3), the sign of competitiveness of tradables maintains its sign, while the coefficient on the competitiveness of non-tradables is reversed (column 3). We attribute the last reversal of sign to multicollinearity, as the variables are strongly and negatively correlated (-0.7, as from table 1).[19] In the last column, we constrain the coefficients of the two competitiveness terms to be equal and opposite (thus building a term equivalent to a Balassa Samuelson term for competitiveness): this term is not significant, as the difference of two collinear variable could have any sign (the last result is also not surprising given that in the first column we strongly reject the coefficient restriction). This last result is, however, of little importance to us, as our model does not support coefficients of identical size and opposite sign.

The results in table 3 suggest that the best specification is the one with just the competitiveness term in the tradable sector included: both terms cannot be simultaneously present or be constrained because of multicollinearity, and the coefficient on competitiveness in the tradable sector is more stable than the other. Note that the half- lives for all of the equations reported in Table 3 are higher than those reported in Table 2 (with the productivity terms included into the basic regression). However, a question arises as to whether our competitiveness terms are in some sense simply an alternative measure of productivity. This issue is addressed in Table 4.

In Table 4 we add our various measures of competitiveness into the model with constrained (first four columns) and unconstrained (last four columns) productivity terms. First, the introduction of the competitiveness terms does not crowd out the significance of the coefficient on the productivity terms, although some of the specifications already rejected on the basis of Table 3 (i.e. columns 3, 4, 7, and 8 in Table 4) alter substantially the coefficients of the productivity terms. Also the coefficient on NFA is now consistently insignificant.

The coefficient on the competitive terms reinforces our presumption that the specification with competitiveness in tradables is the best one (column 2 and 6): not only are the coefficients of the productivity terms very similar to those in Table 2, but the multicollinearity of the two competitiveness terms is again evident: competitiveness in non-tradables is not significant in the specification with both terms unconstrained (columns 1 and 5); both competitiveness terms are positive and significant when entered separately (columns 2, 3, 6, 7);

[19] One explanation for the two competitiveness terms to be so closely correlated is that market structure might move more similarly across the traded and non-traded sectors than productivity does across sectors, a topic which is left for future investigation.

and the constrained competitiveness term (columns 4 and 8) changes sign with respect to the previous Table and now has the opposite sign than both competitiveness terms entered separately.

One of the notable features of the regression presented in Table 4 is the fact that the half-life adjustment speed drops below unity in four instances, with the fastest adjustment speed occurring when both the competitiveness and productivity terms are entered unconstrained.

In Table 5 we further inspect the mechanism through which the variable of interest affects the real exchange rate. To this end, as in Table 2, we introduce the three different measures of the wage discussed above into the best specification that our previous analysis delivered: a specification which comprises the basic macro variables, the productivity in tradables and non-tradables (separately), and the competitiveness in tradables. The addition of the competitiveness terms does not alter the main results we found in Table 2 with respect to the productivity terms: regardless of the measure of the wage chosen, the coefficient on productivity in the tradable sector becomes significantly negative. However, the sign and significance of the competitiveness term remains unchanged, although it falls to roughly one half the pre-wage equation. This last finding cannot be explained in terms of our model.

Tables 6 to 9 replicate the regressions in Tables 2 to 5, but with simple OLS rather than DOLS. Overall these results are remarkably similar to those outlined above, although the coefficients are generally lower.

V. Concluding Comments

This paper derives the theoretical implications for the real exchange rate of a 'new' trade model encompassing different productivities and competitiveness in the tradable and non-tradable sectors. It then tests such implications empirically, by estimating the long-run coefficients via a panel dynamic OLS estimators and testing for the cointegratedness of the variables entering the relationship. Results are compared with those of the standard Balassa-Samuelson approach. In the empirical section, a proxy for our competitiveness term is then developed by following a simple equilibrium relationship derived in the model and common to the new trade theory literature: the inverse of the mark-up equals the equilibrium ratio of variable employment to total employment. Such a parameter is also directly related to the elasticity of substitution and inversely related to the equilibrium economies of scale.

Several results arise from our theoretical model.

- First, the coefficient of the relative productivity of tradables is significantly lower than the coefficient of the relative productivity of non-tradables, in absolute terms.
- Second, the former coefficient changes sign if we introduce the wage into the estimation.

These two results are consistent with our model and depend on the hypothesis of imperfect substitutability of tradables, coupled with an expenditure bias towards domestically produced tradables. An increase in productivity in tradables has two effects: first, a direct negative impact on the price of tradables, and therefore pressure towards a depreciation of the real exchange rate. Second, the lower price induces a larger demand and hence a higher wage (the standard Balassa-Samuelson effect), which instead tends to appreciate the real exchange rate via an increase in the price of non-tradables. Hence, the net effect ensures that the effect of the productivity of tradables is lower than that for the productivity of non-tradables (the first result above). The first effect ensures that, net of the wage channel, the direct impact of the productivity of tradables on the real exchange rate is negative.

- Third, the coefficient of productivity on non-tradables drops when the wage enters the regression.

This result cannot be explained in terms of our model (nor in terms of the standard Balassa-Samuelson framework). However, one possible explanation discussed in the text is that some components of non-tradables (such as the utilities) might be used as intermediate inputs and therefore be indirectly traded. Productivity in these components would thus behave as productivity of tradables.

- Fourth, a measure of competitiveness in the tradable sector is significant and positive.

- Fifth, the coefficient of competitiveness in the tradable sector remains significant and positive, although it drops in size, when we introduce the wage.[20]

The fourth result is consistent with the model if we believe that the CPI-based real exchange rate cannot capture the effect of the change in the number of varieties on the true price index (i.e. on the price of one unit of marginal utility). Neglecting the effect of the change in the number of varieties, an increase in competitiveness of tradables acts exactly like an increase in productivity. The fifth result cannot be explained in terms of our model and requires further investigation of the mechanism through which competitiveness affects the real exchange rate, as it suggests that the competitiveness in tradables does not have the same transmission mechanism as the productivity of tradables.

Given the novelty of our measure of competitiveness, it is important to acknowledge that our proxy for competitiveness is probably highly imperfect, as it is based on a too literal interpretation of our new trade theory model. The existence of other factors of production in addition to labor, the unrealism of equilibrium relationship, and the fact that "number of employees" in the OECD ISD classification might not correspond to what the model requires to be variable employment, all point to the imperfection of such a measure. However, our results clearly show that such a measure, which has not to our knowledge been used before, is powerful in explaining systematic changes of the real exchange rate. Further research is necessary to obtain a better understanding of the role of market structure, competition, and economies of scale in influencing the real exchange rate.

We would like to conclude with a suggestion for further research. We maintained a simple framework simple by assuming an initial symmetric equilibrium. In the absence of such restrictions, the model would have implied that the impact of relative productivity and competitiveness in the two sectors depends also on factors such as the relative size and the initial relative prices. We leave for future research to investigate these interesting aspects, perhaps using a panel regression framework with heterogeneous slopes.

[20] The competitiveness measure in the non-tradable is found to be collinear with the one in tradables, and its effect dominated by the first one. Hence, specific implications for such measure cannot be derived.

Appendix: Variable definitions.

For brevity, OECD International sectoral Database will be referred to as OCDE ISD. The corresponding three letter sectoral code or variable name code is provided.

Real Exchange Rate: $LRER_j = Log(CPI_j / (e_j * CPI_{usa}))$, for CPI = Consumer price index, e = exchange rate (currency units of j per US$) ; Source: IFS.

Relative Real Interest Rate: $INT_j = (i_j - \pi_j) - (i_{usa} - \pi_{usa\,j})$; for i_j = nominal interest rate (long term government bond yield) π_j = CPI inflation rate; Source: IFS.

Relative Net Foreign Assets: $NFA_j = (NFA_j * e_j / GDP_j) - (NFA_{usa} / GDP_{usa})$, for NFA= Net foreign asset position, GDP = Gross Domestic Product, e = exchange rate (currency units of j per US$). Source: IFS, OECD.

Relative Productivity in Tradables: $LATRDWT_j = Log(\Sigma_k(\omega_{kj}TFP_{kj})/ \Sigma_k(\omega_{k,usa}TFP_{usa}))$, for k = agricultural sector (AGR), manufacturing sector (MAN) and transport, storage and communication sector (TRS); the weights being the country-specific relative size of the sectoral value added, averaged over the sample period. Source: OECD ISD.

Relative Productivity in Non-Tradables: $LANTRD_j = Log(\Sigma_k(\omega_{kj}TFP_{kj})/ \Sigma_k(\omega_{k,usa}TFP_{usa}))$, for k = Community, social and personal services (SOC); Electricity, gas and water (EGW); Construction (CST); again the weights being the country-specific relative size of the sectoral value added, averaged over the sample period. Source: OECD ISD.

Balassa-Samuelson term: $LBAL2WT_j = LATRDWT_j - LANTRD_j$

Relative Competitiveness in Tradables: $LE2TRDWT_j = Log(\Sigma_k(\omega_{kj}(EE_{kj}/ET_{kj}))/\Sigma_k(\omega_{kusa}(EE_{k,usa}/ET_{k,usa})))$, for k = agricultural sector (AGR), manufacturing sector (MAN) and transport, storage and communication sector (TRS); the weights being the country-specific relative size of the sectoral value added, averaged over the sample period. EE=Number of Employees, ET=Total Employment. Source: OECD ISD.

Relative Competitiveness in Non-Tradables: $LE2NTRD_j = Log(\Sigma_k(\omega_{kj}(EE_{kj}/ET_{kj}))/\Sigma_k(\omega_{kusa}(EE_{k,usa}/ET_{k,usa})))$, for k = Community, social and personal services (SOC); Electricity, gas and water (EGW); Construction (CST); again the weights being the country-specific relative size of the sectoral value added, averaged over the sample period. EE=Number of Employees, ET=Total Employment. Source: OECD ISD.

Competitiveness like Balassa Samuelson: $LE2BALWT = LE2TRDWT_j - LE2NTRD_j$

Relative Wage in Tradables: $LWTRDWTj = Log(\Sigma_k(\omega_{kj}(WSSS_{kj}/(e_j*EE_{kj})))/ \Sigma_k(\omega_{k,usa}(WSSS_{k,usa} / EE_{k,usa}))$, for k = agricultural sector (AGR), manufacturing sector (MAN) and transport, storage and communication sector (TRS); WSSS = compensation of employees at current prices in national currency, EE= number of employees; e =

exchange rate (currency units of j per US$); the weights being the country-specific relative size of the sectoral value added, averaged over the sample period. Source: OECD ISD.

Relative Wage in Industrial Activity: LWTINj = $Log((WSSS_{kj}/(e_j*EE_{kj})))/(WSSS_{k,usa}/EE_{k,usa}))$, for k = Total Industry (TIN), WSSS = compensation of employees at current prices in national currency, EE= number of employees, e = exchange rate (currency units of j per US$). Source: OECD ISD.

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Table 1. Correlation matrix among variables, accounting for fixed effects

I.e. correlation b/w residuals of regression of each variable on fixed effect

	LRER	NFA	INT	LBAL2WT	LATRDWT	LANTRD	LE2BALWT	LETRDWT	LENTRD	LWTRDWT	LWIND	LWMAN
LRER	1.0	0.1	0.2	0.4	-0.1	-0.5	0.0	-0.6	-0.4	0.9	0.9	0.9
NFA		1.0	-0.1	0.2	-0.3	-0.3	-0.2	-0.2	0.0	0.0	0.0	0.0
INT			1.0	0.1	0.1	-0.1	0.1	0.2	0.1	0.1	0.1	0.1
LBAL2WT				1.0	0.3	-0.8	-0.5	-0.1	0.3	0.5	0.5	0.5
LATRDWT					1.0	0.2	-0.4	0.2	0.4	0.3	0.2	0.2
LANTRD						1.0	0.2	0.2	0.0	-0.3	-0.3	-0.4
LE2BALWT							1.0	0.0	-0.7	-0.3	-0.3	-0.2
LE2TRDWT								1.0	0.7	-0.5	-0.5	-0.5
LE2NTRD									1.0	-0.1	-0.2	-0.2
LWTRDWT										1.0	1.0	1.0
LWIND											1.0	1.0
LWMAN												1.0

Table 2. The Base-line Model of RER
(Dynamic OLS)

	LRER	LRER	LRER	LRER	LRER	LRER	LRER
Net foreign assets (NFA)		**0.005**	**0.003**	**0.001**	**-0.002**	**-0.001**	**-0.001**
		2.94	2.02	0.41	2.37	1.65	1.39
Real interest rates (INT)		**0.03**	**0.013**	**0.006**	**0.004**	**0.002**	**0.001**
		4.20	1.91	0.87	1.57	1.02	0.21
Balassa Samuelson-BS (LBAL2WT)		-	**0.77**	-	-	-	-
		-	6.45	-	-	-	-
Productivity in tradables (LATRDWT)		-	-	**0.417**	**-0.587**	**-0.566**	**-0.412**
		-	-	1.92	6.66	7.30	4.41
Productivity in non-tradables (LANTRD)		-	-	**-0.948**	**-0.259**	**-0.221**	**-0.259**
		-		7.16	4.83	4.54	4.32
Wage in tradables (LWTRDWT)		-	-	-	**0.719**	-	-
		-	-	-	22.06	-	
Wage in industry (LWIND)		-	-	-	-	**0.736**	-
		-	-	-	-	25.08	-
Wage in manufacturing (LWMAN)		-	-	-	-	-	**0.675**
			-	-	-	-	19.27
Testing Restrictions on Coefficients							
Chi-square				4.92			
Probability				0.03			
Panel Unit Root Analysis							
PUR test	-0.62	-0.87	-3.81	-3.25	-1.88	-2.31	-1.72
Delta (from text)	-0.22	-0.22	-0.44	-0.42	-0.26	-0.28	-0.27
Half lifetime (years)	2.8	2.1	1.2	1.3			
Number of observations	153	153	153	153	153	153	153

Absolute t-ratios below coefficients.

Wald Test on restrictions. H0: LATRDWT+LANTRD=0. Do not reject if p-value above desired alpha (0.05).

Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1993) t-ratios discussed in the text. Half lifetime of deviations of the real exchange rate from estimated relation (years): log(0.5)/(log(1+delta)).

Table 3. Relative Competitiveness
(Dynamic OLS)

	LRER	LRER	LRER	LRER
Net foreign assets (NFA)	**0.001**	**0.003**	**0.003**	**0.003**
	0.20	2.06	1.84	1.51
Real interest rates (INT)	**0.034**	**0.040**	**0.032**	**0.019**
	5.38	6.67	4.25	2.55
Competitiveness like BS (LE2BALWT)	-	-	-	**0.101**
	-	-	-	0.23
Comp in tradables (LE2TRDWT)	**3.554**	**2.526**	-	-
	7.32	9.01	-	-
Comp in non-tradables (LE2NTRD)	**-0.994**	-	**1.119**	-
	2.83	-	4.74	-
Testing Restrictions on Coefficients				
Chi-square	89.09			
Probability	0.00			
Panel Unit Root Analysis				
PUR test	-1.83	-0.88	-0.52	-0.94
Delta (from text)	-0.39	-0.28	-0.25	-0.33
Half lifetime (years)	1.4	2.1	2.4	1.7
Number of observations	153	153	153	153

Absolute-ratios below coefficients.

Panel Unit Root (PUR) test: "adjusted" Levin and Lin (1993) t-ratios discussed in the text.

Half lifetime of deviations of the real exch. rate from estimated relation (years): log (0.5)/(log(1+delta)).

Table 4. Relative Productivity and Competitiveness: in Search of a Model
(Dynamic OLS)

	LRER	LRER	LRER	LRER	LRER	LRER	LRER	LRER
								-
Net foreign assets (NFA)	**0**	**0.001**	**0.002**	**0.002**	**-0.001**	**-0.000**	**0.002**	**0.0004**
	0.04	0.99	1.09	1.15	0.87	0.19	1.34	0.18
Real interest rates (INT)	**0.018**	**0.024**	**0.014**	**0.033**	**0.021**	**0.028**	**0.017**	**-0.005**
	3.31	4.65	2.44	0.49	3.43	4.97	2.61	0.75
Balassa Samuleson-BS (LBAL2WT)	**0.769**	**0.736**	**0.997**	**0.944**	-	-	-	-
	7.99	8.87	10.83	7.21	-	-	-	-
Productivity in tradables (LATRDWT)	-	-	-	-	**0.506**	**0.494**	**1.144**	**0.668**
	-	-	-	-	2.34	3.19	5.99	2.29
Productivity in non-tradables (LANTRD)	-	-	-	-	**-0.766**	**-0.772**	**-0.955**	**-0.976**
	-	-	-		7.64	8.10	9.38	7.40
Competitiveness like BS (LE2BALWT)	-	-	-	**-1.590**	-	-	-	**-1.017**
	-	-	-	3.57	-	-	-	1.82
Comp in tradables (LE2TRDWT)	**1.808**	**2.486**	-	-	**2.296**	**2.669**	-	-
	3.93	11.14	-	-	4.27	10.38	-	-
Comp in non-tradables (LE2NTRD)	**0.479**	-	**1.704**	-	**0.131**	-	**1.844**	-
	1.39	-	9.51	-	0.30	-	8.14	-
Testing Restrictions on Coefficients								
Chi-square	1.92							
Probability	0.16							
Panel Unit Root Analysis								
PUR test	-4.67	-3.91	-2.36	-3.19	-5.04	-3.92	-2.42	-3.31
Delta (from text)	-0.59	-0.54	-0.42	-0.44	-0.63	-0.54	-0.42	-0.47
Half lifetime (years)	0.8	0.9	1.3	1.2	0.7	0.9	1.3	1.1
Number of observations	153	153	153	153	153	153	153	153

Absolute t-ratios below coefficients.
Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1993) t-ratios discussed in the text.
Half lifetime of deviations of the real exch. rate from estimated relation (years): log(0.5)/(log(1+delta)).

Table 5. Relative Productivity and Competitiveness: Controlling for the Wage Effect
(Dynamic OLS)

	LRER	LRER	LRER	LRER
Net foreign assets (NFA)	**-0.000**	**-0.002**	**-0.001**	**-0.001**
	0.19	2.28	1.83	1.78
Real interest rates (INT)	**0.028**	**0.012**	**0.009**	**0.010**
	4.97	4.78	4.26	3.95
Productivity in tradables (LATRDWT)	**0.494**	**-0.328**	**-0.349**	**-0.169**
	3.19	3.85	4.67	2.11
Productivity in non-tradables (LANTRD)	**-0.772**	**-0.337**	**-0.297**	**-0.344**
	8.10	7.18	6.96	7.10
Comp in tradables (LE2TRDWT)	**2.669**	**0.950**	**0.824**	**1.124**
	10.38	6.54	6.25	7.92
Wage in tradables (LWTRDWT)	-	**0.560**	-	-
	-	14.45	-	-
Wage in industry (LWIND)	-	-	**0.599**	-
	-	-	16.77	-
Wage in manufacturing (LWMAN)	-	-	-	**0.509**
	-	-	-	13.78
Testing Restrictions on Coefficients				
Chi-square				
Probability				
Panel Unit Root Analysis				
PUR test	-3.92	-2.15	-2.05	-2.27
Delta (from text)	-0.54	-0.32	-0.37	-0.35
Half lifetime (years)	0.9			
Number of observations	153	153	153	153

Absolute t-ratios below coefficients.
Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1993) t-ratios discussed in the text.
Half lifetime of deviations of the real exch. rate from estimated relation (years): log(0.5)/(log(1+delta)).

Table 6. The Base-line Model of RER
(OLS)

	LRER	LRER	LRER	LRER	LRER	LRER	LRER
Net foreign assets (NFA)		**0.004**	**0.003**	**0.001**	**-0.001**	**-0.0004**	**-0.001**
		2.97	2.50	1.23	2.11	0.88	1.22
Real interest rates (INT)		**0.007**	**0.003**	**0.004**	**0.001**	**0.0004**	**0.0003**
		1.99	1.05	1.25	1.37	0.42	0.23
Balassa Samuelson-BS (LBAL2WT)		-	**0.568-**		-	-	-
		-	5.84	-	-	-	-
Productivity in tradables (LATRDWT)		-	-	**0.252**	**-0.453**	**-0.387**	**-0.365**
		-	-	1.57	6.66	6.53	5.43
Productivity in non-tradables (LANTRD)		-	-	**-0.608**	**-0.180**	**-0.184**	**-0.163**
		-		6.39	3.84	4.45	3.44
Wage in tradables (LWTRDWT)		-	-	-	**0.769**	-	-
		-	-	-	27.53	-	
Wage in industry (LWIND)		-	-	-	-	**0.763**	-
		-	-	-	-	31.82	-
Wage in manufacturing (LWMAN)		-	-	-	-	-	**0.740**
			-	-	-	-	27.45
Testing Restrictions on Coefficients							
Chi-square				6.070			
Probability				0.01			
Panel Unit Root Analysis							
PUR test	-0.66	-1.26	-2.85	-3.08	-0.97	-0.88	-1.61
Delta (from text)	-0.22	-0.29	-0.37	-0.39	-0.20	-0.22	-0.21
Half lifetime (years)	2.7	2.0	1.5	1.4			
Number of observations	153	153	153	153	153	153	153

Absolute t-ratios below coefficients.

Wald Test on restrictions. H0: LATRDWT+LANTRD=0. Do not reject if p-value above desired alpha (0.05).

Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1993) t-ratios discussed in the text. Half lifetime of deviations of the real exchange rate from estimated relation (years): log(0.5)/(log(1+delta)).

Table 7. Relative Competitiveness
(OLS)

	LRER	LRER	LRER	LRER
Net foreign assets (NFA)	**0.002**	**0.002**	**0.004**	**0.005**
	1.23	1.69	3.01	2.92
Real interest rates (INT)	**0.010**	**0.011**	**0.010**	**0.007**
	3.24	3.47	2.94	1.98
Competitiveness like BS (LE2BALWT)	-	-	-	**-0.050**
	-	-	-	0.12
Comp in tradables (LE2TRDWT)	**2.716**	**2.082**	**-**	**-**
	5.31	6.98	-	-
Comp in non-tradables (LE2NTRD)	**-0.526**	**-**	**0.966**	**-**
	1.52	-	4.41	-
Testing Restrictions on Coefficients				
Chi-square	51.48			
Probability	0.00			
Panel Unit Root Analysis				
PUR test	-1.71	-2.00	-1.13	-1.22
Delta (from text)	-0.33	-0.33	-0.30	-0.29
Half lifetime (years)	1.8	1.7	2	2
Number of observations	153	153	153	153

Absolute t-ratios below coefficient.

Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1993) t-ratios discussed in the text.

Half lifetime of deviations of the real exch. rate from estimated relation (years): log(0.5)/(log(1+delta)).

Table 8. Relative Productivity and Competitiveness: in Search of a Model
(OLS)

	LRER	LRER	LRER	LRER	LRER	LRER	LRER	LRER
Net foreign assets (NFA)	**0.001**	**0.001**	**0.002**	**0.004**	**0.001**	**0**	**0.002**	**0.003**
	1.38	0.99	2.40	3.09	0.41	0.04	1.86	1.99
Real interest rates (INT)	**0.007**	**0.007**	**0.006**	**0.004**	**0.007**	**0.007**	**0.006**	**0.004**
	2.63	2.57	2.38	1.29	2.73	2.72	2.40	1.37
Balassa Samuleson-BS (LBAL2WTM)	**0.651**	**0.580**	**0.752**	**0.719**	-	-	-	-
	7.29	7.25	8.84	6.81	-	-	-	-
Productivity in tradables (LATRDWT)	-	-	-	-	**0.435**	**0.347**	**0.666**	**0.504**
	-	-	-	-	2.74	2.62	4.84	2.67
Productivity in non-tradables (LANTRD)	-	-	-	-	**-0.701**	**-0.675**	**-0.781**	**-0.768**
	-	-	-		7.47	7.48	8.29	6.91
Competitiveness like BS (LE2BALWT)	-	-	-	**-1.212**	-	-	-	**-0.994**
	-	-	-	3.18	-	-	-	2.41
Comp in tradables (LE2TRDWT)	**1.423**	**2.114**	-	-	**1.644**	**2.061**	-	-
	3.02	8.28	-	-	3.37	8.15	-	-
Comp in non-tradables (LE2NTRD)	**0.577**	-	**1.419**	-	**0.356**	-	**1.381**	-
	1.74	-	7.74	-	1.00	-	7.21	-
Testing Restrictions on Coefficients								
Chi-square	23.50							
Probability	0.00							
Panel Unit Root Analysis								
PUR test	-4.99	-5.26	-4.12	-3.19	-4.29	-4.32	-4.25	-2.67
Delta (from text)	-0.52	-0.56	-0.48	-0.40	-0.49	-0.51	-0.48	-0.39
Half lifetime (years)	0.9	0.8	1	1.3	1	1	1	1.4
Number of observations	153	153	153	153	153	153	153	153

Absolute t-ratios below coefficients.
Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1993) t-ratios discussed in the text.
Half lifetime of deviations of the real exch. rate from estimated relation (years): log(0.5)/(log(1+delta)).

Table 9. Relative Productivity and Competitiveness: Controlling for the Wage Effect
(OLS)

	LRER	LRER	LRER	LRER
Net foreign assets (NFA)	**-0.000**	**-0.001**	**-0.001**	**-0.001**
	0.04	2.75	1.56	1.96
Real interest rates (INT)	**0.007**	**0.003**	**0.001**	**0.002**
	2.72	2.38	1.52	1.45
Productivity in tradables (LATRDWT)	**0.347**	**-0.362**	**-0.312**	**-0.276**
	2.62	5.49	5.46	4.36
Productivity in non-tradables (LANTRD)	**-0.675**	**-0.219**	**-0.218**	**-0.206**
	7.48	4.95	5.60	4.68
Comp in tradables (LE2TRDWT)	**2.061**	**0.621**	**0.552**	**0.677**
	8.15	4.87	4.89	5.45
Wage in tradables (LWTRDWT)	-	**0.690**	-	-
	-	23.85	-	-
Wage in industry (LWIND)	-	-	**0.703**	-
	-	-	27.75	-
Wage in manufacturing (LWMAN)	-	-	-	**0.671**
	-	-	-	24.31
Testing Restrictions on Coefficients				
Chi-square				
Probability				
Panel Unit Root Analysis				
PUR test	-4.32	-1.74	-1.43	-2.57
Delta (from text)	-0.51	-0.27	-0.28	-0.29
Half lifetime (years)	1			
Number of observations	153	153	153	153

Absolute t-ratios below coefficients.
Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1993) t-ratios discussed in the text.
Half lifetime of deviations of the real exch. rate from estimated relation (years): log(0.5)/(log(1+delta)).