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PPP AND THE BALASSA SAMUELSON EFFECT: THE ROLE OF THE DISTRIBUTION SECTOR

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Abstract

This paper investigates the impact of the distribution sector on the real exchange rate, controlling for the Balassa-Samuelson effect, as well as other macro variables. Long-run coefficients are estimated using a panel dynamic OLS estimator. The main result is that an increase in the productivity and competitiveness of the distribution sector with respect to foreign countries leads to an appreciation of the real exchange rate, similarly to what a relative increase in the domestic productivity of tradables does. This contrasts with the result that one would expect by considering the distribution sector as belonging to the non-tradable sector. One explanation may lie in the use of the services from the distribution sector in the tradable sector. Our results also contribute to explaining the so-called PPP puzzle.

JEL Classification: F31

Keywords: Real exchange rates, purchasing power parity, Balassa-Samuelson, distribution sector, PPP puzzle

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Introduction

Very few authors discuss the importance of the distribution sector in influencing the real exchange rate, and those that do consider this sector, either explicitly or implicitly, as non-tradable. For example, Dornbusch (1989) mentions the importance of the distribution sector in influencing the real exchange rate via "the service content of the consumer prices of goods". Recent studies, which use sectoral data to derive measures of relative productivity of tradables and non-tradables (so as to investigate the Balassa-Samuelson effect),[2] include the distribution sector in the non-tradable sector (De Gregorio, Giovannini, and Wolf, 1994; De Gregorio and Wolf, 1994; Chinn and Johnston, 1999). Burstein, Neves, and Rebelo (2000) explicitly discuss the role of the distribution sector in explaining the real exchange rate, but still treat the sector as a non-tradable (it is assumed to influence the domestic consumption price of tradables, after price equalization). Obstfeld and Rogoff (2000) briefly mention, but do not pursue, the role of the distribution sector as an alternative explanation for the relatively slow mean reversion in real exchange rates.

This view of the distribution sector influencing the real exchange rate through the non-tradable sector stems directly from the observation that arbitrage in the goods market does not occur at the consumer level but at the producer level.[3] Even abstracting from transportation costs and market pricing, and even if global market integration equalizes

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[2] The Balassa-Samuelson effect states that an increase in the relative productivity of tradables versus non-tradables of one country versus foreign countries raises its relative wage, thus increasing its relative price of non-tradables and its relative average price, and inducing an appreciation of the real exchange rate (RER). Most empirical studies of the Balassa-Samuelson effect on the RER compare aggregate measures of productivity across countries, such as GDP per capita, GDP per worker, or labor productivity in the manufacturing sector.

[3] It is interesting to note that when internet trade, or other forms of direct producer-consumer trade, will have developed internationally, goods arbitrage will tend to occur also at the consumer level, controlling for transportation costs.

prices at the producer level, the consumer prices for the same good may still differ across countries. For example, if one country has a more efficient distribution sector (say large retail outlets in the USA) than other countries (say small shops in some European countries), it will charge lower prices for the distribution services and it will have a lower consumer price index than its foreign counterpart, as both prices of tradables and non-tradables would, *ceteris paribus*, be lower. This would, in turn, be reflected in a more depreciated real exchange rate.

But is this in fact the case? The issue is important, given the size of the distribution (wholesale and retail trade) sector in the economy (see Tables 1 and 2), which often reaches 20 percent of industrial activity both in terms of value added and of employment, and might therefore account for a large component of prices. For example, using US input-output data, Burstein, Neves, and Rebelo (2000) show that consumption goods contain an important element of distribution services in the U.S. - around 47% of the final price for the agricultural sector and 42% in manufacturing.

This paper addresses the issue by examining the importance of the distribution sector in explaining deviations of the real exchange rate from purchasing power parity (PPP) and by assessing how the sector has its influence on the real exchange rate. To the extent that differences in the efficiency of the distribution sector across countries remain constant over time, they would simply generate constant gaps in consumer price levels across countries. In other words they would affect absolute PPP. Of course, this cannot be tested with the kind of price series usually exploited in PPP based studies – such as the CPI and WPI – since these series are in index form. However, to the extent that these differences change over time (for example, because of productivity growth or changes in the market structure of the retail sector) they would induce converging or diverging trends in relative prices and hence could explain systematic movements in real exchange rates. In the previous example, an empirically testable implication would be the following: an increase in the relative efficiency of the distribution sector with respect to the foreign country induces a depreciation of the real exchange rate.

In this paper long-run relations between the real exchange rate and a measure of efficiency of the distribution sector are estimated for nine countries over a 20-year period using a dynamic panel methodology. In order to ensure that any correlations we find between the real exchange rate and our distribution indicators are not spurious, in the sense that they capture some other trend(s) in the economy, we take as our reference scenario a basic model in which the real exchange rate is regressed on a number of key macroeconomic determinants of the real exchange rate (such as net foreign assets and real interest rate differentials), as well as on terms capturing the Balassa-Samuelson effect (we introduce not only jointly, but also separately, the two components of this effect: productivity in the tradable and non-tradable sectors). We then experiment with adding in various measures of the relative efficiency of the distribution sector: total factor productivity and the ratio of the number of employees to total employment (which, as discussed in Section 3, could be interpreted as a proxy for competitiveness). The importance of these variables is judged both in terms of their statistical significance and the impact they have on the speed of real exchange rate mean-reversion.

The remainder of this paper is set out as follows. In the next section we present a brief overview of some related literature. Section 2 describes a simple theoretical model which illustrates the role that distribution costs can have in determining the real exchange rate. In section 3 we discuss our data set and econometric methods. The empirical results are contained in section 4. Section 5 draws conclusions

1. A brief overview of the literature.

The validity of purchasing power parity (PPP), the proposition that exchange rates are determined by some measure of relative prices, has been the focus of intense empirical scrutiny in the recent academic literature (see, for example, the references in MacDonald (1995) and Rogoff (1996)). Traditional PPP, as originally proposed by Cassel (1922) asserts that although PPP is unlikely to hold continuously, a monetary shock should be absorbed in prices and exchange rates with a lag of about two years. Researchers who utilize cointegration methods to test for mean reversion in the residual of a regression of the nominal exchange rate on relative prices, or those who focus on the mean reversion of the real exchange rate, both come to the same conclusion: significant mean reversion is usually found although this is regarded as being too slow to be consistent with a traditional form of PPP, which—as just stated—requires a mean reversion speed of two years and hence a half-life of one year. The typical half-life reported in these studies is between 3 to 4 years. Such findings of significant mean reversion usually rely on using long historical time spans on a single currency (see Edison (1987), Frankel (1988) and Diebold, Husted and Rush (1991)), or applying panel estimators to data for the recent floating period (see Frankel and Rose (1995), MacDonald (1995), and Oh (1995)).[4]

[4] However, Engel (2000) has demonstrated that there can be substantial size biases in the long time span unit root tests implying that there may not be significant mean reversion in real exchange rates for such periods after all. Furthermore, Cheung and Lai (2000) have demonstrated, on the basis of an impulse response analysis, that the confidence intervals for half-lives are rather wide, and this suggests that a researcher should be cautious in interpreting point estimates of half-lives as a precise measure of mean-reversion.

A variety of avenues have been explored to try to explain the 'PPP puzzle' (Rogoff (1996)). One of these simply involves explicitly recognizing the role of real and macroeconomic factors in driving real exchange rates. The well known Balassa-Samuelson effect (see Balassa (1964) and Samuelson (1964)), discussed in some detail in the next section, introduces a systematic component into the real exchange rate through its effect on the relative price of traded to non-traded goods. The prediction that the real exchange rate is determined by a real interest differential is at the heart of many open economy macroeconomic models, such as the Mundell-Fleming-Dornbusch model; the positive relationship (between a higher differential and an appreciation) may be derived, either by assuming UIP and *ex ante* PPP (as in Meese and Rogoff (1988) and Edison and Melick (1995), or using UIP and a Phillips curve relationship for inflation (as in Obstfeld and Rogoff (1996)). Portfolio balance models (see Branson (1977) and Mussa (1986)) and intertemporal optimizing models (see Obstfeld and Rogoff (1995) and Lane and Milesi-Ferretti (2000)) suggest that higher net foreign assets induce an appreciation of the real exchange rate. The ratio of government spending to GDP is often seen as having a similar (demand) side effect (see Froot and Rogoff (1991), De Gregorio, Giovannini, and Wolf (1994), Rogoff (1992) and Chinn (1997)), as is per capita GDP as a determinant of private sector demand (see, for example, Bergstrand (1991)).[5]

However, there are other factors, relating to the relative price of traded goods that could explain the PPP puzzle. One of these is the pricing to market behavior by exporters, which effectively prevents traditional arbitrage forcing PPP (see Feenstra and Kendall (1997), Chinn and Fujii (1999)). Although this explanation for real exchange rate

[5] Terms of trade fluctuations have also been considered an important determinant of the real exchange rate, but especially for developing countries.

volatility has become especially popular in the new international macroeconomics (see, for example, Betts and Devereux (1996)), Obstfeld and Rogoff (2000) have cast doubt on this as an explanation for the persistence of real exchange rates. Indeed, amongst the factors they propose as being a more appealing explanation is the effect of the distribution sector on prices and hence the real exchange rate. A second explanation stresses the importance of transaction costs relating to the distance between trading centers, particularly transportation costs, in preventing arbitrage between trading centers. Such costs are usually captured in a non-linear framework, such as a threshold autoregressive model, and the application of these models indicates adjustment speeds for real exchange rates which are consistent with a traditional form PPP (see Obstfeld and Taylor (1997)). However, such costs are only a small proportion of traded goods prices and therefore seem insufficient on their own to explain the large observed deviations from PPP.[6] A much more significant set of costs relates to the distribution of goods, as discussed above and we now turn to a discussion of this potential explanation.

2. A Simple Motivational Model

This section provides a very simple framework to illustrate the role of the distribution sector, by explicitly introducing this sector into a simple Balassa-Samuelson framework with tradable and non-tradable goods. In reality, the distribution sector delivers both intermediate inputs to the firms that use them in the final stage of production and final goods to consumers. For the sake of simplicity, we assume that intermediate inputs are used only in the tradable sector and that distribution of final goods is necessary only in

[6] For example, Hummels (1999) estimates the average trade-weighted freight cost in the US in 1994 to be 3.8%, which is clearly very small compared to the effects of distribution costs referred to above.

the tradable sector; relaxation of these assumptions would deliver qualitatively identical results.[7]

The model assumes constant returns to labor in all primary activities, i.e. production of intermediate inputs (I), of distribution services (D), of non-tradables goods (N), and of the aggregation services (A) necessary to manufacture tradables from intermediate inputs. The technology for secondary activities are Cobb-Douglas: in goods I, D and A, for the production of tradables (T); and in goods T and D in order to make tradables available to consumers (TC).[8] The model is then completed by assuming different technologies in the primary activities across countries, identical Cobb-Douglas preferences in tradables and non-tradables across countries, wage equalization within countries, international price equalization for tradables, and non-tradability of intermediate inputs. In formulas, for country i (**i=1, 2**):

$$Y_{ki} = \frac{L_{ki}}{\beta_{ki}}, \quad k = I, D, N, A$$

$$Y_{Ti} = \frac{Y_{Ii}^{\gamma\eta} \; Y_{Di}^{1-\gamma} Y_{Ai}^{\gamma(1-\eta)}}{(\gamma\eta)^{\gamma\eta} \; (1-\gamma)^{1-\gamma} (\gamma(1-\eta))^{\gamma(1-\eta)}},$$

$$Y_{TCi} = \frac{Y_{Ti}^{1-\phi} \; Y_{Di}^{\phi}}{\phi^{\phi} \; (1-\phi)^{1-\phi}},$$

$$U_i = \frac{y_{Ni}^{\alpha} \; y_{TCi}^{1-\alpha}}{\alpha^{\alpha} \; (1-\alpha)^{1-\alpha}}$$

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[7] This choice of assumptions is also in line with the fact that most non-tradable activities (utilities, social services) have a vertically integrated distribution sector.

[8] A Cobb-Douglas technology is chosen for convenience. Assuming an additive rather than multiplicative technology, implying that the price of secondary activities is an arithmetic rather than geometric average of the prices of primary activities, would yield a different level of the real exchange rate, but an identical expression for its percentage change. Literally, a multiplicative technology in the tradable sector, for example, could be interpreted as implying that higher aggregation services (less defective process) can

where L_{ki} and β_{ki} represent, respectively, employment and unit labor input requirement prevailing in sector k and country i (for k= I, D, N, A), and Y_{ki} is the output in sector k of country i (for k= I, D, N, A, T, TC); U_i and y_{ki} stand for, respectively, the utility of one individual of country i and her/his demand for good k (for k=N, TC).

In equilibrium, given firms and consumer maximization problems and goods market clearing, the following equations for the price of the various goods and services of the two countries must hold:

$$p_{ki} = \beta_{ki} w_i, \qquad k = I, D, N, A,$$

$$p_{Ti} = p_{Ii}^{\gamma\eta}\ p_{Di}^{1-\gamma} p_{Ai}^{\gamma(1-\eta)} = w_i\, \beta_{Ii}^{\gamma\eta}\ \beta_{Di}^{1-\gamma} \beta_{Ai}^{\gamma(1-\eta)} \equiv w_i\, \beta_{Ti}^{\gamma}\ \beta_{Di}^{1-\gamma},$$

$$p_{TCi} = p_{Ti}^{1-\phi}\ p_{Di}^{\phi},$$

$$p_{T1} = e\, p_{T2},$$

$$p_i = p_{Ni}^{\alpha}\ p_{TCi}^{1-\alpha},$$

$$RER \equiv \frac{p_1}{e\, p_2} = \frac{p_{N1}^{\alpha}\ p_{TC1}^{1-\alpha}}{e\, p_{N2}^{\alpha}\ p_{TC2}^{1-\alpha}},$$

where w_i is the wage prevailing in country i, $\beta_{Ti} \equiv \beta_{Ii}^{\eta}\ \beta_{Ai}^{1-\eta}$ is the average productivity of the two stages of production of tradable goods in country i, and e is the nominal exchange rate (units of currency 2 for one unit of currency 1).

Price equalization of tradable goods determines relative wages and provides the familiar relation for the real exchange rate, which is now augmented for the distribution sector:

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substitute for higher delivery services (more timely, little damage in the merchandise) or higher inputs (better quality), and vice versa.

$$\frac{w_1}{e\,w_2} = \left(\frac{\beta_{T2}}{\beta_{T1}}\right)^{\gamma} \left(\frac{\beta_{D2}}{\beta_{D1}}\right)^{1-\gamma},$$

$$RER = \left(\frac{w_1}{ew_2}\right)^{\alpha+(1-\alpha)\phi} \left(\frac{\beta_{N1}}{\beta_{N2}}\right)^{\alpha} \left(\frac{\beta_{D1}}{\beta_{D2}}\right)^{(1-\alpha)\phi} = \left(\frac{\beta_{T2}}{\beta_{T1}}\right)^{\alpha\gamma+(1-\alpha)\phi\gamma} \left(\frac{\beta_{N2}}{\beta_{N1}}\right)^{-\alpha} \left(\frac{\beta_{D2}}{\beta_{D1}}\right)^{(1-\gamma)\alpha-(1-\alpha)\phi\gamma}$$

Hence, the real exchange rate of country 1 versus 2 will appreciate with the relative productivity of tradables (β_{T2}/β_{T1}) and will depreciate with the relative productivity of non-tradables (β_{N2}/β_{N1}). It will also appreciate with the relative productivity of the distribution sector (β_{D2}/β_{D1}), if this sector plays a bigger role in delivering goods in the tradable industry rather than to consumers. This is because the productivity of the distribution sector has two effects: on the one hand, it lowers the price of tradables (by lowering the cost of distributing intermediate inputs), thus raising the relative wage and appreciating the real exchange rate (similar to the effect of the productivity of tradables); on the other hand, it lowers the consumer price of tradables, depreciating the real exchange rate (similar to the effect of the productivity of non-tradables). [9]

This simple framework is designed to decompose the Balassa-Samuelson and distributional effects. It clearly neglects other macroeconomic variables, discussed in the previous section, which may be important in determining the real exchange rate. These ‘other’ macroeconomic variables are, however, considered in our empirical estimation.

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[9] The net effect of the distribution sector would be positive if $\phi<(1-\gamma)\alpha/((1-\alpha)\gamma)$. Note that if $\phi=0$ and $\gamma=1$, the distribution sector would disappear from the model and we would obtain the usual Balassa-Samuelson framework, where the exponent of the relative productivity of both tradables and non-tradables is α and $-\alpha$. In our model, the relative productivity of the tradable sector presents two differences with respect to a basic Balassa-Samuelson model: on the one hand, it has a smaller effect, as its impact on wages is less than proportional; on the other hand it has an additional positive effect, as its impact on wages also raises the consumption price of tradables via the employment cost of the distribution sector. Note also that the sum of all the exponents in the RER expression is zero. Allowing for intermediate inputs in the non-tradable sector

3. 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).[10] 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 the time series dimension of the panel were determined by the availability of consistent data, especially for the distribution sector variables, and by the need to balance the panel for the panel unit root test employed.

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 a number of macro-economic variables, including the relative size of net foreign assets to GDP ratios, a relative real interest rate term and measures of the Balassa-Samuelson effect (productivity in tradables and non-tradables are introduced both jointly – the usual way to analyze the Balassa-Samuelson effect – and separately). To check for robustness, we also control for the relative share of government spending to GDP. All these variables, apart from the Balassa-Samuelson terms, are from the IFS, OECD, World bank, and WEO macroeconomic data bases. The relative productivity in tradables and non-tradables are calculated by drawing from the OECD International Sectoral data base.

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would lower the exponents (and hence the impact) of the productivities in both tradable and non-tradable sectors.

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.[11] Notably, we exclude the distribution sector from the non-tradables, in order to focus on this sector separately.[12]

We then sequentially introduce into the regressions variables capturing the relative efficiency in the distribution sector with respect to the USA (proxy for β_{D2}/β_{D1}), calculated from the OECD International Sectoral database. The most obvious measure of efficiency is the relative total factor productivity in this sector. The database however allows the calculation of another proxy for efficiency: the ratio of the number of employees to total employment (E) in the distribution sector. This employment variable is designed to capture the competitiveness in the sector. For example, imagine a family owned retail store in the center of Rome with three members of the family hiring three employees: the E variable would equal ½. Imagine now a Wal-Mart in the USA, with 10 managers (maybe even just 1!) and 100 employees: the E variable would equal 1/11 (if not 1/101).This employment structure is likely to be reflected in the markup charged: in particular, a change in the E variable would imply a change in the price of the distribution services.[13] We therefore explore the empirical effect of each measure of efficiency in the distribution sector, both jointly and separately.

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

[11] 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 (1991). In the export content measurement exercise, the distribution sector is considered as part of services activity, as specific data within this activity is not available. Note that, in this classification, the services the distribution sector sells to the tradable sector would still be classified as non-tradable, inducing an undervaluation of the importance of the distribution sector as a tradable sector.

[12] 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.

[13] This variable is motivated by a simple model of monopolistic competition a' la Dixit-Stiglitz, with CES utility function and a production function characterized by a fixed cost and a constant marginal cost, both

Finally, by introducing the aggregate wage in industrial activity (and in the tradable sector defined above) as well as profit margins in the distribution sector (both series from the OECD International Sectoral database), we are able to analyze how the distribution effect gets 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 non-stationarity 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.

A version of the panel DOLS estimator which allows for limited heterogeneity in the form of fixed effects is:

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

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

costs being in terms of labor. In the equilibrium of this model, if one assumes that the fixed employment cost is given by the managers (the difference between total employment and number of employees) and the marginal cost by the employees, our E variable would equal the inverse of the markup. Hence, a lower 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.[14] As Pedroni (1997) notes, the residuals from an equation like (1) 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:

$$\Delta\omega_{it} = \delta\omega_{it-1} + \sum\nolimits_{j=1}^{n} \theta_{4i} \Delta\omega_{it-j} + u_{it}\,, \qquad (2)$$

where -δ represents the adjustment speed[15] and the t-ratio on this term, denoted "PUR test" in the empirical section of this paper, denotes the significance of the adjustment speed.[16] 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

markup could be interpreted as a more competitive sector. The framework presented above does not include imperfect competition or economies of scale for the sake of presentational simplicity.

[14] 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, as discussed in Section 4.5.

[15] Equation (1) 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.

[16] Levin and Lin (1993) also allow for other options such as fixed effects and time dummies. These options were not necessary in our PUR test, as these means were already removed in the first round of regressions or in the construction of data.

produces a test statistic which has a standard normal distribution and it is this adjusted t-statistic which we use in this paper.

4. Results

This section discusses the empirical results. In order to get a feel for the importance of the measures of efficiency in the distribution sector, we first present a set of regressions for the sectoral price equations. Then we go on to present estimates of our basic model, which consists of a regression of the CPI-based real exchange rate on net foreign assets, a real interest differential and a Balassa-Samuelson term. We proceed by investigating the role of the distribution sector, via the inclusion on the basic model of variables measuring the efficiency of this sector. We then discuss our implications for the "PPP puzzle". Finally, a number of robustness regressions are presented.

4.1. The relevance of the efficiency variables in the distribution sector.

Since a primary element in our model is the determination of prices across countries, we first run a check on the relevance of our efficiency variable in explaining prices in the distribution sector. In particular, using a panel DOLS estimator, we regress the relative price in this sector on relative total factor productivity, the competitiveness variable, and the wage in the distribution sector. These results are reported in Table 3. All variables are significant and with the expected sign (negative, negative, positive). While the relative price in the distribution sector appears to be non-stationary (second column), there is evidence of panel cointegration between this variable and the three aforementioned explanatory variables.[17]

[17] Controlling for real interest rate differentials, which could be interpreted as a macro determinant of sectoral prices, does not alter the result, and the interest rate term enters insignificantly.

4.2. A basic Balassa-Samuelson model of the real exchange rate.

Table 4 presents the basic model of the real exchange rate, which is dependent on two macroeconomic control variables (relative net foreign assets, NFA, and relative real interest rates, INT), and on the Balassa-Samuelson effect or on its two components (the relative productivity of tradable and of non-tradables). Robustness tests are performed here by dropping variables from the regression. In the first column of Table 4, we present the panel unit root (PUR) test for our real exchange rate series, taking into account of fixed effects.[18] The real exchange rate appears stationary, with a half-life of the deviations of approximately 3 years, which is in the range reported by other researchers using panel data sets (see section 1).

In the basic model specification, all of the variables enter with the correct sign and all are statistically significant. When the two productivity variables are entered separately, the control variables are no longer significant, suggesting that the macroeconomic variables are less important than the real variables capturing the Balassa-Samuelson effect. The PUR t-ratio is highly significant and we get a marked rise in the adjustment speed with the implied half-life now very close to the one year horizon.

The magnitude of the coefficient of the Balassa-Samuelson term, as well as of the two components, are about the middle of the range of coefficient estimates of previous work (Chinn and Johnston, 1996, report a range of 0.1 to 1.6 for the absolute value of these coefficients) and particularly close to the estimates related to bilateral exchange rates (as opposed to multilateral). An estimate of approximately 0.8 (with a standard error of about 0.1) could appear to be somewhat high: in the neoclassical world of Balassa-Samuelson the theoretical prediction for this elasticity is that it should equal the expenditure share on non-tradables. However, our result is consistent with those of Chinn and Johnson (1999) who apply a similar methodology and discuss this empirical anomaly. Note also that the theoretical prediction for this elasticity would be higher than the one suggested by the Balassa-Samuelson framework, if tradables, in order to be available for consumption, needed to be aggregated with non-tradables (see Burstein, Neves, and Rebelo, 2000, following Erceg and Levin, 1996).

Most empirical studies which include the Balassa-Samuelson effect either focus on aggregate measures of productivity (such as GDP per worker or labor productivity in manufacturing) or productivity in the tradable sector or the aggregate Balassa-Samuelson term. This is due partly to the lack of data for large set of countries and/or extensive time series, but also to the presumption that all of the action should come from the tradable sector.[19] Our data set facilitates entering the two components of the Balassa Samuelson term separately and testing the constraint that the coefficients on the two terms are equal and opposite, as the basic Balassa-Samuelson theory would suggest. On the basis of the reported chi-squared test, this hypothesis is rejected in the basic model. Perhaps more interestingly, the larger coefficient (in absolute value) is the one on productivity in the non-traded sector.

The coefficient on the NFA term is somewhat smaller than that reported in panel studies which focus on the real exchange rate - net foreign asset relationship (see Gagnon (1996) and Lane and Milesi-Ferretti (2000)), and also the interest rate coefficient is smaller than that reported by MacDonald and Nagayasu (2000), although the latter only focus on the relationship between the real exchange rate and real interest rate. We note

[18] Implicitly we also account for time dummies, as our variables have the cross-sectional mean removed.

that dropping the control variables one at a time, as well as simultaneously, does not significantly affect the size nor alter the significance of the Balassa-Samuelson terms or components, nor the stationarity of the residuals.

4.3. The influence of the distribution sector on the real exchange rate.

Figures 1 and 2 provide a first insight of the importance of the distribution sector, by clearly showing a positive relationship between the real exchange rate and each of the two measures of efficiency in the distribution sector, conditional on the explanatory variables employed in the previous Section.[20]

Table 5 presents econometric evidence of these results. The two benchmark models (the one with the control variables and the Balassa-Samuelson term, and the one with the control variables and the productivity of tradable and of non-tradables separately) are expanded by adding, one at a time or simultaneously, the two measures of relative efficiency in the distribution sector (relative productivity and competitiveness).

The distribution sector does not alter the sign, size, and significance of the coefficient on the Balassa-Samuelson variable. Note that when the two Balassa-Samuelson components are entered separately, however, their coefficients tend to be closer (in absolute value) than when the distribution sector is not in the regression.[21] In terms of the

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[19] In many simple text book representations of the Balassa-Samuelson effect, productivity in the non-traded sector is even assumed to be fixed across countries.

[20] On the vertical axis, the Figures plot the residuals of an OLS regression (with fixed effects and time dummies) of the endogenous variable on relative net foreign assets, interest rates, and productivity in both the tradable and non-tradable sector. On the horizontal axis, the figures plot the residuals of an OLS regression of the respective measures of efficiency in the distribution sector on fixed effects and time dummies.

[21] Indeed, one can actually accept the hypothesis that they are identical. However, our model suggests that once the distribution sector is taken into account, the relation among the coefficients should be different: more precisely, the coefficient of the productivity of non-tradables should equal (in absolute value) the sum of the coefficients of productivity of tradables and of the distribution sector. This new restriction hypothesis cannot properly be tested with our empirical result as we find two empirically useful measures of efficiency in the distribution sector. The reader may nonetheless be interested in knowing that if one ignores this

control variables, the coefficient on the relative interest rate differential is correctly signed, of similar size, and more significant than without the distribution sector. The coefficient of the net foreign asset variable, instead, becomes insignificant. The coefficients on both productivity and competitiveness in the distribution sector are strongly significant and positive (as one would expect, the size of these coefficients is reduced when they are both present in the regression, although they are both still largely significant).

These results suggest that the distribution sector influences the real exchange rate as a traded sector rather than as a non-traded sector, contrary to what the few earlier contributions speculating on the role of this sector have assumed. In terms of our simple theoretical model, this would suggest that the role of the distribution sector via the traded sector is stronger than via the non-traded sector. This plausibly reflects the fact that some components of the non-traded sector – such as utilities and social services – have vertically integrated distribution sectors, while most of the services of the distribution sector gets imputed into the traded components of manufacturing and agriculture.

Note that all of the PUR statistics are statistically significant (which is evidence of the stationarity of the estimated residuals) in Table 5. In the model with both measures of efficiency in the distribution sector, the implied half-life in this regression falls to unity, exactly the number which is the starting point for the PPP puzzle.

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problem (i.e. focuses on the productivity in the distribution sector) the new restriction hypothesis can be rejected in column 2 and accepted in column 6 of Table 5 at the 5 percent level of significance.

4.4. The influence of the distribution sector on the real exchange rate: Controlling for the wage effect is not enough.

This section attempts to further analyze the Balassa-Samuelson mechanism, in order to assess whether the distribution sector follows the same channel of influence on the real exchange rate. As we noted in section 2, the key variable in the Balassa-Samuelson effect is the wage rate. An increase in the productivity of tradables raises the domestic wage (as tradable prices are given) which, in turn, raises the price of non-tradables and induces an appreciation of the RER. An increase in the productivity of non-tradables, instead, would simply lower the price of these goods and induce a depreciation of the RER. We use two measures for the wage rate: the wage rate in the overall industrial activity is the measure suggested by the theory; as a check, we employ also the average wage in the tradable sector (built similarly to the productivity index - see the appendix). Not surprisingly, both measures yield similar results, given that wages are largely correlated across sectors within countries.

The first four columns of Table 6 introduce the wage in the basic model and in the benchmark model with the distribution sector. The wage term is always positive and highly significant, with a plausible coefficient (theoretically it should equal the share of expenditure on non-tradables).

The first main result is that the coefficient on the productivity of tradables becomes statistically negative after the introduction of the wage. In a standard Balassa-Samuelson model one would expect this coefficient to become zero (i.e. insignificant), as the wage would capture all of the effect of the productivity of tradables. The fact that the coefficient is significantly negative might be considered as evidence of imperfect substitutability across international goods produced in different countries. In the presence of imperfect substitutability of tradables, 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, both productivity in tradables and non-tradables would have a negative impact on the real exchange rate once we control for the Balassa-Samuelson effect via the wage channel. We leave for future work a deeper investigation of this interesting result.

The second main result concerns the effect that the introduction of the wage has on the distribution sector. Unlike the coefficient on productivity in the tradable sector, both the coefficients of the two measures of efficiency in the distribution sector maintain their sign as in the regression without the wage, although their size is smaller in absolute terms (third and fourth column of Table 6). This suggests that although productivity and competitiveness in the distribution sector have a similar effect to the productivity of tradables on the real exchange rate, wages do not appear to be the only conduit which facilitates the effect of distribution sector efficiency.

Through which other channel could the distribution sector influence the RER? One potential channel is profits. In fact, as demonstrated in the last two columns of Table 6, the inclusion of operating profits in the regression for the distribution sector makes the coefficient on the productivity in the distribution sector insignificant, leaving unaltered the significance and sign of other variables. Note, however, that competitiveness in the distribution sector remains positive and significant, perhaps suggesting that this variable also captures an externality in market structure, which should affect prices via game-theoretic incentives and would not show up in aggregate wages or sectoral operating profits.

One possible explanation for the role of profits is that international price equalization holds both for intermediate inputs and for final tradables. The equalization of prices of intermediate inputs determines wages and provides the channel for productivity of intermediate goods (part of tradables) to positively influence the RER, consistently with the Balassa-Samuelson effect. Then intermediate inputs are conveyed though the distribution sector to the production of a second stage of tradables. The price of this second stage of tradables, which includes the cost of distribution of such intermediate inputs, are also equalized internationally. If the distribution and the non-tradable sectors use a commonly specific factor such as land (or are similarly less competitive than tradables), and hence face similar operating profit margins, both sectors would see their profit margins being affected by the productivity of the distribution sector.[22] In this case operating profit margins would be the channel for the effect of productivity of the distribution sector on the RER. Productivity in tradables and productivity in the distribution sector would both similarly affect the RER thanks to international price equalization, but one via wages and one via profits. A model consistent with such results is presented in the Appendix.

4.5 The PPP Puzzle.

Although the main focus of our paper is on the role played by the distribution sector on the real exchange rate, our econometric results would seem to have an important bearing on the PPP puzzle. As noted in section 1, this puzzle relates to the finding by a number of researchers that the mean reversion in real exchange rates is too slow to be consistent with a traditional form of PPP. We now bring together the different mean reversion speeds mentioned at various places in the paper. First, we note that the half-life mean reversion speed for our real exchange rate series on its own is around three years (see Table 4), which is entirely consistent with the PPP puzzle. However, expanding the information set to include usual determinants of the real exchange rate raises significantly the speed: including only the relative net foreign asset position and the real interest differential reduces the half-life to 2.1, while including only the Balassa-Samuelson term produces a half-life of 1.6-1.8 years. In the basic model encompassing all these variables, the half-life drops to around 1.2-1.3 years. Perhaps our most striking finding is that by adding our measures of efficiency in the distribution sector to the basic model produces a half-life of about one year (Table 5). It would seem therefore that at least one important explanation for the PPP puzzle (there may of course be others, as we noted in Section 1) is to be found in the fundamental determinants of real exchange rates.

It is worth noting that the mean reversion speeds reported in this paper are calculated using time dummies in the original cointegrating regressions. In case the use of time dummies had a bearing on our mean reversion speeds, we re-estimated a representative set of regressions without time dummies. The estimated half-lives from these regressions turned out to be very similar to those presented in the paper and are therefore not reported

[22] Note that in the OECD dataset, operating profit margins include, for example, land rent.

here. Of course, one good reason for including time dummies in the original regression equations is that they sweep out the common effects arising from the use of a numeraire currency, the US dollar. However, O'Connell (1998) has argued that this may not be a sufficient solution to the problem of contemporaneous correlation and that a variant of the panel unit root test used in this paper may therefore have size biases. On the basis of Monte Carlo simulations, O'Connell tabulates the size biases for a range of different panel dimensions and contemporaneous correlations coefficients: in the worst case scenario, where the contemporaneous correlation is 0.9, the size adjustment for the t-ratios is approximately 37% (for panels such as those employed in this paper, and with a nominal critical value of 5 %). For a contemporaneous correlation of about 0.3, which is the average contemporaneous correlation in our panel residual, the actual size distortion is about 9% (for a nominal critical value of 5 %). As we obtain adjusted t-ratios for PUR test around levels of 6 or 7, all of our PUR tests would still be comfortably significant, not only considering the average correlation, but even in the worst scenario of high correlation. We feel confident, therefore, that the PUR tests reported in this paper indicate the importance of real and macroeconomic variables in explaining the PPP puzzle.

4.6. Robustness.

We perform various robustness tests on our benchmark specification identified in Table 5. First, similar to the exercise in Table 4, we eliminate the two control variables one at a time, as well as simultaneously, and these results are reported in Table 7. Second, in all these regressions we introduce the ratio of government spending to GDP, a variable often seen as a competing explanation to Balassa-Samuelson for explaining secular movements in real exchange rates (see, section 1) and these results are reported in Table 8.[23] Then we exclude one country at a time from the benchmark regression (Table 9). Finally, again for the benchmark regression, we change the time span of the sample and we run plain static OLS (Table 10).

These experiments indicate that our original results are robust. The distribution sector as well as the Balassa-Samuelson variables maintain their sign and significance, with the size of the coefficients varying little. Only in one case does the coefficient of productivity in the distribution sector become insignificant, and this is when the sample period is shortened by four years; this result could simply reflect the fact that with only twelve years of data (given leads and lags), the long-run estimation becomes less accurate.

5. Conclusions

This paper finds that an increase in productivity and in competitiveness of the distribution sector with respect to foreign countries leads to an appreciation of the real exchange rate, similar to what a relative increase in the domestic productivity of tradables would do. This contrasts with the result that one would expect by considering the distribution sector as belonging to the non-tradable sector, as several authors have assumed. Notably, this effect is coexistent with the usual Balassa-Samuelson effect of the productivity in the other tradable and non-tradable sectors (and holds also when controlling for other macro-determinants of the real exchange rate, such as net foreign

[23] In our results, government spending does not appear to have a long run effect when controlling for other variables. This stands in contradiction to the results of Froot and Rogoff (1991) and De Gregorio, Giovannini, and Wolf (1994). However, our results may not be surprising in light of Rogoff (1992) who argues that the effect of government spending should be transitory, as neutralized in the long run by factor mobility.

assets, real interest rates, and government spending to GDP ratios). One possible explanation offered for this result is the use of the services from the distribution sector to deliver intermediate goods used in the production of tradables has a larger impact on the real exchange rate than the use of distribution services to deliver final goods to consumers.

Accurate estimates of the long-run relations are obtained by employing dynamic panel estimation methods (dynamic OLS). Panel unit root tests support the hypothesis of panel cointegration among the series. Accounting for our explanatory variables (including the distribution sector) raises the speed of adjustment of temporary deviations of the real exchange rate from its long-run path, by lowering the half-life of such deviations to approximately one year and, as we have argued, this result would seem to contribute to solving the PPP puzzle. In other words, although the real exchange rate has a slow reversion to its average level (half-life of deviations of about 3 years), it has a reasonable speed of adjustment towards its equilibrium level (half-life of deviations of about 1 year), which depends on macroeconomic variables (such as net foreign assets position, real interest rate differential) but in particular on real variables measuring the Balassa-Samuelson effect and the efficiency in the distribution sector.

It is interesting to note that the channel of transmission of the distribution sector appears to be somewhat different from that predicted by the Balassa-Samuelson effect. The introduction of an aggregate wage variable does not crowd out the effect of the productivity and competitiveness in the distribution sector. However, the introduction of operating profits in the distribution sector makes the productivity of this sector become insignificant. This would be consistent with a model which entails two stages of price equalization (of intermediate inputs and of final tradables, with the latter making use of these intermediate inputs once delivered by the distribution sector) and equalization of operating profits margins across the distribution sector and non-tradables.

Appendix 1. 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 public expenditure size: $GOVY_j$ = (government expenditure/GDP)$_j$ - (government expenditure /GDP)$_{usa}$; Source: World Bank, World Economic Outlook (IMF) database.

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 Productivity in Distribution Sector: $LARWH_j = Log(TFP_{kj}/TFP_{usa})$, for k= Wholesale and retail trade sector (RWH). Source: OECD ISD.

Relative Competitiveness in Distribution Sector: $LERWH_j = Log((EE_{kj}/ET_{kj})/(EE_{k,usa}/ET_{k,usa}))$, for k= Wholesale and retail trade sector (RWH), EE=Number of Employees, ET=Total Employment. Source: OECD ISD.

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.

Relative Profit Margin in Distribution Sector: $LORWH_j = Log(OP_{kj}/OP_{usa})$, for k= Wholesale and retail trade sector (RWH), and OP = ratio of gross operating surplus to value added less indirect taxes. Source: OECD ISD.

Relative Wage in Distribution Sector: $LWRWH_j$ = $Log((WSSS_{kj}/(e_j*EE_{kj})))/(WSSS_{k,usa} / EE_{k,usa}))$, for k= Wholesale and retail trade sector (RWH), 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.

Relative Price in Distribution Sector: $LDRWH_j$ = $Log((GDP_{kj}/(e_j*GDPV_{kj})))/(GDP_{k,usa} / GDPV_{k,usa}))$, for k= Wholesale and retail trade sector (RWH), GDP= value added at market prices and current prices in national currency, GDPV= value added at market prices and 1990 prices in national currency, e = exchange rate (currency units of j per US$). Source: OECD ISD.

Appendix 2. A model consistent with the impact of the distribution sector via operating profit margins.

This appendix extends the model presented in the text to obtain predictions consistent with the results derived in Section 4.4 and Table 6: the positive effect of the productivity of tradables on the real exchange rate is mostly via wages while the effect of the productivity of the distribution sector is also via operating profit margins. Note that operating profit margins in the OECD database include return to factors such as land.[24] Hence, one could conceive the following channels. On the one hand, the Balassa-Samuelson effect of tradables operates via the impact on wages of price equalization of goods which do not involve the distribution sector (such as traded intermediate inputs). A similar effect of the distribution sector operates via the impact on the returns to other

[24] "Gross operating surplus is defined as the sum of operating surplus and consumption of fixed capital. The operating surplus during a period of account is the excess of the value added by resident producers during the period, over the sum of the costs of employee compensation, consumption of fixed capital and indirect

factors (specific to distribution and non-tradable sectors) of price equalization of tradable goods whose production involved the distribution sector (such as final tradables).

We now modify the model presented in the text by assuming that intermediate inputs are also traded and that the production functions in the distribution and non-tradable sector encompass both labor and land (H); for simplicity, neglect the aggregation stage in the tradable sector. In light of these new assumptions, for i=1, 2, obtain:

$$Y_{Ii} = \beta_{Ii}^{-1} L_{Ii},$$

$$Y_{Ni} = \beta_{Ni}^{-1} L_{Ni}^{\varepsilon}\ H_{Ni}^{1-\varepsilon} \Big/ \ (\varepsilon)^{\varepsilon}\ (1-\varepsilon)^{1-\varepsilon},$$

$$Y_{Di} = \beta_{Di}^{-1} L_{Di}^{\nu}\ H_{Di}^{1-\nu} \Big/ \ (\nu)^{\nu}\ (1-\nu)^{1-\nu},$$

$$Y_{Ti} = Y_{Ii}^{\gamma}\ Y_{Di}^{1-\gamma} \Big/ \ (\gamma)^{\gamma}\ (1-\gamma)^{1-\gamma},$$

$$Y_{TCi} = Y_{Ti}^{1-\phi}\ Y_{Di}^{\phi} \Big/ \phi^{\phi}\ (1-\phi)^{1-\phi},$$

$$U_i = \frac{y_{Ni}^{\alpha}\ \ y_{TCi}^{1-\alpha}}{\alpha^{\alpha}\ (1-\alpha)^{1-\alpha}},$$

where the symbols have the same interpretation as in the text. In equilibrium:

$$p_{Ii} = \beta_{Ii} w_i,$$

$$p_{Ni} = \beta_{Ni} w_i^{\varepsilon}\ r_i^{1-\varepsilon},$$

$$p_{Di} = \beta_{Di} w_i^{\nu}\ r_i^{1-\nu},$$

$$p_{Ti} = p_{Ii}^{\gamma}\ p_{Di}^{1-\gamma} = (w_i\, \beta_{Ti})^{\gamma} (\beta_{Di} w_i^{\nu}\ r_i^{1-\nu})^{1-\gamma},$$

$$p_{TCi} = p_{Ti}^{1-\phi}\ p_{Di}^{\phi},$$

$$p_{T1} = e\, p_{T2}$$

taxes reduced by subsidies, which they incur during the period." OECD International Sectoral Database

$$p_i = p_{Ni}^{\alpha} \ \ p_{TCi}^{1-\alpha}$$

$$RER = \frac{p_1}{e\,p_2} = \frac{p_{N1}^{\alpha} \ \ p_{TC1}^{1-\alpha}}{e\,p_{N2}^{\alpha} \ \ p_{TC2}^{1-\alpha}}$$

where r_i is the land rent in country i, and $\beta_{Ti} \equiv \beta_{Ii}$ now defines the productivity in the production of tradable goods in country i. Price equalization of intermediate inputs (I) determines the relative wages, while price equalization for final tradables (T) determines the relative return on H:

$$\frac{w_1}{e\,w_2} = \frac{\beta_{T2}}{\beta_{T1}} \quad , \qquad \left(\frac{r_1}{e\,r_2}\right)^{1-\nu} = \frac{\beta_{D2}}{\beta_{D1}}\left(\frac{\beta_{T1}}{\beta_{T2}}\right)^{\nu}$$

The equilibrium real exchange rate is now given by:

$$RER = \left(\frac{\beta_{T2}}{\beta_{T1}}\right)^{\alpha(\varepsilon-\nu)/(1-\nu)} \left(\frac{\beta_{N2}}{\beta_{N1}}\right)^{-\alpha} \left(\frac{\beta_{D2}}{\beta_{D1}}\right)^{\alpha(1-\varepsilon)/(1-\nu)}$$

The relative productivity of tradables has a positive effect on the real exchange rates via the wages and a negative one via the return on H: hence, for the net effect to be positive (as empirically found), the wage channel has to be stronger. The relative productivity of the distribution sector of country 1 versus 2 affects positively the real exchange rates via the return on H. [25]

manual, 1998, p.33.

[25] The impact of the distribution sector is unambiguously positive in this setup as the elimination of the agglomeration services enhance the positive impact of the distribution sector on factor rewards (return to H in this case, as opposed to wage in the text). As usual, the real exchange rate will depreciate with the relative productivity of non-tradables.

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Figure 1. conditional correlation

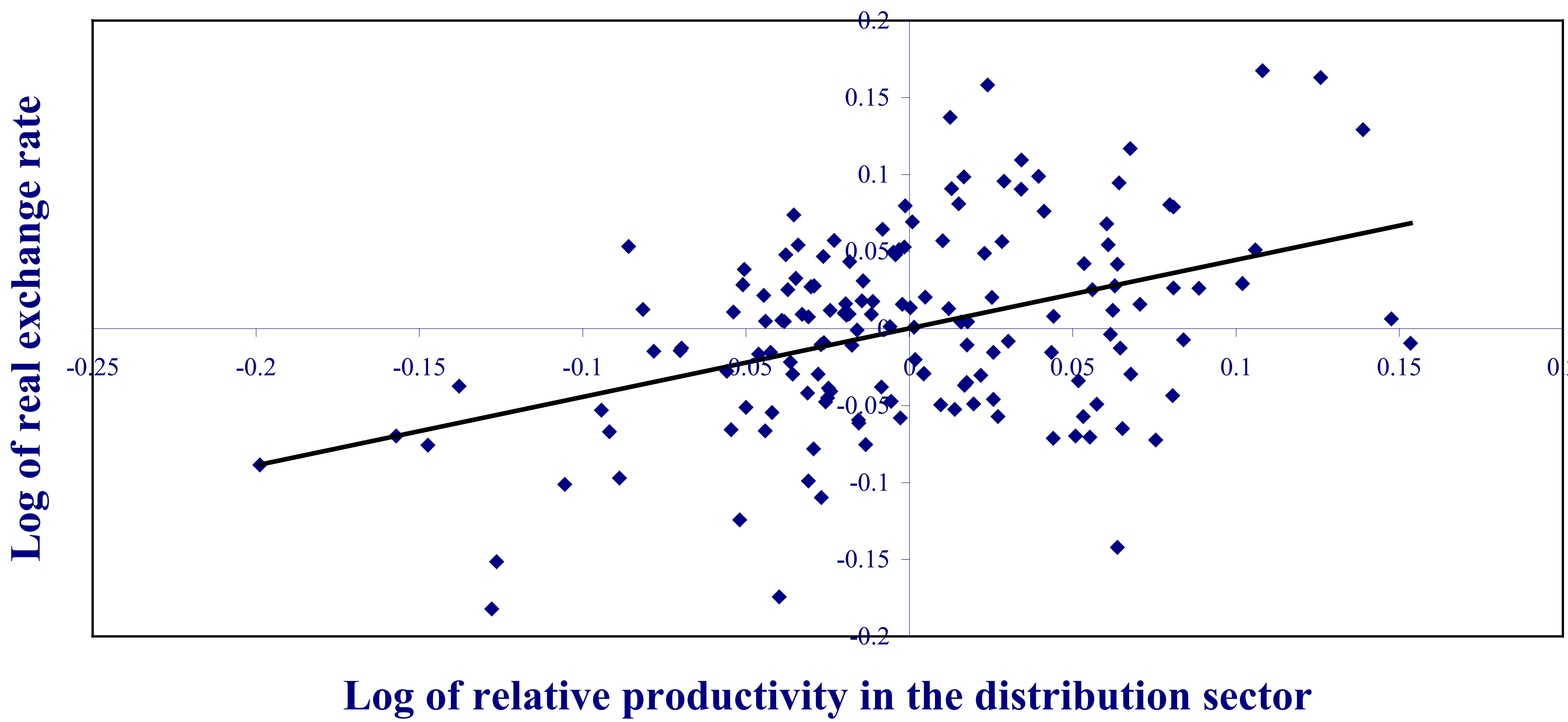

Figure 2. conditional correlation

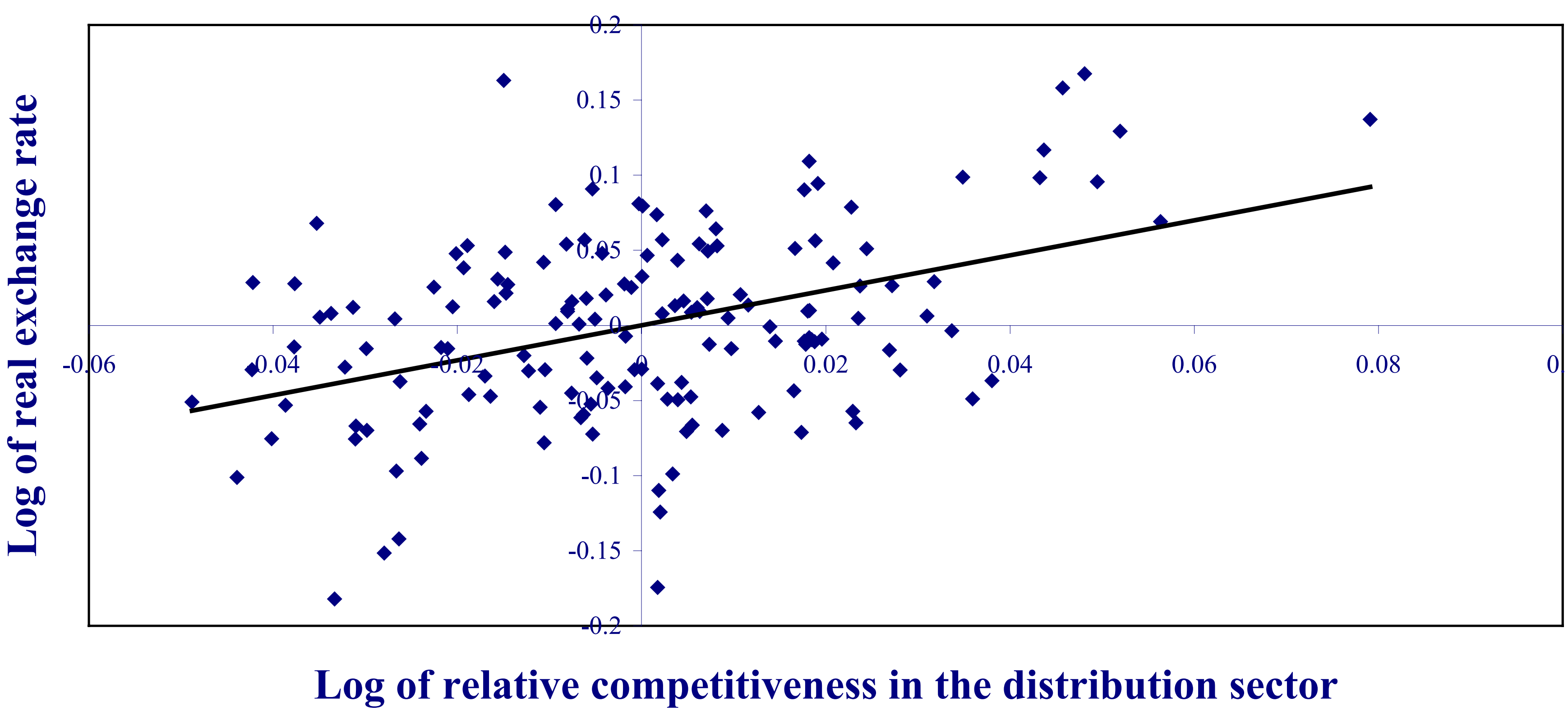

Table 1: Sectoral Composition of Economic Activity

(1970-92 Average of 10 European Countries)

	Sectoral Share in Industrial Activity		Sectoral Share in National GDP	
	Gross Domestic Value Added (GDP)	Total Employment (ET)	Gross Domestic Value Added (GDP)	Total Employment (ET)
Sector				
Community, social & personal serv. (SOC)	10.15	11.34	8.71	9.18
Finance, ins., real est., bus. ser (FNI)	15.37	9.18	12.84	7.12
Transport, storage & communication (TRS)	8.51	8.10	7.15	6.36
Wholesale & retail trade (RWH)	15.21	18.68	12.87	14.91
Construction (CST)	8.21	9.73	6.92	7.73
Electricity, gas and water (EGW)	3.44	1.14	2.91	0.90
Manufacturing (MAN)	28.91	30.03	24.47	23.87
Mining and quarrying (MID)	1.85	0.67	1.57	0.54
Agriculture, hunt., for. & fishing (AGR)	5.24	10.15	4.40	8.16
Other	3.11	0.97	18.17	21.23
Total Industry (TIN)	100.00	100.00		
Total Economic Activity (TET)			100.00	100.00

Source: OECD International Sectoral Database; OECD datacode in parenthesis.

Table 2: Importance of Distribution Sector
(Wholesale & Retail Trade (RWH), 1970-92 Average)

	Gross Domestic Value Added (GDP)	Total Employment (ET)
Country		
Belgium (BEL)	17.16	20.92
Denmark (DNK)	17.49	16.99
Finland (FIN)	13.00	16.99
France (FRA)	15.54	18.11
Italy (ITA)	17.29	18.77
Japan (JPN)	15.07	18.97
Norway (NOR)	14.45	18.43
Sweden (SWE)	13.06	17.67
Western Germany (WGR)	10.85	15.81
United States (USA)	18.23	24.17
Average	15.21	18.68

Source: OECD International Sectoral Database; OECD datacode in parenthesis.

Table 3: Determinants of the Relative Prices of the Distribution Sector
(Dynamic OLS)

	Price (DRWH)	Price (DRWH)
Productivity (ARWH)	**-0.613**	**-**
	5.87	-
Competitiveness (ERWH)	**-0.609**	**-**
	2.49	-
Wage (WRWH)	**0.651**	**-**
	10.99	-
Panel Unit Root Analysis		
PUR test	-4.82	-0.97
Delta (from text)	-0.23	-0.22
Half lifetime (years)	2.7	2.8
Number of observations	153	153

Absolute t-ratios below coefficients
Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1996) 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: Basic Model of RER and its Robustness
(Dynamic OLS)

		basic model								
	LRER [1]	**LRER**	**LRER**	**LRER**	**LRER**	**LRER**	**LRER**	**LRER**	**LRER**	**LRER**
Net foreign assets (NFA)	**-**	**0.004**	**0.001**	**0.004**	**0.001**	**-**	**-**	**-**	**-**	**0.005**
	-	2.02	0.41	1.92	0.61	-	-	-	-	2.94
Real interest rates (INT)	**-**	**0.013**	**0.007**	**-**	**-**	**0.014**	**0.012**	**-**	**-**	**0.03**
	-	1.91	0.87	-	-	2.23	1.83	-	-	4.20
Balassa samuelson (LBAL2WT)	**-**	**0.769**	**-**	**0.815**	**-**	**0.760**	**-**	**0.785**	**-**	**-**
	-	6.45	-	7.58	-	6.67	-	7.26	-	-
Productivity in tradables (LATRDWT)	**-**	**-**	**0.418**	**-**	**0.425**	**-**	**0.271**	**-**	**0.315**	**-**
	-	-	1.93	-	2.04	-	1.37	-	1.66	-
Productivity in non-tradables (LANTRD)	**-**	**-**	**-0.948**	**-**	**-0.934**	**-**	**-0.909**	**-**	**-0.910**	**-**
	-	-	-7.15	-	-7.95	-	-7.67	-	-8.07	-
Testing restrictions on balassa samuelson										
Chi-square			4.92		4.76		9.63		8.64	
Probability			0.03		0.03		0.00		0.00	
Panel Unit Root Analysis										
PUR test	-7.02	-7.08	-6.64	-7.31	-6.65	-6.44	-5.93	-6.02	-5.92	-4.75
Delta (from text)	-0.22	-0.44	-0.42	-0.44	-0.42	-0.38	-0.35	-0.32	-0.35	-0.282
Half lifetime (years)	2.8	1.2	1.3	1.2	1.3	1.4	1.6	1.8	1.6	2.1
Number of observations	153	153	153	153	153	153	153	153	153	153

Absolute t-ratios below coefficients
Wald Test on restrictions. H0: LATRDWT=-LANTRD. Do not reject if p-value above desired alpha (0.05)
Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1996) 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
[1] First column provides PUR test on residual of LRER on fixed effects.

Table 5: The Influence of the Distribution Sector on RER
(Dynamic OLS)

					benchmark model	
	LRER	**LRER**	**LRER**	**LRER**	**LRER**	**LRER**
Net foreign assets (NFA)	**-0.003**	**-0.003**	**-0.001**	**-0.002**	**-0.002**	**-0.002**
	1.44	1.32	0.44	0.85	1.55	1.29
Real interest rates (INT)	**0.012**	**0.011**	**0.018**	**0.018**	**0.016**	**0.017**
	2.02	1.59	3.34	2.65	2.82	2.6
Balassa samuelson (LBAL2WT)	**0.687**	**-**	**0.893**	**-**	**0.832**	**-**
	6.59	-	9.41	-	8.45	-
Productivity in tradables (LATRDWT)	**-**	**0.664**	**-**	**0.733**	**-**	**0.857**
	-	3.36	-	3.98	-	4.58
Productivity in non-tradables (LANTRD)	**-**	**-0.706**	**-**	**-0.934**	**-**	**-0.82**
	-	5.79	-	8.63	-	7.22
Productivity in distribution (LARWH)	**0.797**	**0.767**	**-**	**-**	**0.422**	**0.437**
	7.92	6.43	-	-	3.63	3.39
Competitiveness in distribution (LERWH)	**-**	**-**	**2.043**	**1.979**	**1.482**	**1.518**
	-	-	8.85	7.49	5.35	5.14
Testing restrictions on coefficients						
Chi-square		6.463				3.024
Probability		0.011				0.082
Panel Unit Root Analysis						
PUR test	-7.38	-7.08	-6.29	-6.22	-6.86	-6.97
Delta (from text)	-0.44	-0.44	-0.46	-0.45	-0.5	-0.51
Half lifetime (years)	1.2	1.2	1.1	1.2	1.0	1.0
Number of observations	153	153	153	153	153	153

Absolute t-ratios below coefficients
Wald Test on restrictions. H0: LATRDWT+LANTRD+LARWH=0. Do not reject if p-value above desired alpha (0.05)
Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1996) 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 6: The Influence of the Distribution Sector on RER: Controlling for the Wage Effect
(Dynamic OLS)

	LRER	LRER	LRER	LRER	LRER	LRER
Net foreign assets (NFA)	**-0.002**	**-0.001**	**-0.003**	**-0.003**	**-0.003**	**-0.002**
	2.37	1.65	3.97	4.00	3.42	3.29
Real interest rates (INT)	**0.004**	**0.002**	**0.007**	**0.005**	**0.006**	**0.005**
	1.58	1.02	2.74	2.53	2.54	2.71
Productivity in tradables (LATRDWT)	**-0.587**	**-0.566**	**-0.253**	**-0.278**	**-0.120**	**-0.153**
	6.67	7.30	2.78	3.60	1.37	2.13
Productivity in non-tradables (LANTRD)	**-0.259**	**-0.221**	**-0.306**	**-0.283**	**-0.459**	**-0.393**
	4.83	4.54	6.08	6.46	8.38	8.50
Productivity in distribution (LARWH)	-	-	**0.230**	**0.182**	**-0.010**	**-0.021**
	-	-	4.47	4.04	0.16	0.39
Competitiveness in distribution (LERWH)	-	-	**0.353**	**0.392**	**1.008**	**0.978**
	-	-	2.69	3.46	5.91	6.96
Wage in tradables (LWTRDWT)	**0.719**	**-**	**0.580**	**-**	**0.530**	**-**
	22.06	-	16.45	-	16.29	-
Wage in industry (LWIND)	**-**	**0.737**	**-**	**0.606**	**-**	**0.566**
	-	25.09	-	19.71	-	20.44
Wage in manufacturing (LWMAN)	**-**	**-**	**-**	**-**	**-**	**-**
	-	-	-	-	-	-
Profits in distribution (ORWH)	**-**	**-**	**-**	**-**	**0.104**	**0.095**
	-	**-**	-	-	3.47	3.77
Panel Unit Root Analysis						
PUR test	-4.7	-5.48	-7.03	-5.95	-6.87	-7.94
Delta (from text)	-0.26	-0.28	-0.41	-0.38	-0.46	-0.54
Half lifetime (years)	2.3	2.1	1.3	1.4	1.1	0.9
Number of observations	153	153	153	153	153	153

Absolute t-ratios below coefficients
Panel Unit Root (PUR) test: 'adjusted' Levin and Lin (1996) 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 7: Robustness: Dropping Control Variables
(Dynamic OLS)

	LRER	LRER	LRER	LRER	LRER	LRER
Net foreign assets (NFA)	**-0.002**	**-0.001**	**-**	**-**	**-**	**-**
	1.18	0.66	-	-	-	-
Real interest rates (INT)	**-**	**-**	**0.018**	**0.018**	**-**	**-**
	-	-	3.61	3.27	-	-
Balassa samuelson (LBAL2WT)	**0.843**	**-**	**0.821**	**-**	**0.829**	**-**
	8.52	-	8.71	-	8.52	-
Productivity in tradables (LATRDWT)	**-**	**0.923**	**-**	**0.930**	**-**	**0.964**
	-	4.68	-	5.33	-	5.34
Productivity in non-tradables (LANTRD)	**-**	**-0.802**	**-**	**-0.795**	**-**	**-0.763**
	-	7.26	-	7.64	-	7.11
Productivity in distribution (LARWH)	**0.409**	**0.359**	**0.377**	**0.412**	**0.406**	**0.400**
	3.30	2.68	3.45	3.36	3.48	3.12
Competitiveness in distribution (LERWH)	**1.170**	**1.128**	**1.489**	**1.528**	**1.174**	**1.144**
	4.15	3.96	5.43	5.31	4.18	4.04
Panel Unit Root Analysis						
PUR test	-6.97	-6.82	-6.76	-7.18	-6.97	-7.03
Delta (from text)	-0.47	-0.48	-0.49	-0.5	-0.44	-0.46
Half lifetime (years)	1.1	1.1	1.0	1.0	1.2	1.1
Number of observations	153	153	153	153	153	153

Absolute t-ratios below coefficients
Panel Unit Root (PUR) test: ‘adjusted’ Levin and Lin (1996) 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: Robustness: The Influence of the Government Spending Ratio
(Dynamic OLS)

	LRER	LRER	LRER	LRER	LRER	LRER	LRER	LRER
Net foreign assets (NFA)	**-0.003**	**-0.002**	**-0.002**	**-0.002**	**-**	**-**	**-**	**-**
	1.77	1.46	1.41	0.94	-	-	-	-
Real interest rates (INT)	**0.0148**	**0.017**	**-**	**-**	**0.017**	**0.017**	**-**	**-**
	2.51	2.48	-	-	3.08	2.92	-	-
Balassa samuelson (LBAL2WT)	**0.822**	**-**	**0.805**	**-**	**0.815**	**-**	**0.796**	**-**
	8.16	-	7.91	-	8.54	-	8.11	-
Productivity in tradables (LATRDWT)	**-**	**0.8599**	**-**	**0.896**	**-**	**0.956**	**-**	**0.954**
	-	4.504	-	4.47	-	5.34	-	5.16
Productivity in non-tradables (LANTRD)	**-**	**-0.799**	**-**	**-0.776**	**-**	**-0.780**	**-**	**-0.742**
	-	6.92	-	6.88	-	7.44	-	6.95
Productivity in distribution (LARWH)	**0.404**	**0.4328**	**0.398**	**0.364**	**0.346**	**0.387**	**0.381**	**0.380**
	3.36	3.2659	3.17	2.65	3.02	3.08	3.22	2.95
Competitiveness in distribution (LERWH)	**1.5629**	**1.6241**	**1.344**	**1.312**	**1.570**	**1.619**	**1.350**	**1.337**
	5.63	5.448	4.79	4.55	5.70	5.58	4.84	4.71
Government spending ratio (GOVYM)	**-0.004**	**-0.005**	**0.01**	**0.00**	**-0.01**	**-0.01**	**0.02**	**0.01**
	0.14	0.155	0.19	0.08	0.18	0.34	0.55	0.22
Panel Unit Root Analysis								
PUR test	-7.11	-7.23	-7.99	-7.5	-6.99	-7.14	-8.29	-8.22
Delta (from text)	-0.52	-0.53	-0.53	-0.53	-0.51	-0.53	-0.55	-0.55
Half lifetime (years)	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9
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 (1996) 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: Robustness: Excluding One Country at a Time
(Dynamic OLS)

		Excluding								
	Benchmark LRER	**BEL LRER**	**DEN LRER**	**FIN LRER**	**FRA LRER**	**ITA LRER**	**JAP LRER**	**NOR LRER**	**SWE LRER**	**WGR LRER**
Net foreign assets (NFA)	**-0.002**	**-0.005**	**-0.002**	**-0.002**	**0.000**	**-0.005**	**0.001**	**-0.002**	**-0.001**	**-0.003**
	1.30	2.32	0.99	1.39	0.16	2.38	0.83	1.44	0.46	1.75
Real interest rates (INT)	**0.017**	**0.013**	**0.015**	**0.013**	**0.024**	**0.008**	**0.019**	**0.028**	**0.025**	**0.021**
	2.61	1.96	2.03	2.01	2.98	1.20	2.96	3.77	3.57	2.83
Productivity in tradables (LATRDWT)	**0.857**	**1.073**	**0.885**	**0.673**	**0.925**	**0.764**	**0.636**	**0.373**	**1.155**	**0.968**
	4.59	5.47	4.66	3.24	4.58	3.63	3.39	1.59	5.00	4.78
Productivity in non-tradables (LANTRD)	**-0.820**	**-0.926**	**-0.807**	**-0.979**	**-0.704**	**-0.685**	**-0.501**	**-0.950**	**-0.851**	**-0.863**
	7.22	7.88	6.75	7.65	5.16	5.02	3.81	7.78	7.11	7.02
Productivity in distribution (LARWH)	**0.437**	**0.295**	**0.547**	**0.226**	**0.256**	**0.561**	**0.274**	**0.363**	**0.462**	**0.427**
	3.40	1.97	4.02	1.46	1.53	4.12	2.10	2.74	3.52	3.44
Competitiveness in distribution (LERWH)	**1.518**	**1.508**	**1.481**	**1.664**	**2.114**	**1.743**	**0.812**	**1.476**	**1.740**	**1.645**
	5.14	4.98	4.84	5.40	4.98	5.00	2.38	4.92	5.55	5.05
Number of observations	153	136	136	136	136	136	136	136	136	136

Absolute t-ratios below coefficients

Table 10: Robustness: Changes in Time Span and Static OLS

	Benchmark DOLS 1973 - 89 LRER	DOLS 1975 - 87 LRER	DOLS 1975 - 89 LRER	DOLS 1973 - 1987 LRER	Static OLS 1973 - 89 LRER
Net foreign assets (NFA)	**-0.002**	**0.002**	**0.000**	**-0.001**	**-0.001**
	1.30	0.94	0.09	0.24	0.74
Real interest rates (INT)	**0.017**	**0.012**	**0.015**	**0.019**	**0.004**
	2.61	1.33	1.92	2.61	1.53
Productivity in tradables (LATRDWT)	**0.857**	**1.186**	**1.230**	**0.662**	**0.506**
	4.59	4.02	5.03	3.16	3.59
Productivity in non-tradables (LANTRD)	**-0.820**	**-1.064**	**-1.060**	**-0.795**	**-0.679**
	7.22	6.11	7.92	5.82	7.37
Productivity in distribution (LARWH)	**0.437**	**0.225**	**0.332**	**0.358**	**0.339**
	3.40	1.22	2.21	2.37	3.72
Competitiveness in distribution (LERWH)	**1.518**	**1.757**	**1.527**	**1.541**	**1.089**
	5.14	3.94	4.29	4.52	4.42
Number of observations	153	117	135	135	153

Absolute t-ratios below coefficients