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The real exchange rate of the dollar for a panel of OECD countries: Balassa-Samuelson or distribution sector effect?*

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Abstract

The purpose of this paper is to analyse the role of productivity in the behaviour of the dollar real exchange rate against a group of OECD countries' currencies. To do this, a general specification is tested, paying special attention to the breakdown of the productivity variable into tradables, non-tradables and distribution sector productivity. The applied methodology relies on the Pool Mean Group estimation methodology proposed by Pesaran et al (1999) to obtain error correction models in panels without imposing equal long and short-run parameters for the panel. The results point to the relevance of the differences in the distribution sector productivity to explain the real exchange rate, especially in the European Union countries. These results are in accordance with New Open Macroeconomics models predictions concerning the role of both distribution sector productivity and fiscal expenditure on the real exchange rate.

Keywords: real exchange rates, productivity, cointegration, panel, distribution sector

JEL classification: C33, F31

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1 Introduction

The introduction of the Euro as a major international currency has fostered the interest of academic research on the determinants of the euro-dollar real exchange rate. In particular, the first episodes of strong real depreciation just after the euro launching were mainly associated with productivity differentials. According to the "New Economy" argument, the introduction of new information technologies had been more successful in the United States and, as a result, the productivity gap with other OECD countries, especially the EU countries, had widened. However, the empirical evidence has been mixed so far.

Recently, and using different measures of aggregate productivity, Alquist and Chinn (2002), Camarero et al. (2005) and Schnatz et al. (2004) have found empirical evidence supporting the role of productivity to explain the euro-dollar real exchange rate behaviour. However, as they use aggregate productivity measures, the models they specify do not allow for the Balassa-Samuelson effect. Recent theoretical contributions by Devereux (1999) and MacDonald and Ricci (2003) stress the relevance of decomposing productivity into three components: traded-goods sector, non-traded goods and distribution services. This breakdown allows for a careful consideration of the role played by the distribution sector productivity and its influence on real exchange rate behaviour.

According to Devereux (1999), the deregulation process undergone in many economies that were opening up in recent years to international competition in the distribution services, may have caused a real exchange rate depreciation through the reduction in traded goods prices. In a New Open Macroeconomics (NOM hereafter) setting, the importance of this effect may have been such that it might compensate the Balassa-Samuelson effect so that the total effect perceived is a depreciation of the currency. In contrast, MacDonald and Ricci (2003) would argue that a relative increase in distribution services productivity may act as a traded good (as it reduces the cost of producing traded goods) and cause an appreciation of the currency.

The present paper analyses the behaviour of the real exchange rate of the dollar against a group of OECD countries for the period 1970-1998. Using the econometric methodology proposed by Pesaran et al. (1999) we specify a general model that encompasses the most important explanatory variables suggested by the theory: from the simpler form of the Meese and Rogoff (1988) monetary model, to the Balassa-Samuelson effect and the Rogoff (1992) model on the role of fiscal policy for real exchange rate determination. In addition, the adopted specification allows us to test for the above mentioned distribution effect on real exchange rates.

This paper adds to the literature on the role of productivity in real exchange rate determination in several respects. First, the productivity measure is based on OECD labour productivity, allowing for three sectors: tradables, non-tradables and distribution. Second, the variable we are focused on is the real exchange rate for the pre-euro currencies of the euro-area countries, in a panel including also other OECD countries. Third, the econometric methodology applied does not impose equal long-run parameters for all the variables, so that an important degree of heterogeneity is allowed.

The rest of the paper is organised as follows. Section two is devoted to a brief summary of the theoretical issues. The third section describes the data and the model specified. The empirical results are discussed in section four and finally, the last section sets out the conclusions.

2 Theoretical issues

Although the theoretical approach adopted in this paper can be called eclectic, a special emphasis is placed on the distinction between productivity in the traded goods sector, non-traded goods and distribution services productivity, as in MacDonald and Ricci (2003). The empirical model encompasses a general specification including the main explanatory variables used in the literature.

According to the seminal paper of Meese and Rogoff's (1988), the real exchange rate q_t is defined as $q_t \equiv -e_t + p_t - p_t^*$, where e_t is the price of the domestic currency in terms of the foreign currency and p_t and p_t^* are the logarithms of domestic and foreign prices. Three assumptions are made: first, that when a shock occurs, the real exchange rate returns to its equilibrium value at a constant rate; second, the long-run real exchange rate, $\hat{q}_t$, is a non-stationary variable; finally, the uncovered real interest rate parity is fulfilled.

Combining the three assumptions above, the real exchange rate can be expressed in the following form:

$$q_t = \varphi(R_t - R_t^*) + \hat{q}_t \tag{1}$$

where R_t^* and R_t stand for the real foreign interest rate and the domestic real interest rates for an asset of maturity k, respectively. This leaves relatively open the question of which are the determinants of $\hat{q}_t$ which is a non-stationary variable.

This model has been very influential in the empirical literature. In fact, the implementation of the empirical tests depends on the treatment of the expected real exchange rate derived from equation (1). The simplest model will assume that the expected real exchange rate is constant, while more sophisticated models are specified using other determinants.

This model was first tested, in its simplest version, in the well-known works of Campbell and Clarida (1987) and Meese and Rogoff (1988), which were unable to find a long-run relationship between the two variables. However, Baxter (1994) and MacDonald and Nagayasu (2000) found more encouraging results later.

The assumption that the expected real exchange rate is constant can be relaxed, so that the real exchange rate would be explained using additional variables. This approach was first introduced by Hooper and Morton (1982) who modelled the expected real exchange rate as a function of accumulated current account. Wu (1999) has recently obtained good results (even in terms of forecasting ability) for this type of specification.

MacDonald (1998) also follows this approach, dividing the real exchange rate determinants into two components: the real interest rate differential and a set of fundamentals. These fundamentals would explain the behaviour of the long-run (equilibrium) real exchange rate, and include productivity differentials, the effect of relative fiscal balances on the equilibrium real exchange rate, the private sector savings and the real price of oil.

In what follows, this eclectic approach is described in more detail, as it is be the basis of the empirical analysis in the next sections.

Assuming that PPP holds for non-traded goods, it is possible to arrive at the following expression for the long-run equilibrium real exchange rate:

$$\hat{q}_t \equiv q_t^T + \alpha_t(p_t^T - p_t^{NT}) - \alpha_t^*(p_t^{T^*} - p_t^{NT^*}) \tag{2}$$

where q_t^T stands for the real exchange rate for traded goods, assumed to be constant in the Balassa-Samuelson model; $(p_t^T - p_t^{NT}) - (p_t^{T^*} - p_t^{NT^*})$ is the relative price of traded to non-traded goods between the home and the foreign country and α and α^* are the weights.

Based on (2), there are two potential sources of variation in the equilibrium real exchange rate. First, movements in the relative prices of traded to non-traded goods between the home and foreign country (second and third terms in (2)), linked to the traditional Balassa-Samuelson effect. The second source is the non-constancy of the real exchange rate for traded goods (the first term in (2)).

Two factors, in turn, may introduce variability in q_t^T.

First, fiscal policy, whose relation with the real exchange rate depends on the approach considered. According to the Mundell-Fleming model, an expansionary fiscal policy reduces national savings, increases the domestic real interest rate and generates a permanent appreciation. In contrast, the portfolio balance models consider that a permanent fiscal expansion would cause a decrease in net foreign assets and a depreciation of the currency. In the context of the New Open Macroeconomics models, Ganelli (2005) argues that it is possible to make the two approaches compatible: a fiscal expansion would temporally cause an appreciation of the currency, although a tendency to depreciate would prevail in the long-run through the net foreign assets effect

In addition, private sector net savings may also affect the real exchange rate, influenced in turn by demographic factors. Thus, the cross-country variations of saving rates may also affect the relative net foreign asset position.

Due to the focus of this paper on the productivity differentials, the role of these variables deserves further discussion.

The traditional breakdown of productivity into traded and non-traded goods sectors was an adequate framework to test for the Balassa-Samuelson effect. Specifically, in the 1960s, Balassa (1964) and Samuelson (1964) found that developing countries in the economic catch-up process had higher productivity gains in the tradable sector than industrial countries. Thus, they attributed long-run deviations from PPP to differences in rates of growth of productivity in the traded goods industries.

The theoretical model is commonly formulated[1] as a two-country model with tradable goods (industry) and a non-tradable good (services). It assumes perfect competition in the tradable goods markets and perfect mobility in the national labour markets (but no labour mobility between the two countries). Production is based on Cobb-Douglas production functions, also assuming competitive markets and profit maximization, so that the marginal productivity of labour must correspond to the real wage in the respective sector. Also nominal wages in the traded and non-traded sectors are assumed to be equal, as there is perfect labour mobility between the traded and non-traded sector. Then:

$$-c\frac{A^{T}}{A^{NT}} = -\frac{P^{NT}}{P^{T}} \tag{3}$$

where A^i are the labour productivities in the respective sectors and c is a positive constant that represents the relative weights of traded and non-traded goods. Assuming that productivity in the non-traded goods is constant (due

[1] See, for example, De Grauwe and Skudelny (2002).

to the slow increase in services productivity), an increase in traded goods productivity would push the relative price of non-traded to traded goods upward. As the overall consumer price level is a composite of traded and non-traded goods, inflation will rise. This would generate persistent real exchange rate appreciation through a rate of growth of non-traded goods prices that is higher than that of slower growing countries.

The Balassa-Samuelson effect has been considered one of the leading explanations of real exchange rate departures from PPP. However, this model has only found a limited support in the empirical literature, with the exception of Japan. It has been argued that the assumptions implicit in the model are unrealistic, especially in the short-run. In particular, substantial and persistent deviations from the law of one price in traded goods occur (see Engel (1995), Canzoneri, Cumby and Diba (1996) and Isard and Symansky (1995)), whereas the model assumes that the real exchange rate is driven by movements in the relative price of non-traded goods.

Devereux (1999) discusses the main prediction of the Balassa-Samuelson model and describes a puzzle found, among others, in Asian countries: results by Isard and Symansky (1995) indicate not just a departure from the Balassa-Samuelson hypothesis but also substantial and persistent deviations from the law of one price in traded goods across countries. In a NOM model, Devereux (1999) considers that nominal rigidities cannot explain this behaviour alone, and argues that the distribution sector services may play a role of critical importance for the traded-goods sector. In a general equilibrium model, he also tries to solve the puzzling tendency for many faster growing Asian countries to experience real exchange rate depreciation against Japan and the US. As already mentioned, the model is based on the importance of the distribution sector services for traded goods. The central idea is that even for internationally traded commodities, there is a substantial non-traded element in the final goods price purchased by the consumer. Due to deregulation processes, the growth in manufacturing productivity has been mirrored by (endogenous) productivity growth in the distribution network of the countries. This can cause continuous reductions in traded good prices. Therefore, even if the conditions for the Balassa-Samuelson effect are met, a real depreciation can be found in these countries.

MacDonald and Ricci (2003) extend the Balassa-Samuelson model[2] to include the distribution sector, which they consider is not strictly non-tradable. They argue that the distribution sector delivers both intermediate inputs to the firms that use them in the final stage of production and final goods to consumers as well. In order to maintain the main Balassa-Samuelson hy-

[2] See MacDonald and Ricci (2001) for a detailed presentation of the theoretical model.

pothesis they assume price equalization of tradable goods, which determines relative wages and provides the real exchange rate relation, augmented by the distribution sector.

As a result, the real exchange rate will appreciate with the relative productivity of tradables, $(a_t^T - a_t^{T*})$, and will depreciate with the relative productivity of non-tradables, $(a_t^{NT} - a_t^{NT*})$, as above. Concerning the relative productivity of the distribution sector, $(a_t^D - a_t^{D*})$, the real exchange rate appreciates if the distribution sector plays a bigger role in delivering goods to the tradable industry rather than to consumers. If this is not the case, the distribution sector would behave as a non-traded good sector. The reason for this ambiguity can be found in a twofold effect coming from an increase in the relative productivity of the distribution sector[3]. On the one hand, it lowers the price of tradables (lowers their distribution costs), raises relative wages and appreciates the currency (similar to the effect of the productivity of tradables). On the other hand, it lowers the consumer price of tradables, and then depreciates the currency (similar to the effect of the productivity of non-tradables). The net effect will, therefore, depend on which of the two effects prevails. As in the Devereux (1999) model, the Balassa-Samuelson hypothesis is a special case of this particular formulation. Hence, the predictions of Devereux (1999) and MacDonald and Ricci (2003) can differ, depending on the productivity and deregulation developments in the country studied.

Finally, all the factors mentioned above can be summarized in the following empirical specification:

$$\begin{aligned} q_t &= \varphi(R_t - R_t^*) + \hat{q}_t = \\ &= f(\underset{(+)}{(R_t - R_t^*)}, \underset{(+)}{(a_t^T - a_t^{T*})}, \underset{(-)}{(a_t^{NT} - a_t^{NT*})}, \underset{(+/-)}{(a_t^D - a_t^{D*})}, \underset{(-/+)}{(g_t - g_t^*)}, \underset{(+)}{dnfa_t}) \end{aligned} \tag{4}$$

where $(a_t^T - a_t^{T*})$ is the difference in productivity in the traded sector between the domestic and the foreign country, whereas $(a_t^{NT} - a_t^{NT*})$ is the non-traded sector equivalent; $(a_t^D - a_t^{D*})$ is the distribution sector productivity differential; $(g_t - g_t^*)$ is the public expenditure differential; and $dnfa_t$ is the relative net foreign asset position of the economy. Thus, the real exchange rate will

[3] There is a debate about whether productivity differences in information technologies and the distribution sectors between the US and the EU are real or just a myth. Timmer and Juklaar (2005) revise the national accounts data and adjust the information to include quality improvements. The conclusions reported are that the productivity difference is substantial, even after the corrections are made.

appreciate when the real interest rate differential increases, as well as when the productivity differential in the traded-goods sector and the net foreign asset position increase. In contrast, the real exchange rate depreciates when the non-traded goods productivity differential widens. Concerning fiscal policy, both a depreciation or an appreciation are compatible with the theory, although the expected long-run effect should be negative (a depreciation) according to Ganelli (2005). Similarly, an increase in productivity differentials in the distribution sector may both appreciate or depreciate the currency, as we are testing two competing hypotheses.

3 Data and hypothesis testing

In this paper we have applied cointegration panel techniques to analyse the real exchange rate of the dollar for a group of OECD countries: Australia, Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Sweden and the UK. The data has been obtained from the IMF for the financial variables, Lane and Milesi-Ferreti (2000) for net foreign assets and the OECD Stan database for public expenditure, production and employment data. In particular, the productivity variables have been computed as value added per worker[4].

From the sector breakdown provided by the OECD Stan database, manufactures, transport and communication have been considered tradable-goods sectors, whereas the non-tradables sectors consist of: agriculture; electricity, gas and water supply; construction; financial services; community, social and personal services. Finally, the distribution sector is wholesale and retail trade. In order to compute the final variable for the tradable and non-tradable-goods sectors[5] some form of averaging was needed. To calculate the weights, we sum the total value added in the tradable sector, as well as in the non-tradable sector separately. Then, we compute the percentage that each component from the OECD breakdown (i.e. construction, financial services...etc. in the non-traded goods sector) represents in total value added. We take 1990 as the base-year for the averaging.

This sector classification is not incontrovertible. Concerning, first, the sectors that are traditionally considered tradables in the literature, all the empirical studies include manufactures. In addition to this sector, Tyrvainen

[4]See appendix A for a more detailed description of the sources of the data and the calculations made.

[5]Recall that the distribution sector consists of just one OECD sector (wholesale and retail trade).

(1998) and Alberola and Tyrvainen (1998) also include transportation (and communications). This is the option we have adopted. In addition to these two sectors, De Gregorio, Giovannini and Wolf (1994), Chinn and Johnston (1997) and MacDonald and Ricci (2001) also include agriculture and mining. Another alternative frequently adopted has been directly exclude agriculture-mining from the analysis due to the high degree of public intervention and protection associated to this sector (examples are Égert et al. (2002), Strauss (1995, 1996, 1999) and Wu (1996)). In our case, agriculture has been considered non-traded for the same reason: the US and the EU maintain heavy restrictions on agricultural trade, together with internal subsidies.

Finally, with the exception of the real exchange rate, all the estimations have been based on variables computed as differentials using the US as the benchmark.

As described above, the empirical specified model is an eclectic one, so that it encompasses different hypotheses concerning the Balassa-Samuelson effect and the role of the distribution sector. In addition, this general specification also encompasses simpler models of real exchange rate determination. The estimated models are the following:

Model 1: Meese and Rogoff (1988) Monetary model:

$$rer_{it} = \beta_1 difr_{it} + u_{it}$$

Model 1b: Hooper and Morton (1982) model:

$$rer_{it} = \beta_1 difr_{it} + \beta_2 dnfa_{it} + u_{it}$$

Model 2: Balassa-Samuelson Hypothesis plus distribution sector:

$$rer_{it} = \beta_1 difr_{it} + \beta_2 dprot + \beta_3 dprod + u_{it}$$

Model 3: Rogoff (1992) model plus distribution sector:

$$rer_{it} = \beta_1 dprot + \beta_2 dprod + \beta_3 dpex + u_{it}$$

Model 4: Extended Monetary model:

$$rer_{it} = \beta_1 difr_{it} + \beta_2 dprot + \beta_3 dprod + \beta_4 dpex + u_{it}$$

where $difr_t$ represents the real interest rate differential; $dnfa_t$ is the net foreign assets position relative to the US; $dprot_t$ and $dprod_t$ stand for the productivity differential in the tradable-goods sector and the distribution sector, respectively, whereas $dpex_t$ is the relative public expenditure over GDP.

The first step followed in the empirical testing strategy consists of selecting the best models, according to the information criteria and following a general-to-specific approach. In this general specification, the model also included non-traded goods productivity differential. However, this variable was nonsignificant in all cases. Both its insignificance and the values of the information criteria recommended its exclusion from the specifications detailed above[6]. Notwithstanding this exclusion, a testable hypothesis is whether the distribution sector is acting as a non-tradable and may be capturing the non-traded goods effects on the real exchange rate.

Therefore, after the selection process, models 1 to 4 are those for which the estimation techniques provided the best results in terms of the information criteria. Other alternative specifications were not supported by the data. Models 1 and 1b are versions of the Meese and Rogoff (1988) and Hooper and Morton (1982) models, respectively. Some of the estimation results of Model 1 presented in the next section include, as an alternative, the long-term interest rate differential, which is also possible according to the theory. Model 2 is a version of the Balassa-Samuelson effect, extended to include the distribution sector productivity, as in Devereux (1999) and MacDonald and Ricci (2003). The specification Model 3 is a version of the Rogoff (1992) model also augmented by the distribution sector. Finally, Model 4 is the most general specification, as it encompasses some of the previous models.

4 Empirical results

4.1 Order of integration of the variables

In this subsection we present the results obtained from the analysis of the order of integration of the variables using panel unit root tests. We have applied the *LM* test for the null hypothesis of stationarity proposed by Hadri (2000) with heterogeneous and serially correlated errors, as well as the Im, Pesaran and Shin (2003) unit root test (IPS test hereafter). As in the case of time series unit root and stationarity tests, the approach we adopt is to use the two types of tests together

We present the unit root test results for the null of stationarity in the first two columns in table 1. We use the two statistics proposed by Hadri (2000), that are the panel equivalents to the Kwiatkowski et al. (1992) statistics for the time series case. The Z_μ statistic tests for the null of level stationarity,

[6] The results that include non-traded goods productivity are available upon request.

whereas Z_τ tests for the null of trend stationarity against nonstationary alternatives. The two statistics proposed by Hadri (2000) are distributed as $N(0,1)$. It should be stressed that these tests are, according to Hadri, the most appropriate for series highly time dependent with relatively large T (the time dimension) and moderate N (the number of cross-sections). The null hypothesis of stationarity is easily rejected either by Z_μ , by Z_τ or both of them at the same time for all the variables considered. The results obtained using the unit root IPS test are presented in the last two columns in table 1. The null hypothesis of a unit root cannot be rejected for the majority of the cases (the only two exceptions being $difrl_{it}$ for the non-trended statistic and rer_t for the trended case). Therefore, the general conclusion is the same as in the stationarity tests: the variables are non-stationary.

4.2 Pooled Mean Group Estimation results

The Pooled Mean Group (PMG hereafter) estimator proposed by Pesaran et al. (1999) combines two procedures that are commonly used in panels. First, the Mean Group (MG) estimator, where separate equations are estimated for each group, then the Mean Group estimator is computed giving consistent estimates of the average of the parameters. However, this estimator does not take account of the fact that some parameters may be the same across groups. Second, the traditional pooling estimators (such as the fixed and random effects estimators), that allow the intercepts to differ across groups whereas all the other coefficients and the variances are constrained to be the same. Therefore, the PMG estimator involves both pooling and averaging. This estimator allows the intercepts, short-run coefficients and error variances to differ freely across groups, but the long-run coefficients are constrained to be the same. However, an interesting feature of this methodology is that some of the long-run parameters can be also unconstrained, so that they may be different for each group. This possibility can be tested using LR-type tests. This is especially appropriate for the OECD case, a group of highly integrated economies that share common features. However, the degree of integration also differs among them, as the Euro-area countries are involved in a more formal institutional, economic and political setting.

The analysis is carried out in several stages. First, the specification of the statistical model, where the lag order of the Autoregressive Distributed Lag (ARDL) model is selected using information criteria (Akaike's AIC). Second, selection of the relevant variables and comparison of alternative model specifications, which also use information criteria to compare competing models. Third, testing the hypothesis of equal long-run parameters. Fourth, discussion of the results for both the panel and the individual estimations, using univariate specification tests as well as cointegration tests applied to the error correction parameter.

The results of applying the Pesaran et al. (1999) techniques to the different specifications and tests results, for the three groups of countries considered, are presented in Table 2, panels a, b and c.

The first group, in panel a, is the case of the whole group of countries *(*where *N=12).* From the information criteria (in the far left-hand side of the table), the best models are Model 4 and Model 1. Whereas Model 1 is the most simple monetary model, Model 4 includes not only the real (short-term) interest rate differential but also the productivity differential in the traded-goods sector and the fiscal expenditure variable. In Model 4, the productivity differential in the distribution sector turns out to be non-significant and excluded from the specified and estimated model. According to the Hausman test, the restrictions on the long-run parameters can be accepted in the two models. Therefore, due to the lower value of the information criteria, Model 4 is the one finally selected. It should be noted that the restriction of across-group equality of the long-run parameters can be accepted for the productivity differential, but not for the other two variables, that have to be estimated unconstrained.

The same type of analysis is carried out in Table 2, panel b for the 5 Euro-zone countries (Belgium, France, Germany, Italy and the Netherlands) in the sample. From the use of the information criteria, but also from the specification analysis, Model 4 is the one selected. Also in this case, the traded-goods productivity differential is constrained to have equal long-run parameters. However, for the Euro-zone, the eclectic specification in Model 4 also includes the productivity differential in the distribution sector. As a comparison exercise, the results for the 8 EU countries in the sample are presented in the row at the bottom of panel b. The same type of specification obtained for the 5 euro-area countries is the one selected for the EU members according to the AIC and, moreover, the hypothesis of equal long-run parameters is also accepted for the distribution sector productivity differential.

Finally, Table 2, panel c shows the specification and model selection results for the non-Euro zone countries. Models 1 and 4 are again the two most suitable specifications for this group of more heterogeneous countries. However, it is hard, from the information criteria and the specification tests, to decide which is the best model. Probably the most simple monetary model is more appropriate in this case, as the countries in this sub-sample are more integrated in the financial markets than in the goods or factor markets.

As a provisional conclusion from the first stages of the analysis, both the traded sector productivity and the distribution sector productivity seem to play an important role for the European countries. In contrast, as the OECD is a wider area, real monetary factors are the fundamental explanation of the bilateral real exchange rates with the dollar. In addition, the behaviour pattern against the dollar of the currencies that belong to the Euro-area may not really differ from those of the other EU countries. This supports the feasibility of a larger Euro-zone that would include the UK, Sweden and Denmark.

The previous remark is confirmed in the Pooled Mean Estimates of the long-run parameters in Model 4 presented in Table 3. The results for the Euro-area and the EU countries in the sample can be found in the two first columns of the table. Some common features can be derived from the parameters estimates and signs. First, all the variables have the signs and magnitudes compatible with the theoretical model[7]. Second, the distribution sector productivity differential has a negative sign and, thus, behaves as a non-traded sector, supporting Devereux's hypothesis. Alternatively, the distribution sector may be capturing the majority of the non-traded goods effects on the real exchange rate, so that this would explain the early exclusion of the non-tradables productivity differential. Third, the variable that represents fiscal policy also has a negative sign (that is, a relatively expansionary fiscal policy in Europe would depreciate the European currency), as in the portfolio balance models. This result is the one predicted by Ganelli (2005) in a NOM formulation. This means that the long-run effects of expansionary fiscal policies would be to depreciate the real exchange rate, even if short-run effects may be positive, as in the Mundell-Fleming setting. Fourth, the error correction coefficient is large in the two cases (-0.436 for the Euro-area countries and -0.346 for the 8 EU countries) so that the half life of a shock would be between one and two years, as expected from the PPP theory. Finally, the error correction coefficients are also highly significant, so that the long-run parameter estimates can be considered cointegration relationships.

Similar conclusions can be drawn from the two other groups of countries, for which Model 4 is also an acceptable specification. However, the distribution sector does not play such an important role (this variable was not significant). Therefore, a working hypothesis may be that other OECD countries were not as affected by the deregulation process in the distribution sector as the EU countries. The reason for this can be associated with the

[7]Some large coefficients are linked to the productivity differential in traded goods. In contrast, the theory predicts a value around one. This result may be related to the estimation technique, that increases in consistency with the number of countries in the group. Note that the magnitude of the parameter decreases in the group of 8 EU members as compared to the EU 5.

implementation of the Single Market programme and the free movement of capitals, financial services and, in general terms, the reduction of monopolistic practices in the area. This is a feature that is common to Euro-area countries and non-Euro countries, as it is related to earlier stages in the European integration process.

Next, the individual parameter estimates for the long-run relationships and the error correction parameters are presented in Table 4 for the EU countries (first panel of the table) and the Euro-area countries (lower panel). In the larger group of countries, the hypothesis of equal long-run parameters was accepted for the two productivity differentials with opposite signs and values around unity. The rest of the parameters were estimated unconstrained. Concerning the real interest differential with the US, only for the cases of France, Germany and the Netherlands was the variable significant, whereas the public expenditure differential was significant for six out of the eight countries, the exceptions being Holland and Denmark. It should be stressed that the parameter values, although all them have the same sign, differ in magnitude, being the one of Sweden the smallest (-0.743) and the one of Italy the largest (-5.083). Finally, the error correction parameter was also significant for all the EU countries except for Denmark, with some of them very large and close to -0.5. That would imply very short half lives of the shocks of around one year or one year and a half.

The results for the individual country estimates are very similar in the case of the Euro-area countries, as it is shown in the lower part of Table 4. The most remarkable difference is related to the non-acceptance of the equal parameters restriction for the productivity differential in the distribution sector. From the unconstrained estimates of the EU countries it becomes evident that the reason for the rejection of the above mentioned hypothesis is the different behaviour of the Belgian variable. For this country, the sign is positive, that is, an increase in services sector productivity relative to the US *appreciates* the currency. In this case, it must have prevailed the tradables-like effect (reduction in the production costs of the tradables goods). It should also be noted that, compared with the EU countries results, the parameter estimates are larger for both the productivity differential in the tradables sector and distribution services sector. As for the error correction coefficients, also in this case they are large and highly significant.

Last, the individual countries' specification tests are reported in table 5, and confirm that the models are correctly specified.

4.3 Comparison with previous empirical results on real exchange rates and distribution sector productivity differentials

These results can be compared with previous empirical studies carried out using a similar sector breakdown for productivity and considering the case of the distribution sector. These are the cases of MacDonald and Ricci (2003) and Lee and Tang (2003).

Using Total Factor Productivity (TPF hereafter), MacDonald and Ricci (2003) study the dollar real exchange rate for a group of OECD countries. However, due to the limitations of the International Sectoral Database, their sample starts in 1970 but finishes in 1991. For this period, the results using Dynamic OLS techniques in a panel point to the significance of the three productivity variables (for traded-goods, non traded-goods and the distribution sector). In addition, the distribution sector productivity effect on the real exchange rate is similar to that of a traded good. However, the results are not directly comparable, due to the different data span, as well as to the use of TPF productivity. In addition, the long-run parameter estimates are restricted to be homogeneous.

Lee and Tang (2003) analyse the behaviour of the real exchange rate also for a panel of OECD countries and using cointegration techniques. They compare the results derived from the two main different measures of productivity, that is, TFP and labour productivity, and obtain sign reversals when TFP is used. In addition, they do not find significant the relative productivity variable in the distribution sector, but conclude that it is the traded-goods sector productivity what matters for real exchange rate determination, rather than relative prices between tradeables and nontradeables. Also in this case, no allowance is made for the long-run parameters to differ among the countries in the panel.

Compared to previous studies, the results obtained in the present paper support the view of Devereux (1999) model, as an increase in relative productivity in the distribution sector tends to *depreciate* the currency. In addition, also in accordance with Devereux (1999) and Lee and Tang (2003), the tradable goods sector plays an important role in real exchange rate determination. Finally, the discrepancies found with the other two studies that focus on a similar group of OECD countries may be due to the non-fulfillment of the restrictions imposed on the long-run parameters. Thanks to the use of the PMG Estimators, these hypotheses can be tested as a part of the specification process. This is of special relevance for the group of countries analysed, as they share different degrees of economic integration among them. Thus, it is not realistic to impose equal long-run parameters to all the countries in the group, as the real economy may behave very differently in the EU members as compared to the rest of the OECD countries.

5 Concluding remarks

This paper analyses the behaviour of the real exchange rate of the dollar against a group of twelve OECD countries for the period 1970-1998. To do this, we specify a general empirical model that encompasses the most important explanatory variables suggested by the theory, paying special attention to the role of productivity and its breakdown into three sectors: tradables, non-tradables and distribution.

This paper differs from previous empirical literature testing for the distribution sector productivity effect on several respects. First, the data span covers a relatively long time period, from 1970 to 1998; second, the labour productivity variable has been computed using recent OECD data from the STAN database; third, the econometric techniques applied are the Pooled Mean Group estimators that allow for a flexible form of model comparison and hypothesis testing, and that does not require imposing equal long-run parameters for all the group members in the explanatory variables of the model.

From the use of the above mentioned technique, the twelve countries analysed can be divided into two main groups: the EU countries and the non-EU countries. In addition, the Euro-area countries have been also considered and compared to the non-Euro EU countries. The model selected for any group of EU countries is the more general one, which includes as explanatory variables the real interest rate differential, the public expenditure differential and relative productivities both for the traded good sector and the distribution sector. For the non-EU countries, the best model is the simple monetary model, that consists of the real interest rate differential. The larger model is also an acceptable specification, according to the tests applied, and the results are presented for the sake of comparison.

In brief, the main empirical findings are the following: first, the restriction of common long-run parameters is accepted only for some of the explanatory variables (either one or both productivities for the EU countries and the real interest differential for the non-EU countries); second, the non-traded goods productivity differential turns out not to be significant, that would be compatible with the Balassa-Samuelson effect, that assumes no productivity gains in this sector and, therefore, little scope for real exchange rate effects; third, the distribution services sector acts as a non-tradable for the

EU countries (a relative increase in productivity depreciates the currency) and confirms Devereux's hypothesis; finally, it should be noted that the chosen empirical specification for the EU countries combines demand and supply factors.

Moreover, two of the obtained empirical results will confirm recent predictions from NOM theoretical models. First, the role of the distribution sector (and therefore of domestic good market developments) on the external competitiveness of the countries, as in Devereux (1999) and, second, that a fiscal expansion has a long-run negative (depreciating) effect on the real exchange rate (Ganelli, 2005). The relevance of these results arises from the adequacy of the NOM hypotheses in the case of the group of countries studied in this paper as well as from the relative scarcity of empirical work testing these new theories.

To conclude, it might be inferred from the results that the role of productivity differentials, especially in the distribution sector for the EU countries can be associated with the deregulation process successfully achieved with the implementation of the Single Market initiative. This is confirmed by the fact that when we compare the results of the wider model, in all the country groups analysed the productivity differential in the traded goods sector is significant. However, this is not the case of the distribution sector productivity, only significant for EU countries.

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A Data

The data used in the paper is annual and spans from 1970 to 1998. The countries considered are Australia, Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Sweden, the UK and the US, that acts as benchmark country. Specifically, the variables are the following:

$\mathbf{rer}_t$: CPI based bilateral real exchange rate against the dollar (in logarithms).

$\mathbf{difrs}_t$: short-term real interest rate differential with the US, based on Call Money Rates. The inflation rate has been obtained after applying the Hodrik and Preston filter to CPI data. Source: IMF International Financial Statistics.

$\mathbf{difrl}_t$: long-term real interest rate differential with the US, based on 10-year bond interest rates. Computed as $difrs_t$.

$\mathbf{dnfa}_t$: difference in cumulated current account balance as a percentage of GDP. Source: Lane and Milesi-Ferreti (2001).

$\mathbf{dpex}_t$: difference in public expenditure as a percentage of GDP. Source: OECD STAN database.

Productivities: the productivity variables have been computed as value added per worker. When more than one sector was involved, the variable was a weighted average based on 1990 values. The productivities were transformed into indices and then in logarithms. All the variables are relative to the benchmark country, the US. Source: OECD STAN database.

$\mathbf{dprot}_t$: tradable sectors are manufactures and transport and communication.

$\mathbf{dpront}_t$: non-tradable sectors are agriculture, electricity, gas and water supply, construction, financial services, community, social and personal services.

$\mathbf{dprod}_t$: the distribution sector consists of wholesale and retail trade.

B Tables

Table 1
Panel stationarity and unit root tests

	Hadri (2000) *(l=2)*		IPS (2003) *(l=2)*	
Variables	Z_μ	Z_τ	$\bar{z}_{NT}$ (non-trended)	$\bar{z}_{NT}$ (trended)
rer_{it}	-1.048	16.93*	-0.048	2.005*
(prob.)	(0.14)	(0.00)	(0.48)	(0.02)
$difrs_{it}$	0.425	22.47*	-1.328	-0.942
	(0.33)	(0.00)	(0.09)	(0.17)
$difrl_{it}$	0.165	6.06*	-1.792*	-0.636
	(0.43)	(0.00)	(0.03)	(0.26)
$prot_{it}$	4.831*	39.30*	-0.137	0.285
	(0.00)	(0.00)	(0.44)	(0.38)
$pront_{it}$	4.661*	20.20*	-0.719	-1.536
	(0.00)	(0.00)	(0.23)	(0.06)
$pror_{it}$	5.491*	14.53*	-0.119	-0.571
	(0.00)	(0.00)	(0.45)	(0.28)
$dpex_{it}$	5.17*	62.41*	0.644	0.968
	(0.00)	(0.00)	(0.25)	(0.16)
$dnfa_{it}$	3.94*	32.27*	-1.207	-0.167
	(0.00)	(0.00)	(0.11)	(0.43)

Note: the models have been specified with two lags ($l = 2$). An asterisk denotes rejection of the null hypothesis (non-stationarity in the IPS test and stationarity in the Hadri test). The statistics are distributed as $N(0, 1)$.

Table 2: Model Comparison

Model 1: $rer_{it} = \beta_1 difr_{it} + u_{it}$

Model 1b: $rer_{it} = \beta_1 difr_{it} + \beta_2 dnfa_{it} + u_{it}$

Model 2: $rer_{it} = \beta_1 difr_{it} + \beta_2 dprot + \beta_3 dprod + u_{it}$

Model 3: $rer_{it} = \beta_1 dprot + \beta_2 dprod + \beta_3 dpex + u_{it}$

Model 4: $rer_{it} = \beta_1 difr_{it} + \beta_2 dprot + \beta_3 dprod + \beta_4 dpex + u_{it}$

Panel a	N=12 All countries			*Variables*					
	AIC	SBC	Hausman test [p-val.]	$difrs_t$	$difrl_t$	$dprot_t$	$dprod_t$	$dpex_t$	$dnfa_t$
Model 1	386.13	361.41	0.95 [0.33]	$=\forall^*$	—	—	—	—	—
	390.44	365.70	0.22 [0.64]	—	$=\forall^*$	—	—	—	—
Model 1b	392.27	365.66	0.27 [0.60]	$=\forall^*$	—	—	—	—	$\neq^*$
Model 2	394.18	365.67	0.69 [0.41]	$=\forall^*$	—	$\neq$	$\neq$	—	—
Model 3	388.88	362.16	1.8 [0.18]	—	—	$=\forall^*$	—	$\neq^*$	—
Model 4	385.32	356.80	0.01 [0.94]	$\neq^*$	—	$=\forall^*$	—	$\neq^*$	—
			joint test13.01 [0.00]	$=\forall^*$	—	$=\forall^*$	—	$\neq^*$	—

Panel b	N=5 Euro-Area			*Variables*					
	AIC	SBC	Hausman test [p-val.]	$difrs_t$	$difrl_t$	$dprot_t$	$dprod_t$	$dpex_t$	$dnfa_t$
Model 1	163.46	154.64	LR $\chi^2(4)$=1.18[0.88]	$=\forall^*$	—	—	—	—	—
	168.88	160.05	LR $\chi^2(4)$=5.70[0.22]	—	$=\forall^*$	—	—	—	—
Model 2	161.89	150.13	0.85 [0.36]	$\neq^*$	—	$\neq^*$	$=\forall^*$	—	—
Model 3	160.58	148.81	0.35 [0.56]	—	—	$=\forall^*$	$\neq$	$\neq^*$	—
Model 4	160.96	147.73	2.32 [0.37]	$\neq^*$	—	$=\forall^*$	$\neq^*$	$\neq^*$	—
	N=8(EU)								
Model 4	259.68	239.26	5.53 [0.06]	$\neq$	—	$=\forall^*$	$=\forall^*$	$\neq^*$	—

Panel c	N=7 Non-Euro coun.			*Variables*					
	AIC	SBC	Hausman test[p-val.]	$difrs_t$	$difrl_t$	$dprot_t$	$dprod_t$	$dpex_t$	$dnfa_t$
Model 1	221.96	208.95	1.38 [0.75]	$=\forall$	—	—	—	—	—
	221.76	208.73	0.05 [0.83]	—	$=\forall^*$	—	—	—	—
Model 1b	228.04	213.40	1.60 [0.09]	$=\forall^*$	—	—	—	—	$\neq$
Model 2	236.99	220.73	0.46 [0.50]	$=\forall^*$	—	$\neq$	$\neq$	—	—
Model 3	228.14	213.39	0.40 [0.53]	—	—	$=\forall^*$	—	$\neq^*$	—
Model 4	224.20	207.94	0.05 [0.83]	$\neq^*$	—	$=\forall^*$	—	$\neq^*$	—

Note: the signs $=\forall$ and $\neq$ denote homogeneity and heterogeneity of the estimated parameters, respectively. An asterisk means that the variable is signficant.

Table 3

Pooled Mean Group Estimation
Model 4

$$rer_{it} = \beta_1 difr_{it} + \beta_2 dprot_{it} + \beta_3 dprod_{it} + \beta_4 dpex_{it}$$

Variables	*Euro-area* $(N = 5)$	*EU countries* $(N = 8)$	*OECD non euro* $(N = 7)$	*All countries* $(N = 12)$
$difr_t$	0.021^a	0.014^a	0.019^a	0.016^a
	(1.91)	(1.53)	(2.71)	(3.23)
$dprot_t$	3.166	1.511	1.381	0.365
	(7.09)	(4.00)	(2.32)	(2.57)
$dprod_t$	-1.761^a	-0.911	—	—
	(-2.12)	(-3.11)	—	—
$dpex_t$	-2.609^a	-3.110^a	-3.872^a	-2.685
	(-2.95)	(-2.53)	(-2.64)	(-2.23)
ecm_{t-1}	-0.436	-0.346	-0.347	-0.376
	(-17.37)	(-8.94)	(-10.41)	(-12.03)

Note: t-Students in parentheses. ^{a} indicates that the corresponding variable was not subject to the restriction of equal long-run parameters for all the members of the group. Thus, its estimate is the Mean Group Estimate, instead of the PMGE.

Table 4
Individual Estimates
Model 4

EU countries	$N = 8$				
Countries	$difr_t$	$prot_t$	$prod_t$	$dpex_t$	ecm_{t-1}
Belgium	0.010	**1.510**	**-0.910**	**-3.605**	**-0.390**
	(1.48)	(4.00)	(-2.48)	(-2.65)	(-3.73)
France	**0.025**	**1.510**	**-0.910**	**-1.498**	**-0.490**
	(4.34)	(4.00)	(-2.48)	(-1.98)	(-5.88)
Germany	**0.064**	**1.510**	**-0.910**	**-3.005**	**-0.312**
	(2.34)	(4.00)	(-2.48)	(-7.93)	(-2.71)
Italy	0.015	**1.510**	**-0.910**	**-5.083**	**-0.310**
	(1.54)	(4.00)	(-2.48)	(-2.71)	(-3.05)
The Netherlands	**0.019**	**1.510**	**-0.910**	-2.779	**-0.490**
	(3.21)	(4.00)	(-2.48)	(-1.60)	(-4.23)
Denmark	0.012	**1.510**	**-0.910**	-8.998	**-0.184**
	(0.85)	(4.00)	(-2.48)	(-1.74)	(-1.74)
Sweden	0.005	**1.510**	**-0.910**	**-0.743**	**-0.238**
	(0.43)	(4.00)	(-2.48)	(-4.45)	(-3.16)
United Kingdom	-0.013	**1.510**	**-0.910**	**-4.729**	**-0.353**
	(-1.91)	(4.00)	(-2.48)	(-1.97)	(-2.59)

Euro-countries	$N = 5$				
Countries	$difr_t$	$prot_t$	$prod_t$	$dpex_t$	ecm_{t-1}
Belgium	0.001	**3.166**	**1.123**	**-4.841**	**-0.509**
	(1.48)	(7.09)	(2.47)	(-5.27)	(-5.77)
France	**0.033**	**3.166**	**-1.209**	**-4.240**	**-0.390**
	(4.11)	(7.09)	(-1.96)	(-2.34)	(-5.14)
Germany	**0.056**	**3.166**	**-3.169**	-2.046	**-0.399**
	(3.34)	(7.09)	(-5.23)	(-1.82)	(-4.35)
Italy	0.008	**3.166**	**-3.523**	-0.170	**-0.483**
	(1.70)	(7.09)	(-6.30)	(-0.10)	(-5.33)
The Netherlands	**0.027**	**3.166**	**-2.028**	**-3.984**	**-0.397**
	(3.71)	(7.09)	(-4.32)	(-1.97)	(-4.09)

Note: significant coefficients in bold.

Table 5
Individual countries specification tests
Model 4 ($N = 8$)

	$\bar{R}^2$	Correl.	FF	NO	HE
Belgium	0.70	1.60	0.00	0.26	1.43
France	0.53	0.25	0.15	0.67	0.51
Germany	0.64	4.60	0.91	0.99	1.30
Italy	0.55	0.02	2.22	0.60	0.68
The Netherlands	0.43	0.02	0.13	1.29	3.59
Denmark	0.54	0.25	4.89	0.04	0.59
Sweden	0.45	9.98	0.26	0.73	0.63
United Kingdom	0.38	0.28	0.01	1.59	1.24

Note: Correl. stands for first order correlation, FF for the functional form test, whereas NO and HE stand for the normality and the heteroskedasticity tests, respectively.