DOCUMENTOS DE ECONOMIA Y FINANZAS INTERNACIONALES

Testing the BalassA-Samuelson hypothesis in two different groups of countries: OECD and Latin America.

José García Solanes
Fernando Torrejón Flores

February 2005

DEFI 05/02

Asociación Española de Economía y Finanzas Internacionales

FEDEA
Fundación de Estudios de Economía Aplicada

http://www.fedea.es/hojas/publicaciones.html

ISSN 1696-6376

TESTING THE BALASSA-SAMUELSON HYPOTHESIS IN TWO DIFFERENT GROUPS OF COUNTRIES: OECD AND LATIN AMERICA.

José García Solanes*

Universidad de Murcia and CentrA

Fernando Torrejón Flores

Universidad de Murcia

December 2004

ABSTRACT:

This paper studies the Balassa-Samuelson hypothesis (BSH) in the context of two areas with strong differences in economic development, twelve OECD countries and twelve Latin American economies, taking the USA as the benchmark. Applying panel cointegration techniques, we find that while the first stage of the hypothesis, which links productivities and prices, is satisfied in each group of countries, the second stage, which relates relative sector prices with the real exchange rate, only holds in the Latin American area. The failure of the latter in the OECD countries as a whole is reflected in departures from PPP in the tradable sectors.

Key Words: Balassa-Samuelson effect, Panel cointegration, Economic development, Exchange rate systems.

JEL Classification: E31, F31, C15

---

* Correspondence to the author: Facultad de Economía y Empresa, Campus de Espinardo, 30.100 Murcia (Spain). E-mail: solanes@um.es, Tel: +34 968 36 37 82; Fax: +34 968 36 37 58

1. Introduction[1]

According to the Balassa and Samuelson hypothesis (Balassa (1964), Samuelson (1964)), the productivity differential between the tradable (T) and non-tradable (N) sectors is the main determinant of real exchange rates. Since improvements in the tradable sector productivity are normally linked to economic growth, a correlation between relative economic development and the real exchange rate is also postulated. Thus, it is expected that countries growing faster will tend to experience real exchange rate appreciations with respect to other, slowly growing economies. The Balassa and Samuelson hypothesis (BSH) has important implications for exchange rate policy and for the trade-off that many countries face between inflation targets and exchange-rate stability.

The empirical evidence obtained so far regarding the BSH indeed indicates that the best results apply in the context of economies that grow at very divergent speeds, such as Japan compared to the USA in the post World War II period (see, for instance, Hsieh (1982) and Marston (1987)), and transition countries that need to grow very fast if they are to catch up with the standards of living of their developed neighbours. This is the situation in some Southern East Asian countries (Isard and Symansky (1997)) with respect to Japan during recent years, and in Central and Eastern European countries with respect to Germany since the early nineties (Halpern and Wyplosz (2001), Kovács (2002), Égert (2002a,b), Égert et al. (2002)). In a recent paper, Drine and Rault (2003) also found strong evidence to support the BSH for several groups of Central and South American countries during the period 1960-1999, taking the USA as a benchmark. Although estimates on the magnitude of the BS-effect vary substantially across estimating methods, countries and time-periods, it seems that productivity-driven appreciations range between 0.1% and 1.6% a year, once the influence of other real factors that also affect the real exchange rate (RER) is excluded[2].

The empirical findings referring to economies that do not exhibit pronounced divergences in economic development between them, such as groups of countries in the OECD, are not unanimous. For example, whereas Alberola and Tyrväinen (1998), Chinn and Johnston (1999) and MacDonald and Ricci (2001) obtained positive results for the whole general BS proposition, Canzoneri, Cumby and Diba (1999) found favourable evidence only for that part of the hypothesis that links the productive differential with the relative price of the tradable and non-tradable sectors. Heston, Nuxoll and Summers (1994) also found that the difference between tradable and non-tradable prices moved with the income levels of OECD countries, which is consistent with the results of Canzoneri, Cumby and Diba.

Despite the fact that the magnitude and the statistical significance of the empirical results are sensitive to the level of economic development of the areas analysed, to our knowledge, no empirical study attempts to compare the fulfilment of the BSH in two areas which exhibit sharp differences in standards of living and growth with respect to a common foreign developed country. To fill this gap, we undertake such a comparative analysis in the context of twelve OECD countries (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Spain and the United Kingdom), and twelve Latin American economies (Argentina, Bolivia, Chile, Colombia, Costa Rica, Ecuador, Mexico, Nicaragua, Paraguay, Peru, Uruguay and Venezuela). We take the USA as the benchmark to calculate productivity and price differentials, as well as real exchange rates, and use the same theoretical and empirical approaches in both cases.

---

[1] We are grateful to Fundación del BBVA for the financial support in the frame of "Primeras Ayudas a la Investigación en Ciencias Sociales, año 2002". We also thank to Enrique Alberola-Ila for his helpful comments on our empirical methodology.

[2] The need to disentangle Balassa and Samuelson effects from other real influences is especially important in the Central and Eastern European countries recently joining the EU, as emphasized by the European Commission (2002). The reason is that the deep structural reforms they had to undertake at earlier stages of their transition towards market economies distorted relative prices at least during the first 5 or 6 years of he process. The interaction of transition with BS-effects exaggerates RER appreciations. For instance, the estimates by Kovács and Simon (1998) and Halpern and Wyplosz (2001), which do not separate those influences, suggested that the productivity differential caused approximately a 3% real exchange-rate appreciation, whereas other authors that take into account those influences, such as Corricelli and Jazbec (2001), Égert (2002a,b) and Égert et al (2002), found a much lower impact.

The BSH is, in fact, composed of two stages. The first (denoted BS-1 hereinafter) relates the difference in productivities with the difference in prices of the tradable and non-tradable sectors. The second (BS-2) establishes the link between the price differential and the real exchange rate measured with CPI deflators. This second relationship is immediately obtained by assuming that PPP holds in the tradable sector. In order to look at the BSH more closely and detect the origin of the failure when the results for the entire BSH are poor, we test each part of the hypothesis separately, using the same methodology as . Another novelty of our investigation is that we classify the branches of activity into tradables and non-tradables according to the disaggregated methodology of the United Nations, which is a more rigorous approach than previously used. This allows us to calculate more accurately the variables of interest. For this task, our statistical sources are the OECD (*National Accounts of the OECD countries*), national banks, national statistic institutes, CEPAL (Economic Commission for Latin America and Caribbean of the United Nations), and the ILO (International Labour Organisation). We use annual observations of the period 1990-2001.

In the econometric part of this work, we apply the new panel data unit-root tests suggested by Im, Pesaran and Shin (2002), and Levin and Lin (1993), and the recent panel data cointegration techniques proposed by Pedroni (1995, 1997, 1999). Furthermore, to estimate the cointegration vector we used both OLS regressions and the DOLS methodology suggested by Kao and Chiang (1997). We obtain very satisfactory results for the first stage of the BSH in both groups of countries considered. The coefficient of the productivity differential has the correct sign, and its absolute value lies in the range established by the theoretical model in all cases. We do not find evidence to show that estimates of the BS-1 are better in one group than in the other. However, things look very differently in the tests of the second part of the hypothesis (BS-2). Here we find that PPP holds for the tradable sectors of the Latin American countries as a whole, but not for the group of OECD countries. Furthermore, when looking at individual members, we find that BS-2 is verified in more cases inside the Latin American group (seven countries) than in the OECD area (three countries).

The failure of PPP in the tradable sectors in developed areas is not surprising on theoretical or on empirical grounds. The New Open Macroeconomics literature provides theoretical reasons, based on transportation costs and pricing-to-the market behaviour of exporters, and some empirical works have already found results along the same lines. For instance, Canzoneri, Cumby and Diba (1999) rejected BS-2 in a group of 14 OECD countries, and Égert (2002a) and Égert et al. (2002) also found unfavourable evidence for this relationship in a group of nine Central and Eastern European countries that takes the EU as a benchmark.

The remainder of this paper is organised as follows. In section 2 we derive the two parts of the BSH. In section 3 we explain the composition of our tradable and non tradable sectors and the way in which the variables of interest are measured. This section also includes a descriptive analysis of the main relationship that will be tested and discussed in section 4. Finally, in section 5 we summarise the main findings and derive some policy implications.

2. Theoretical framework

The BSH is based on the following assumptions: a) there are two sectors in the economy that produce tradable (T) and non-tradable (N) goods, respectively, with the same production function; b) the prices of tradable goods (P_T) and the interest rate (*R)* are determined in the world market; c) PPP holds in the tradable sector; d) labour is perfectly mobile across sectors inside the country, but less mobile between countries; e) wages are led by developments in the tradable sectors, and then translated to the non-tradable sector (wage equalisation across sectors).

Suppose that the production in each sector is governed by a constant-return-to-scale Cobb-Douglas function:

(1) $$Y_T = A_T L_T^{\alpha} K_T^{1-\alpha} \qquad 0 < \alpha < 1$$

(2) $$Y_N = A_N L_N^{\beta} K_N^{1-\beta} \qquad 0 < \beta < 1$$

where *Y, L, K, A* stand for output, labour, capital and total factor productivity. *N* and *T* denote variables in the tradable and non-tradable sector, respectively. The elasticity of production with respect to labour is larger in the non-tradable sector than in the tradable sector ($\beta > \alpha$).

Profit maximisation of producers, in situation of perfect competition, coupled with wage equalisation, delivers the following results:

(3) $$W = P_T \alpha A_T (\frac{K_T}{L_T})^{1-\alpha}$$

(4) $$W = P_N \beta A_N (\frac{K_N}{L_N})^{1-\beta}$$

(5) $$R = P_T (1-\alpha) A_T (\frac{K_T}{L_T})^{-\alpha}$$

(6) $$R = P_N (1-\beta) A_N (\frac{K_N}{L_N})^{-\beta}$$

After taking natural logs in the last four equations, from (3) and (4) we obtain:

(7) $$\ln\alpha + a_T + (1-\alpha)(k_T - l_T) = rel + \ln\beta + a_N + (1-\beta)(k_N - l_N)$$

where *rel* is the relative price of non-tradable goods in terms of tradables $(p_N - p_T)$

From (5) and (6), we obtain:

(8) $$(k_T - l_T) = \frac{\ln(1-\alpha) + a_T - r}{\alpha}$$

(9) $$(k_N - l_N) = \frac{rel + \ln(1-\beta) + a_N - r}{\beta}$$

Substituting (8) and (9) into (7) gives:

(10) $$rel = p_N - p_C = z + \frac{\beta}{\alpha} a_T - a_N$$

where z encompasses a set of terms that are constant for the small open country:

$$z = \beta\ln\alpha - \beta\ln\beta + \frac{\beta(1-\alpha)}{\alpha}\ln(1-\alpha) - (1-\beta)\ln(1-\beta) + \frac{(\alpha-\beta)}{\alpha} r$$

A similar equation can be derived for the foreign country:

(10') $$rel^* = p_N^* - p_T^* = z^* + \frac{\beta^*}{\alpha^*} a_T^* - a_N^*$$

where the superscript "*" accompanies the foreign variables.

By assuming that $\alpha = \alpha^*$, $\beta = \beta^*$, and that both countries face the same international rate of interest, the difference between relative prices, *dp*, will be:

(11) $$dp = rel - rel^* = \frac{\beta}{\alpha}(a_T - a_T^*) - (a_N - a_N^*)$$

Equation (11) establishes that the difference between the productivities of the tradable sectors and non-tradable sectors of two countries determines the difference between the relative prices of the two non-tradable sectors. Economies that have a particularly high productive tradable sector will exhibit a relatively high price of non-tradable goods, and a relatively high rate of inflation. This is the first stage of the BS hypothesis.

The mechanism through which increases in productivity in the tradable sector are transmitted to increases in prices in the non-tradable sector is well known. Since the price of tradable goods is determined in the international market, productivity increases in this sector determine nominal wage increases that also spread over the non tradable sector by virtue of labour mobility (and/or centralised union negotiations). As a result, the relative price of non-tradable goods will rise.

The second stage of the BS hypothesis establishes a relationship between productivities and the real exchange rate measured with CPI indices, and is derived as follows. The real exchange rate is defined in natural logs (*q*):

(12) $$q = e + p^* - p$$

where *p* and *p** denote (the log of) general domestic and foreign general price indices, and *e* is the log of the nominal exchange rate, which is defined as the price of the foreign currency in terms of the domestic currency. Note that a decrease in *q* indicates a real appreciation.

Assuming that the weight of non-tradable goods in the consumer's basket is λ in the domestic country, and λ^* in the foreign one, (($1-\lambda$) and ($1-\lambda^*$) for traded goods in each country, respectively), the logs of the general domestic prices may be expressed as:

(13) $$\begin{aligned} p &= \lambda p_N + (1-\lambda) p_T = \lambda.rel + p_T \\ p^* &= \lambda^* p_N^* + (1-\lambda^*) p_T^* = \lambda^*.rel + p_T^* \end{aligned}$$

By substituting (13) into (12), and assuming that the weight of non-tradables is the same in the consumer basket of each country, the following expression for the real exchange rate is obtained:

(14) $$q = (e + p_T^* - p_T) - \lambda(rel - rel^*)$$

Since, by assumption, PPP holds in the tradable sector, the last expression simplifies and become:

(15) $$q = -\lambda(rel - rel^*)$$

According to (15), there is a negative relationship between the difference in the relative price ratios and the CPI-deflated real exchange rate. This is the second part of the BS hypothesis.

Taking into account the entire BS hypothesis, it is easy to see that the real appreciation in the exchange rate should be equal to the increase of the productivity differential transmitted to the CPI via the non-tradable inflation pass-through. In fact, by substituting (11) into (15) gives:

(16) $$q = -\lambda\left[\frac{\beta}{\alpha}(a_T - a_T^*) - (a_N - a_N^*)\right]$$

It is worth noting that the second part of the BS hypothesis relies crucially on the fulfilment of PPP in the tradable sector.

3. Sector classification, measurement of variables and descriptive analysis

3.1 Data sources and sector classification

The data set used in this study consists of annual average labour productivity, the relative price of non-tradable goods and real exchange rates. The panel data set covers two groups of countries: 12 OECD members (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Spain and the United Kingdom) on the one hand, and 12 Latin American countries (Argentina, Bolivia, Chile, Colombia, Costa Rica, Ecuador, Mexico, Nicaragua, Paraguay, Peru, Uruguay and Venezuela) on the other. For each country we take the USA economy as the benchmark foreign country, since all the countries mentioned have substantial economic exchanges with this economy. The data set covers the period from 1990 to 2001 in both cases. All the series are transformed into natural logarithms, and then converted into indices, with the year 1990 being the base.

The data sources for constructing the price and productivity indices for the developed countries are the data bases of the OECD "*National Accounts of the OECD countries, vol. II (1970-2001)*". In addition, valuable information from the central banks of those countries was required to complete some series. The sources for the less developing countries were their central banks, statistic institutes, CEPAL (Economic Commission for Latin America and Caribbean of the United Nations), and the ILO (International Labour Organisation). The IMF database was used for the nominal exchange rates of each country.

In order to calculate productivity and relative prices, it is crucial to correctly classify the economic branches into tradable (open) and non-tradable (sheltered) sectors. The task is not straightforward because no consensus exists on this issue, as shown in Table 1, that we constructed with the help of Égert et al. (2002).

We have adopted the criterion that is explained in Table 2. The tradable sector includes all the tradable economic activities specified in the official statistics, excluding agriculture. Agricultural activities were dropped in both groups of countries, although for different reasons. In the case of the OECD area, the explanation is twofold; first, the bulk of exports corresponds to industrial goods, and second the exchanged volumes of agricultural goods are influenced by distorting protectionist and subsidy policies applied in those countries. In the case of the Latin American area, the exclusion is less evident since the share of agricultural products (particularly coffee, cotton and soya) in total exports is important in all the countries of this group. Our decision obeys the fact that data on employment, for the Latin American countries, correspond to urban work, while agricultural work is predominantly rural.

Public sector activities were also excluded from the tradable sector in all countries because they are not performed under conditions of free competition, and producers do not behave as profit maximisers. As a result, the components of the tradable sector are manufacturing, transportation, storage and communications, mining and quarry, the last activity including oil and natural gas extraction. The inclusion of the last branch seems very important in the case of the Latin American countries which have traditionally been producers and exporters of raw materials. As can be verified by comparing with Table 1, our classification is more highly disaggregated than previous studies.

Table 1. An overview of sector classification

Author	Open (tradable) sector	Sheltered (non-tradable) sector
De Gregorio-Giovannini-Wolf (1994) De Gregorio-Wolf (1994) Chinn-Johnston (1997) Duval (2001) MacDonald-Ricci (2001)	Criterion: Exports/Total production > 10% Manufacturing Agriculture Mining Transports	Rest
De Gregorio-Giovannini-Krueger (1994)	Industry, Energy	Services (private)
Kovács and Simon (1998) Kovács (2001)	Manufacturing	Services Energy; public services and agriculture are excluded.
Canzoneri-Cumby-Diba (1999) Aitken (1999) Sinn-Reutter (2001)	Manufacturing	Rest
Hsieh (1982) Chinn (1997) Ito-Isard-Symansky (1997) Golinelli-Orsi (2001)	Manufacturing	Rest
Tyrväinen (1998) Alberola-Tyrväinen (1998)	Manufacturing and Transportation	Services (public services and Agriculture are excluded)
Strauss (1995, 1996, 1999) Wu (1996) Swagel (1999) Rother (2000)	Manufacturing	Rest (agriculture is excluded)
Égert et al.. (2002)	Industry (excluding construction)	Rest (agriculture is excluded)

The non-tradable sector includes six categories of private services, and excludes public services because of the lack of data on production and/or employment for those activities.

Table 2. Classification of the tradable and non-tradable activities

Tradable goods (j)
1.Manufacturing
2. Transport, Storage and Communications
3. Mining and quarry
Non-tradable goods (j)
4. Electricity, Gas and Water Supply
5. Construction
6. Wholesale and Retail Trade. Repair of Motor Vehicles and Personal and Household Goods
7. Hotels and Restaurants
8. Financial Intermediation
9. Real Estate, Renting and Business Activities
Branches excluded from the analysis
10. Education
11. Health and Social Work
12. Other social service activities
13. Domestic Services
14. Non-Governmental Organisations
15. Agriculture, Forestry, Hunting and Fishing
16. Public Administration

The items of this classification follows the lines of the United Nations, *Statistical Papers*, Series M, nr. 4/Rev. 3, New York, 1990.

3.2 Price differentials and productivity measures

We define the relative price of non-tradables with respect to tradables as the ratio of the two corresponding sector GDP deflators. To obtain deflator indices we first measured the aggregate production, that is the value added (*VA*), in each sector, taking into account the items *(j)* specified in Table 2:

(17) $$VA_i = \sum_j VA_i(j) \qquad i = T, N$$

We measured each added value in both nominal *(CVA)* and real terms *(BVA)*, using current prices and the prices of the base year (1990), respectively, and then we calculated the price deflators, P_T and P_N, according to the following expressions:

(18) $$P_i = \frac{CVA_i}{BVA_i} \qquad i = T, N$$

To obtain the average productivities of labour, we first computed total labour employment in each sector, EM_T and EM_N, respectively, according to the following formula:

(19) $$EM_i = \sum_j EM_i(j) \qquad i = T, N$$

Then, we calculated average productivities *(* PRL_T and PRL_N*)* with these expressions:

(20) $$PRL_i = \frac{BVA_i}{EM_i} \qquad i = T, N$$

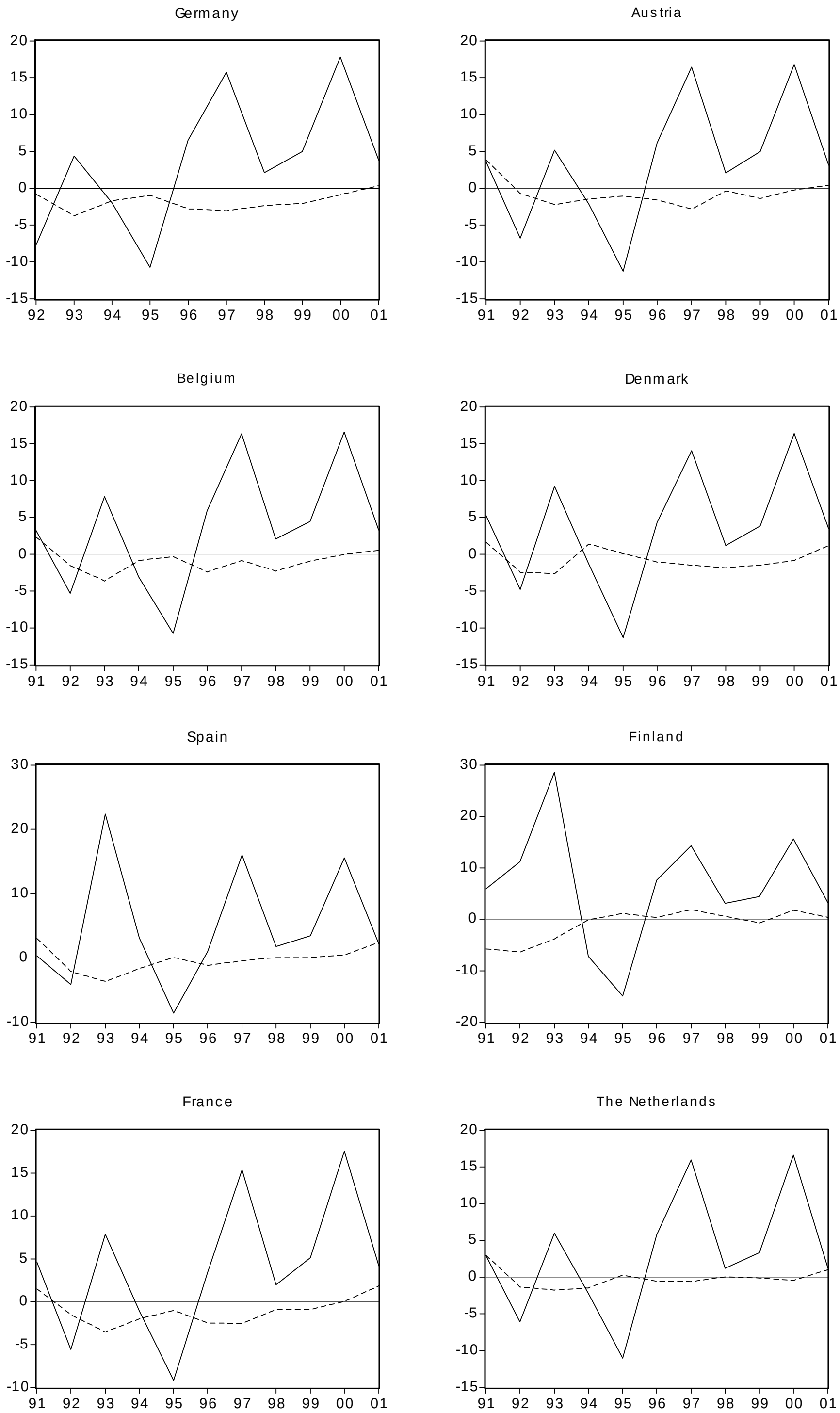
3.3 Descriptive analysis.

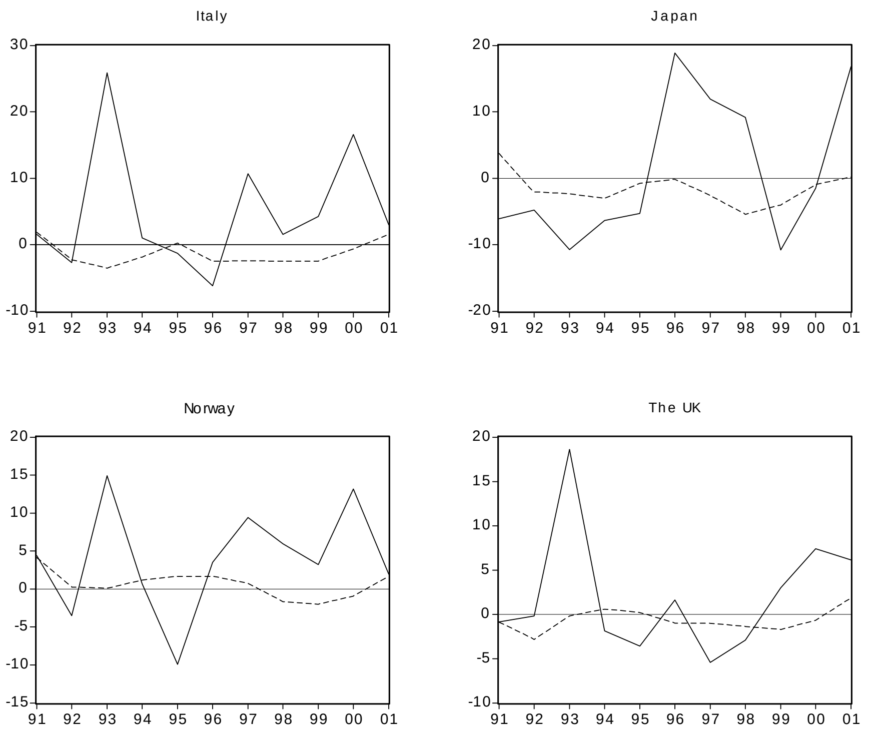
As explained above, it is expected that countries growing faster will tend to experience real exchange-rate appreciations with respect to other, slowly growing economies. To verify this in a simple and descriptive way, Graphs 1 and 2 show the evolution of the difference in GDP growth and the variation of the CPI real exchange rate of each individual country with respect to the USA during the period covered in this study, in OECD and Latin American countries, respectively. The difference between the rates of growth (GDIF) is represented by the dashed line, whereas the variation in the real exchange rate (RERVAR) is indicated by the solid line. Taking into account the definition of the real exchange rate that we use (equation (12)), we should find that two conditions are met: a) a negative correlation between GDIF and RERVAR, in the sense that positive values of the first variable are accompanied by negative values of the second, and b) an upward trend in the dashed line should go with a downward trend in the solid line, and vice versa.

As far as the OECD countries are concerned, these two features are not commonly found in individual members. In general, RERVAR is much more volatile than GDIF in each country, indicating that the two variables are disconnected to some extent. In most cases, GDIF exhibits an almost uniform path with a negative sign since 1992, while RERVAR shows strong fluctuations in which depreciations are predominant. An additional feature is that real exchange rate developments are very similar in the ten continental OECD countries. It seems that the BSH might be satisfied at most in Denmark, Finland, Norway, Italy and the UK. In short, the simple visual analysis is not very supportive of the BSH in the group of developed economies of our sample.

Graph 1:
Growth differential (GDIF) and variations in the real exchange rate (RERVAR) of twelve OECD countries with respect to the USA, 1991-2001

GDIF: _ _ _ _ _ _ _ _ _ _ _ _ _ _ RERVAR: ____________________

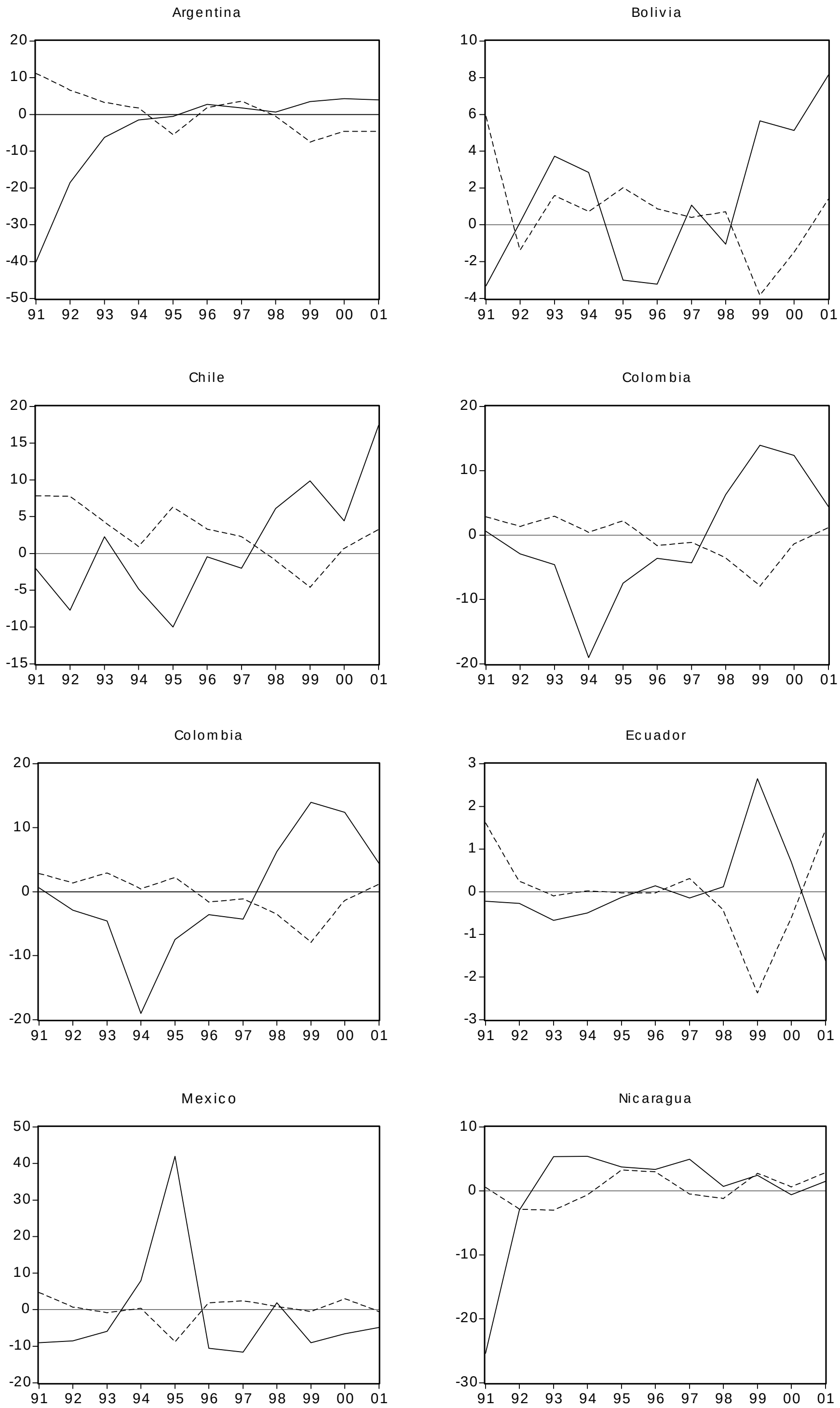


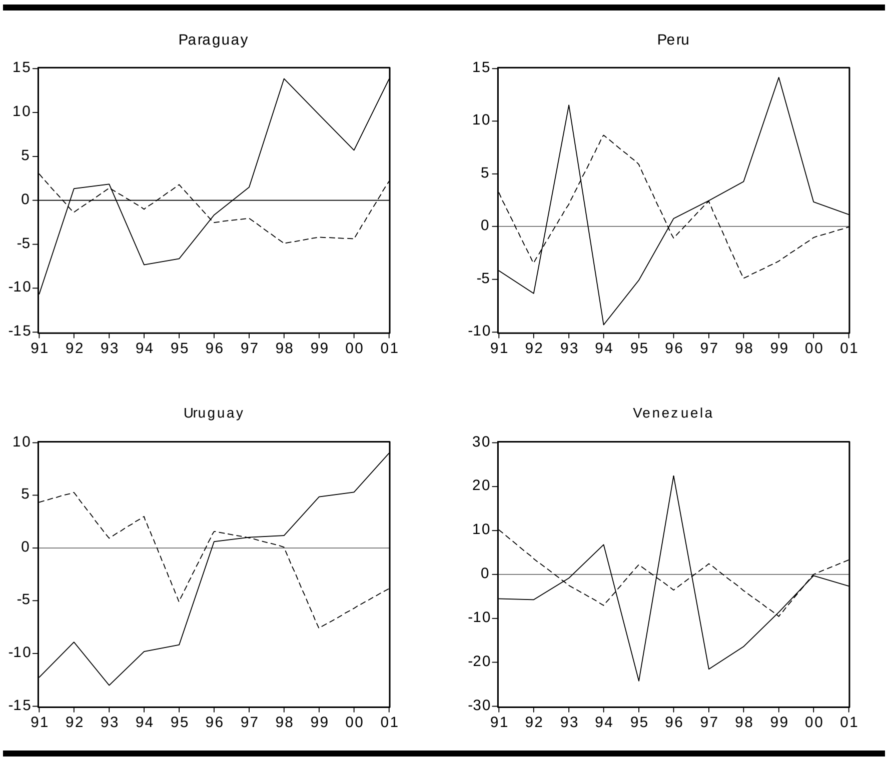


GDIF stands for the difference in the rates of growth between the domestic country and the USA.
RERVAR indicates the variation in the real exchange rate of the domestic currency with respect to the US Dollar. A negative sign means real appreciation of the domestic currency.

Graph 2:
Growth differential (GDIF) and variations in the real exchange rate (RERVAR) of twelve Latin American countries with respect to the USA, 1991-2001

GDIF: _ _ _ _ _ _ _ _ _ _ _ _ _ _ RERVAR: ____________________





GDIF stands for the difference in the rates of growth between the domestic country and the USA
RERVAR indicates the variation in the real exchange rate of the domestic currency with respect to the US Dollar. A negative sign means real appreciation of the domestic currency.

As regards as the group of Latin American economies, Graph 2 offers a very different picture. It can be seen that both variables exhibit similar degrees of variability, and conditions a) and b) seem more commonly satisfied in these economies. The only country that may be clearly discarded on visual grounds is Nicaragua, where the two variables have the same sign in most years of the sample.

To summarise, the descriptive analysis suggests that the BSH is satisfied more easily, and in more cases, within the group of Latin American countries than in the set of OECD economies covered by our analysis. In the following section we perform econometric analysis to test rigorously the BSH and ascertain whether our first impressions are confirmed.

4. Empirical analysis

In this section, we apply recent panel stationary and cointegration techniques to test the two stages of the BSH in the two areas under study, since we believe that this methodology, based on pooled observations, increases the reliability of the estimates in countries (such as those of the Latin American area) for which only short time series exist. Panel and cross section techniques have already been applied by Halpern and Wyplosz (2001), De Broeck and Slok (2001) and Égert et al. (2002) in the context of Central and Eastern European transition countries, and by Drine and Rault (2002) using data of a large group of Latin American countries.

Before performing the cointegration tests, we applied panel unit-root tests to the following variables measured in natural logs:

$dp = rel - rel^*$
$daT = a_T - a_T^*$
$daN = a_N - a_N^*$
$(dp + daN)$
e
$dpT = p_T - p_T^*$

In order to solve the problems arising from possible contemporaneous correlations between the series, we corrected the data by subtracting the cross average in each year from each original gross value, and applied our tests to both gross and corrected series. The results of the Levin and Lin (1993) and Im, Pesaran and Shin (2002) test indicate that all of the series have a unit root in the two panels of our study[3], which justifies further investigation into whether the variables maintain the long run relationships derived from our model. In the following lines we apply cointegration tests and estimate the cointegration vectors when justified.

4.1 The first stage of the BS hypothesis. Cointegration tests

Given that the theoretical model postulates that the coefficient of $(a_N - a_N^*)$ (equation (11)), is equal to minus one, we include this restriction in our tests and, consequently, estimate the relationship between the composed variable $(dp + daN)$ and daT. According to equation (11), the coefficient of daT should be positive and higher than unity. We will consider two alternative cases: in the first, we will assume that all panel members share the same parameters (homogeneous model); in the second, we assume that each individual country has its own (differentiated) parameters, which will be revealed by the estimation results (heterogeneous model).

4.1.1 Homogeneous model

The relationship to be tested is:

(21) $$(dp + daN)_{i,t} = \theta_0 + \theta_T daT_{i,t} + \varepsilon_{i,t}$$

Table 3 shows the results of the Pedroni (1995) test for homogeneous panels, applied to both groups of countries. The first two columns for each group (under the head of A and B) provide the results when

[3] The results can be obtained from the authors upon request.

residuals are obtained from OLS regressions, using gross and corrected data, respectively[4]. The values of the third column (under the head of C) are derived applying DOLS regressions to non-corrected data. Two rows are specified, in accordance with the two standardised statistics of the Pedroni (1995) test. As can be seen, in all cases, except for case B in the OECD group, the null hypothesis that the two variables are not cointegrated can be rejected at 1% level. Rejection is stronger when residuals are obtained with DOLS regressions. Consequently, the panel test provides strong evidence that the variables *(dp + daN)* and *daT*, are, in fact, cointegrated in each area of our study, as the first part of the BSH predicts.

Table 3
Cointegration test with Pedroni (1995) method for homogeneous panels
Regression: $(dp + daN)_{i,t} = \theta_0 + \theta_T daT_{i,t} + \varepsilon_{i,t}$
(1990-2001)

	Latin American countries			OECD countries		
Statistics	A	B	C	A♣	B	C
PEDE1	-4.17*	-5.71*	-11.93*	-4.18*	-0.54	-9.00*
PEDE2	-4.00*	-5.47*	-11.42*	-4.00*	-0.52	-8.62*

1. PEDE1 and PEDE2 are the two standardised statistics of the Pedroni (1995) test. They follow a typical left -tail normal distribution
2. Level of significance: 1%(*), 5%(**) y 10%(***).
4. A: Non-corrected data (OLS); B: corrected data (OLS); C: non-corrected data (DOLS).
5. H_0: there is no cointegration between the two variables.
6. Cointegration tests for one explanatory variable.
♣. The spurious regression includes one trend.

4.1.2 Heterogeneous model

In this case, the relationship that we estimate is:

(22) $$(dp + daN)_{i,t} = \theta_{0,i} + \theta_{T,i} daT_{i,t} + \varepsilon_{i,t}$$

Table 4 shows the panel cointegration results for the first four Pedroni (1997) statistics encountered for this kind of model. The null hypothesis is that the residuals of all panel members are not stationary, i. e. there is no cointegration between the two variables, compared with the alternative hypothesis that the panel is stationary with only one autoregressive parameter. In both groups of countries, the null hypothesis is rejected by the statistics PEDHE1, for cases A and C, and by PEDH4 for all kinds of regression at 1% significance. For these reasons we may accept a long run relationship between the variables *(dp + daN)* and *daT* in the two areas, each country having its own specific parameters. Consequently, the following step is to estimate the corresponding cointegration vectors.

[4] In cases where contemporaneous correlation was sufficiently high (bigger than 0.5) we corrected the series by subtracting the cross average from each time observation.

Table 4
Cointegration test with Pedroni (1997) method for heterogeneous panels
Regression: $(dp + daN)_{i,t} = \theta_{0,i} + \theta_{T,i} daT_{i,t} + \varepsilon_{i,t}$
(1990-2001

	Latin America countries			OECD countries		
Statistics	A	B	C	A	B	C
PEDHE1	2.25**	0.15	6.73*	2.19**	-0.27	7.15*
PEDHE2	0.04	-0.19	0.10	1.64	0.81	0.61
PEDHE3	-1.00	-3.00*	-0.75	2.60	-0.27	0.68
PEDHE4	-90.72*	-184.04*	-104.76*	-35.03*	-235.19*	-90.10*

1. The PEDHE1 statistics follows a typical right-tail normal distribution. Statistics PEDHE2, PEDHE3 y PEDHE4 are distributed according to a typical left-tail normal distribution.
2. Level of significance: 1%(*), 5%(**) y 10%(***).
3. A: Non-corrected data (OLS); B: corrected data (OLS); C: transformed data for heterogeneous panels (DOLS) following the Kao and Chiang (1997) methodology.
4. H_0: there is no cointegration between the two variables.
6. Cointegration tests for one explanatory variable.

4.2 The first stage of the BS hypothesis. Cointegration vectors

4.1.1 Homogeneous model

Table 5 offers the point estimates, using gross data and performing both OLS (columns A) and DOLS (columns C) estimations. It is apparent that in all cases and for both groups of countries $\hat{\theta}_T$ has a positive sign, and is statistically significant, as postulated by the theory. This parameter is higher in the group of OECD countries (1.27) than in the Latin American area (0.89) under DOLS estimations, indicating that in the first area the relative price differential is more sensitive to productivity increases in the tradable sector.

Table 5
Estimation of the cointegration vector
Homogeneous model: $(dp + daN)_{i,t} = \theta_0 + \theta_T daT_{i,t} + \varepsilon_{i,t}$
(1990-2001)

	L. A. countries		OECD countries	
	A	C	A♣.	C
$\hat{\theta}_{NC}$	-1	-1	-1	-1
$\hat{\theta}_C$	0.91 (0.00)	0.89 (0.00)	0.61 (0.00)	1.27 (0.00)
$\bar{R}^2$	0.51	0.72	0.54	0.34

1. Figures between parenthesis indicate p-values.
2. A: Non-corrected data (OLS); C: non-corrected data (DOLS)
3. The p-values of the DOLS estimation come from the variances matrix, once corrected for heteroskedasticiy applying the White method. The values of the Lagrange-multiplier statistics are 30.72 y 85.05 for L. A. and OECD countries, respectively. The p-values corresponding to those values, which follow a χ^2_N distribution, are close to zero, indicating that the null hypothesis of heterokedasticiy can be rejected.
♣. The spurious regression includes a trend.

Let us now investigate whether the size of the common parameter $\hat{\theta}_{T}$ fully satisfies the BS hypothesis in each area, under the accepted restriction that $\theta_N = -1$. More specifically, we want test the following hypothesis:

H_0: $\theta_T \geq 1$

H_1: $\theta_T < 1$

According to the results of the test, contained in Table 6, the null hypothesis cannot be rejected. The values of the *t* statistic shown in the first and fifth columns, and the corresponding *p*-values for NT-K degrees of freedom shown underneath, do not permit its rejection. Furthermore, it can be observed that the 95% confidence intervals built for the parameter $\hat{\theta}_{T}$ contain values that are equal or higher than unity. In fact, the confidence interval for the Latin American and OECD groups are (0.57, 1.21) and (0.57, 1.98). For those reasons, we cannot reject the hypothesis that $\hat{\theta}_{T}$ is equal or bigger than unity in both cases.

Table 6
The first part of the Balassa and Samuelson hypothesis
Homogeneous model: $H_0 : \theta_C \geq 1$ $H_1 : \theta_C < 1$
(1990-2001)

L. A. countries	t_{NT-K}	**H$_0$**	**CI at 95%**	**First part of the BSH**	t_{NT-K}	**H$_0$**	**CI at 95%**	**First part of the BSH**	**OECD countries**
L. A. countries	*-0.67* (0.25)	NR	0.56901 1.21317	*Yes*	*0.77* (0.78)	NR	0.57256 1.96773	*Yes*	OECD countries

1.The values in italics correspond to the quantiles of the distribution t_{NT-K}.
2.The values between parenthesis are the p-values of the corresponding quantiles.
3.The test is left tail.
4. The intervals of confidence are built with a coefficient of 95%. The corresponding cells indicate the upward and downward limits, respectively.

To sum up, we may assert that the first part of the BS hypothesis, in the homogeneous version, holds in both areas. Moreover, the parameter $\hat{\theta}_{T}$ tend to be higher in the group of OECD countries.

The homogeneous model assumes common parameters for all countries of each area, but it is evident that in reality the individual values may differ between countries. For this reason, we undertake, in turn, estimations for heterogeneous panels.

4.1.1 Heterogeneous model

Table 7 offers the individual estimates of the parameter $\hat{\theta}_T$ for the members of the two areas. In the Latin American group, the results are correctly signed and significant at lower than 10%, using both estimation techniques, in the following countries: Argentina, Bolivia, Colombia Ecuador, Mexico, Nicaragua, Paraguay and Peru. Venezuela can also be included in this set under OLS regressions. Looking at the OECD group, we find similar positive results in Spain, the Netherlands, Italy, Japan and the United Kingdom. The values obtained for Germany and Belgium could also be accepted considering DOLS and OLS regressions, respectively.

Table 7
Estimation of the cointegration vector
Heterogeneous model: $(dp + daN)_{i,t} = \theta_{0,i} + \theta_{T,i} daT_{i,t} + \varepsilon_{i,t}$
(1990-2001

	L. A. countries		OECD countries		
	A	C	A	C	
$\hat{\theta}_{N_i}$	-1	-1	-1	-1	$\hat{\theta}_{N_i}$
$\hat{\theta}_{Ti}$					$\hat{\theta}_{Ti}$
Argentina	1.70 (0.00)	1.65 (0.00)	0.68 (0.73)	6.89 (0.01)	Germany
Bolivia	0.92 (0.00)	0.75 (0.01)	-0.98 (0.39)	-2.48 (0.20)	Austria
Chile	-0.98 (0.02)	-0.98 (0.02)	1.37 (0.00)	2.09 (0.19)	Belgium
Colombia	1.00 (0.01)	2.42 (0.00)	0.20 (0.90)	-3.22 (0.33)	Denmark
Costa Rica	-0.79 (0.45)	-2.15 (0.00)	1.60 (0.00)	1.80 (0.00)	Spain
Ecuador	1.44 (0.00)	1.53 (0.00)	-0.02 (0.92)	-0.54 (0.18)	Finland
Mexico	2.09 (0.00)	2.08 (0.00)	0.58 (0.70)	-0.87 (0.34)	France
Nicaragua	1.17 (0.00)	1.10 (0.00)	2.55 (0.00)	2.54 (0.01)	The Netherlands
Paraguay	1.00 (0.00)	1.07 (0.00)	1.73 (0.00)	1.54 (0.00)	Italy
Peru	1.19 (0.00)	1.53 (0.00)	0.72 (0.00)	2.10 (0.00)	Japan
Uruguay	0.19 (0.57)	-0.03 (0.95)	2.44 (0.12)	2.32 (0.31)	Norway
Venezuela	1.30 (0.00)	0.68 (0.43)	0.97 (0.00)	0.73 (0.05)	The UK
$\bar{R}^2$	0.73	0.98	0.36	0.99	$\bar{R}^2$

1. Figures between parenthesis indicate p-values.
2. A: non-corrected data (OLS); C: non-corrected data (DOLS)
3. The p-values of the DOLS estimation come from the variances matrix, once corrected for heteroskedasticiy applying the White method. The values of the Lagrange-multiplier statistics for column A are 50.78 y 138.44 for L. A. and OECD countries, respectively. The values for column C are 60.84 y119.49, respectively. The null hypothesis of heteroskedasticity can be rejected because in all cases the obtained p-values are close to zero.

In order to ascertain the extent to which individual panel members have point estimates of the parameter $\hat{\theta}_{T}$ equal or higher than unity, as specified in the first part of the BS model, we perform the following test:

$H_0: \quad \theta_{T,i} \geq 1$

$H_1: \quad \theta_{T,i} < 1$

The results for the Latin American and OECD groups are reported on the left and right sides, respectively, of Table 8.

Table 8
The first part of the Balassa and Samuelson hypothesis
Heterogeneous model: $H_0: \theta_C \geq 1$, $H_1: \theta_C < 1$
(1990-2001)

L. A. countries	t_{NT-K}	H_0	CI at 95%	First part of the BSH	t_{NT-K}	H_0	CI at 95%	First part of the BSH	OECD countries
Argentina	*1.69* (0.95)	NR	0.88937 2.42060	*Yes*	*2.32* (0.99)	NR	1.85635 11.92289	*Yes*	Germany
Bolivia	*-0.96* (0.17)	NR	0.22006 1.27157	*Yes*	—	—	—	—	Austria
Chile	*-4.80* (0.00)	R	-1.80001 -0.16524	*No*	*1.089* (0.87)	NR	0.70400 2.03326	*Yes*	Belgium
Colombia	*2.87* (0.99)	NR	1.43996 3.39732	*Yes*	—	—	—	—	Denmark
Costa Rica	*-13.37* (0.00)	R	-2.61397 -1.68186	*No*	*4.14* (0.99)	NR	1.41961 2.18753	*Yes*	Spain
Ecuador	*2.60* (0.99)	NR	1.12620 1.92835	*Yes*	—	—	—	—	Finland
Mexico	*3.05* (0.99)	NR	1.38140 2.78669	*Yes*	—	—	—	—	France
Nicaragua	*1.69* (0.95)	NR	0.98348 1.20982	*Yes*	*1.62* (0.95)	NR	0.65611 4.41434	*Yes*	The Netherlands
Paraguay	*0.52* (0.70)	NR	0.79482 1.34995	*Yes*	*3.46* (0.99)	NR	1.23030 1.84751	*Yes*	Italy
Peru	*1.36* (0.91)	NR	0.75630 2.30062	*Yes*	*2.23* (0.99)	—	1.12182 3.07239	*Yes*	Japan
Uruguay	—	—	—	—	—	—	—	—	Norway
Venezuela♠	*1.07* (0.86)	NR	0.74403 1.86202	*Yes*	*-0.77* (0.22)	NR	0.02191 1.43203	*Yes*	The UK

1.The values in italics correspond to the quantiles of the distribution t_{NT-K}.
2.The values between parenthesis are the p-values of the corresponding quantiles.
3.The test is left tail.
4. The intervals of confidence are built with a coefficient of 95%. The corresponding cells indicate the upward and downward limits, respectively.
♠ The values come from OLS estimates.

Columns 1 and 5 contain the *t* statistic, under the null hypothesis. In most cases of the Latin American group, the values of *t* do not generate significant *p*-values (specified between brackets), which means that the null hypothesis cannot be rejected. The countries where this holds are Argentina, Bolivia, Colombia, Ecuador, Mexico, Nicaragua, Paraguay, Peru and Venezuela. The confidence intervals, at 95%, reported in the second column, confirm these results. Thus, for Argentina, for example, the DOLS estimated value of $\theta_{T,i}$ is 1.65, and its confidence interval is (0.89, 2.42), which contains the unity value.

As far as the OECD group is concerned, the good results correspond to Germany, Belgium, Spain, Netherlands, Italy, Japan, and United Kingdom.

To sum up, we find evidence that the first stage of the BS hypothesis is satisfied in each group of countries as a whole, and that when we look at individual panel members, the favourable evidence is found in 9 out of 12 Latin American countries, and in 7 out of 12 OECD members. The reason why the BS-1 holds more easily in the Latin American group could be explained by the fact that the differences in economic development with respect to the USA are greater in that set of countries than in the OECD.

5.1 The second stage of the BS hypothesis. Cointegration tests

As explained above, the PPP in the tradable sector is the corner stone of the BS-2. In order to verify whether this relationship is satisfied, we apply panel cointegration tests to the equation that links the nominal exchange rate with the price differential. We will consider both the homogeneous and the heterogeneous models.

5.1.1 Homogeneous model

The model that we test is:

(23) $$e_{i,t} = \gamma_0 + \gamma_p dpT_{i,t} + \varepsilon_{i,t}$$

Table 9 shows the Pedroni (1995) cointegration statistics, PEDE1 and PEDE2, for homogeneous panels. In the case of the Latin American group, the null hypothesis of non-cointegration may be rejected at 1% significance, using the DOLS residuals. For the group of OECD countries, we find favourable evidence not only with the DOLS but also with the OLS regressions. Consequently, we may assert that there is a cointegration relationship between the price differential of tradables and the nominal exchange rate in each group of countries.

Table 9
Cointegration test with the Pedroni (1995) meted for panel data
Homogeneous model: $e_{i,t} = \gamma_0 + \gamma_p dpT_{i,t} + \varepsilon_{i,t}$
(1990-2001)

	L. A. countries			OECD countries		
Statistics	A	B	C♠	A	B	C♠
PEDE1	-0.17	0.14	-15.24*	-3.67*	-1.95**	-13.65*
PEDE2	-0.16	0.14	-14.59*	-3.53*	-1.86**	-13.07*

1. PEDE1 and PEDE2 are the two standardised statistics of the Pedroni (1995) test. They follow a typical left -tail normal distribution
2. Level of significance: 1%(*), 5%(**) y 10%(***).
4. A: Non-corrected data (OLS); B: corrected data (OLS); C: non-corrected data (DOLS).
5. H_0: there is no cointegration between the two variables.
6. Cointegration tests for one explanatory variable.
♣. Includes fixed effects.

5.1.2 Heterogeneous model

The model becomes:

(24) $$e_{i,t} = \gamma_0 + \gamma_{p,i} dpT_{it} + \varepsilon_{i,t}$$

As can be seen, we allow each member of the panel to have its own and specific parameter, $\gamma_{p,i}$. The results of the Pedroni (1997) test can be seen in Table 10. The null hypothesis of no-cointegration can be rejected in both groups, especially when DOLS estimations are considered. For instance, in the case of the Latin American group, the null of no cointegration can be rejected at 1% significance, with the statistics PEDHE1, PEDHE3, and PEDHE4.

Tabla 10
Cointegration test with the Pedroni (1997) method for panel data
Heterogeneous model: $e_{i,t} = \gamma_0 + \gamma_{p,i} dpT_{it} + \varepsilon_{i,t}$
(1990-2001)

	L. A. countries			OECD countries		
Statistics	A	B	C	A	B	C
PEDHE1	0.64	0.27	8.18*	0.29	1.54***	4.66*
PEDHE2	0.90	-0.44	-0.64	0.89	-1.82**	-1.29***
PEDHE3	0.34	-2.61*	-2.03*	-0.34	-3.42*	-3.55*
PEDHE4	-93.95*	-122.07*	-115.79*	-98.73*	-231.96*	-151.39*

1. The PEDHE1 statistics follows a typical right-tail normal distribution. Statistics PEDHE2, PEDHE3 y PEDHE4 follows a typical left-tail normal distribution.
2. Level of significance: 1%(*), 5%(**) y 10%(***).
3. A: Non-corrected data (OLS); B: corrected data (OLS); C: :transformed data for heterogeneous panels (DOLS) following the Kao and Chiang (1997) methodology.
4. H_0: there is no cointegration between the two variables.
6. Cointegration tests for one explanatory variable.

Since it seemed that a long run relationship exists between the two variables in each group of economies, we decided to estimate the cointegration vector in each model, and to test, in turn, the PPP hypothesis in the tradable sectors.

5.2 The second stage of the BS hypothesis. Cointegration vectors

5.2.1 Homogeneous model

The results are reported in Table 11. For the Latin American group, the estimated value for $\hat{\gamma}_p$, using the DOLS method, is 0.92, and has a p-value close to zero, which indicates that the estimation is statistically significant. As far as the OECD group is concerned, we obtained favourable estimates using both OLS with gross data, and DOLS, which delivers less biased results in small samples. In the first case, $\hat{\gamma}_p$ is equal to 1.31, and in the second case its value is 0.98.

Table 11
Estimation of the cointegration vector
Homogeneous model: $e_{i,t} = \gamma_0 + \gamma_{p,i} dpT_{it} + \varepsilon_{i,t}$
(1990-2001)

	L. A. countries		OECD countries	
	A	C	A	C
$\hat{\gamma}_p$	—	0.92 (0.00)	1.31 (0.00)	0.98 (0.00)
$\bar{R}^2$	—	0.99	0.39	0.80

1. Figures between parenthesis indicate p-values.
2. A: Non-corrected data (OLS); C: non-corrected data (DOLS)
3. In the case of the Latin American countries, the p-value of the DOLS estimation comes from the variances matrix, once corrected for heteroskedasticity applying the White method. The value of the Lagrange-multiplier statistic in column C is 40.25, which generates a p-value close to zero. This permits rejecting the null hypothesis of heteroskedasticity..
4. In the case of the OECD countries, the p-value of the OLS estimation comes from a variance matrix in which heteroskedasticity was corrected applying the White method. The value of the Lagrange-multiplier statistic in column A is 51.20 which produces a p-value close to zero, indicating that the null of heteroskedasticity can be rejected. The statistic in column A is equal to 16.20, having a p-value equal to 0.19, which does not allow us rejecting the null hypothesis of heteroskedasticity.

These results strongly suggest that the estimated parameter does not differ statistically from unity in either group of countries, especially when using DOLS methodology, which provides better and less biased estimates in small panel samples. Consequently there is strong evidence that PPP is fulfilled in the tradable sectors, which suggests that the second part of the BSH is satisfied. However, given that the results for the OECD area are not devoid of heteroskedasticity, a more rigorous method to test the null hypothesis that $\gamma_p = 1$ is needed. One possibility would be to test whether the real exchange rate (deflated with price indexes of the tradable sectors) is a stationary variable. The natural log of this real exchange rate is:

(25) $$q_T = e + p_T^* - p_T$$
$$q_T = e + dpT$$

The proposed test consist of verifying whether the stochastic series

(26) $$\varepsilon_{i,t} = (e + dpT)_{i,t}$$

is stationary. If $\varepsilon_{i,t}$ is a *I(0)* variable, $e_{i,t}$ and $dpT_{i,t}$ are cointegrated with $\gamma_p = 1$.

The results of the Levin and Lin (1993) unit-root test for panel samples are displayed in Table 12. In the case of the Latin American countries, the unit root hypothesis is rejected at 10%, and PPP(T) with respect to the USA is accepted. However, in the case of the OECD group, the null hypothesis cannot be rejected, and we cannot accept that $\gamma_p = 1$. It is established that $e_{i,t}$ and $dpT_{i,t}$ are cointegrated in the OECD members as a whole, but with a common (average) slope different from unity.

Table 12

Unit root test on stationarity of $\varepsilon_{i,t} = (e + dpT)_{i,t}$

Method of Levin and Lin (1993) to test whether $\gamma_p = 1$

Homogeneous model
(1990-2001)

Series	**L. A. area**	**OECD area**
Non-filtered series		
t-statistics of $\hat{\rho}$	-6.09	-5.61
t*-statistics of $\hat{\rho}$	-1.55	0.06
p-value	0.06***	0.52
Ho	*R*	*NR*
Second part of the BSH	*Yes*	*Not*
Filtered series		
t-statistics of $\hat{\rho}$	-1.59	-1.98
t*-statistics of $\hat{\rho}$	-1.53	-1.90
p-value	0.06***	0.03**
Ho	*R*	*R*
Second part of the BSH	*Yes*	*Yes*

1.The null hypothesis is H_0: each of the panel members has unit root, as opposed to the alternative H_1: all of the individuals of the panels are stationary.
2. The model for the non-filtered series includes an independent term. The model for the filtered series does not includes any independent term nor any trend.
4. (*), (**), (***) indicate 1%, 5% y 10% significance, respectively.

5.2.1 Heterogeneous model

The estimated vectors of the equation $e_{i,t} = \gamma_{0,i} + \gamma_{p,i} dpT_{it} + \varepsilon_{i,t}$ are presented in Table 13 for each group of countries. As can be observed in the Latin American group, the value of $\gamma_{p,i}$ as estimated by DOLS methodology, is close to unity for Bolivia, Chile, Colombia, Costa Rica, Ecuador, Mexico, Paraguay, Uruguay and Venezuela; and the group widens to include Argentina and Peru when the estimates are obtained with OLS.

Tabla 13
Estimation of the cointegration vector
Heterogeneous model: $e_{i,t} = \gamma_{0,i} + \gamma_{p,i} dpT_{it} + \varepsilon_{i,t}$
(1990-2001)

	L. A. countries		**OECD countries**		
	A	C	A	C	
$\hat{\gamma}_{pi}$					$\hat{\gamma}_{pi}$
Argentina	0.87 (0.00)	0.01 (0.00)	-1.69 (0.45)	-9.14 (0.04)	Germany
Bolivia	1.01 (0.00)	0.87 (0.00)	3.96 (0.00)	3.19 (0.00)	Austria
Chile	0.80 (0.00)	0.80 (0.00)	0.47 (0.67)	0.17 (0.95)	Belgium
Colombia	0.84 (0.00)	0.98 (0.00)	1.53 (0.00)	1.52 (0.00)	Denmark
Costa Rica	0.84 (0.00)	0.85 (0.00)	2.10 (0.00)	2.18 (0.00)	Spain
Ecuador	1.00 (0.00)	0.98 (0.00)	2.70 (0.01)	2.91 (0.12)	Finland
Mexico	0.91 (0.00)	0.99 (0.00)	-2.09 (0.03)	-2.53 (0.03)	France
Nicaragua	1.72 (0.00)	1.17 (0.00)	3.51 (0.00)	3.35 (0.00)	The Netherlands
Paraguay	0.94 (0.00)	0.80 (0.02)	2.29 (0.00)	2.11 (0.00)	Italy
Peru	0.97 (0.00)	1.21 (0.00)	0.43 (0.31)	-0.04 (0.97)	Japan
Uruguay	0.90 (0.00)	0.80 (0.00)	0.59 (0.00)	0.42 (0.03)	Norway
Venezuela	0.88 (0.00)	0.87 (0.00)	0.85 (0.03)	0.33 (0.62)	The UK
$\bar{R}^2$	0.99	0.99	0.70	0.98	$\bar{R}^2$

1. Figures between parenthesis indicate p-values.
2. A: Non-corrected data (OLS); C: non-corrected data (DOLS)
3.The p-values of the OLS and DOLS estimations come from the variances matrix, once corrected for heteroskedasticity applying the White method. The value of the Lagrange-multiplier statistics in column A are 123.34 and 25.32 for the Latin American and OECD countries, respectively. The multiplier statistics in column C are 52.49 and 26.37. In every case, those statistics produce p-values close to zero, which allows us to reject the null hypothesis of homoskedasticity.

However, in the case of the OECD group, the statistically significant estimates are far from unity for all of the members, except for the UK using OLS estimations. Consequently, it can be said that PPP(T) clearly holds in a higher number of countries in the Latin American group than in the OECD area. But before giving a definitive verdict for individual members, we perform the following additional test:

$H_0: \quad \gamma_{p,i} = 1$

$H_1: \quad \gamma_{p,i} \neq 1$

Table 14
Test of PPP in the tradable sectors
Heterogeneous model: $H_0: \gamma_{pi} = 1$, $H_1: \gamma_{pi} \neq 1$
(1990-2001)

L. A. countries	χ_q^2	H_0	CI at 95%	Second part of the BSH	χ_q^2	H_0	CI at 95%	Second part of the BSH	OECD countries
Argentina	*53623* (0.00)	R	0.00603 0.02288	*Not*	*5.14* (0.02)	R	-17.9887 -0.28312	*Not*	Germany
Bolivia	*4.71* (0.03)	NR	0.74494 0.98829	*Yes*	*36.15* (0.00)	R	2.46913 3.91181	*Not*	Austria
Chile	*1.15* (0.28)	NR	0.42237 1.17183	*Yes*	—	—	—	—	Belgium
Colombia	*0.00* (0.94)	NR	0.48112 1.48164	*Yes*	*17.91* (0.00)	R	1.27648 1.76268	*Not*	Denmark
Costa Rica	*43.97* (0.00)	R	0.81014 0.89744	*Not*	*5.75* (0.02)	R	1.20649 3.16295	*Not*	Spain
Ecuador	*0.35* (0.55)	NR	0.91032 1.04837	*Yes*	*3.08* (0.08)	NR	0.78428 4.61002	*Yes*	♠Finland
Mexico	*0.01* (0.91)	NR	0.90878 1.08111	*Yes*	*9.96* (0.00)	R	-4.75304 -0.31725	*Not*	France
Nicaragua	*48.03* (0.00)	R	1.12290 1.22120	*Not*	*4.18* (0.04)	R	1.07536 5.61780	*Not*	The Netherlands
Paraguay	*0.32* (0.57)	NR	0.12133 1.48691	*Yes*	*2.80* (0.09)	NR	0.79663 3.43310	*Yes*	Italy
Peru	*0.75* (0.39)	NR	0.72468 1.70422	*Yes*	—	—	—	—	Japan
Uruguay	*7.92* (0.00)	R	0.66167 0.94113	*Not*	*9.74* (0.00)	R	0.04549 0.78648	*Not*	Norway
Venezuela	*10.96* (0.00)	R	0.78934 0.94703	*Not*	*0.17* (0.68)	NR	0.09718 1.59275	*Yes*	♠The UK

1.The values in italics correspond to the quantile of the distribution χ_q^2 with q=1 degrees of freedom

2.The values between parenthesis are the p-values of the corresponding quantiles

4.The intervals of confidence are built with a coefficient of 95%. The upper and lower values in each cell are the upper and lower limits, respectively.

♠ Using OLS estimations

The results are displayed in Table 14. The first four columns correspond to the Latin American group. Column 1 presents the values of the Wald statistics and the corresponding p-values are specified underneath. According to these findings, the null hypothesis cannot be rejected, that is, the PPP(T) may be accepted in the cases of Bolivia, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru and, perhaps, Costa Rica if we take into account that the upper limit of the confidence interval of this country is not far from unity. The 95% confidence interval for the parameter $\gamma_{p,i}$ reported in column 3 of the same table confirms that there is not reason for rejecting PPP(T) in the afore- mentioned seven countries.

By contrast, the results for the OECD countries suggest that, in general, the null hypothesis should be rejected. In fact, in most cases the confidence interval does not include the unity, and for some cases where it is included (Finland, Italy and the UK), the spread is excessively large, requiring caution in the interpretation of the results. The finding that PPP(T) does not hold in panels of developed countries, especially when the USA is taken as a counterpart to measure the real exchange rate, is not new. SØndergaard (2001) detected disequilibria in the relative prices of the tradable goods of a group of OECD countries, and attributed them to monopolistic competition between firms. Engel (2002) also found that the variations in the RER in a set of OECD economies were almost exclusively caused by deviations from PPP in the tradable sectors, due to transportation costs and to the pricing-to-the-market behaviour of firms. In our opinion, PPP(T) is fulfilled more easily and extensively in the Latin American group because the prices of many tradable goods are frequently indexed to nominal exchange rate movements.

As a synthesis of the empirical part of this paper, Table 15 summarises the results of our empirical tests applied to the first and second stage of the BS hypothesis. Looking at the simultaneous fulfilment of the two BS stages, we find that in the Latin American group the hypothesis holds in the area as a whole and in seven individual countries. By contrast, in the OECD group the entire BS hypothesis only holds in three individual countries, but not in the whole area due to PPP deviations in the tradable sectors of those countries with respect to the USA.

Table 15
The two stages of the Balassa and Samuelson hypothesis
(1990-2001)

	L. A. countries					**OECD countries**					
	First part			**Second part**		**First part**			**Second part**		
	$\hat{\theta}_{NCi}$	$\hat{\theta}_{Ci}$	**Fulfil.**	$\hat{\gamma}_{pi}$	**Fulfil.**	$\hat{\theta}_{NCi}$	$\hat{\theta}_{Ci}$	**Fulfil.**	$\hat{\gamma}_{pi}$	**Fulfil.**	
Argentina	-1	1.65	*Yes*			-1	6.89	*Yes*			Germany
Bolivia	-1	0.75	*Yes*	1	*Yes*						Austria
Chile				1	*Yes*	-1	1.37	*Yes*			Belgium
Colombia	-1	2.42	*Yes*	1	*Yes*						Denmark
Costa Rica						-1	1.80	*Yes*			Spain
Ecuador	-1	1.53	*Yes*	1	*Yes*				1	*Yes*	Finland
Mexico	-1	2.08	*Yes*	1	*Yes*						France
Nicaragua	-1	1.10	*Yes*			-1	2.54	*Yes*			The Netherlands
Paraguay	-1	1.07	*Yes*	1	*Yes*	-1	1.54	*Yes*	1	*Yes*	Italy
Peru	-1	1.53	*Yes*	1	*Yes*	-1	2.10	*Yes*			Japan
Uruguay											Norway
Venezuela	-1	1.30	*Yes*			-1	0.73	*Yes*	1	*Yes*	The UK
Panel	-1	0.89	*Yes*	1	*Yes*	-1	1.27	*Yes*			Panel

In the areas and/or countries where there is positive evidence that the BSH is entirely fulfilled, a correlation exists between the difference in output growth and RER variations with respect to the USA. These econometric results largely confirm our previous descriptive analysis.

5. Concluding remarks

The literature testing the Balassa and Samuelson hypothesis provides different results depending on the degree of economic development of the countries analysed with respect to a foreign developed country. Thus, whereas some studies show that the BSH tends to be satisfied in groups of countries lagging considerably behind the USA, other works obtain very poor results in areas with similar standards of living to that country. In this paper we test the BSH, looking at two areas differing substantially in development and growth: twelve OECD countries, on the one hand, and twelve Latin American economies, on the other hand. We take the USA as the benchmark country. In order to detect the origin of possible failures, we split the BSH into two parts and subject them to individual scrutiny. We use pooled observations and apply recent panel techniques to overcome the problem of insufficient data in many countries of our sample.

We find that while the first stage of the hypothesis, which links the difference in productivities and growth with the difference in prices of the tradable and non tradable sectors, is satisfied in each group of countries, the second stage, which relates the price differential with the real exchange rate, holds in the Latin American area but not in the group of the OECD countries as a whole. The failure is reflected in departures from PPP in the tradable sectors, and is probably due to transportation costs and to the fact that the pricing behaviour of the OECD firms are strongly oriented by market considerations. Putting together the results for individual countries, it follows that the entire BSH clearly holds in seven Latin American countries (Bolivia, Chile, Colombia, Ecuador, Mexico, Paraguay and Peru) and perhaps in only three OECD economies (Finland, Italy and the UK).

The fact that the BSH holds for the whole Latin American group and for most of the panel members considered within has some exchange-rate-policy implications. Since the difference in economic growth with respect to the USA is especially volatile in these countries (as a result of frequent supply shocks), maintaining the nominal exchange rate pegged or very stable to the US dollar, the BS effect requires high variability in domestic CPI inflation rates. Difficulties are aggravated in cases where negative supply shocks and slow growth episodes impose equilibrium inflation rates lower than in the USA. Under such situations, the authorities in the area might feel compelled either to maintain very restrictive monetary and fiscal policies to beat down inflation, or to allow overvaluation in the real exchange rate. Both outcomes harm growth and employment. The solution to avoid these negative results would be to permit sufficient flexibility in the nominal exchange rate.

References

Aitken, B. (1999), ‘Ireland and the Euro: Productivity Growth, Inflation and the Real Exchange Rate’, *IMF Staff Country Report* 108, pp. 5-27, September, Washington D. C.

Alberola-Illa, E. And Tyrväinen, T. (1998): ‘Is There Scope for Inflation Differentials in EMU?’, Bank of Spain, Working Paper, Nº 9823

Balassa, B. (1964), ‘The Purchasing Power Parity Doctrine: A Reappraisal’, *Journal of Political Economy*, 72, 584-596

Canzoneri, M, B., Cumby, R. E., and Diba, B. (1999), ‘Relative labor productivity and the real exchange rate in the long run: evidence for a panel of OECD countries’, *Journal of International Economics*, 47, pp. 245-266.

Chinn, M. D. (1997): ‘The Usual Suspects? Productivity and Demand Shocks and Asia-Pacific Real Exchange Rates’, NBER Working Paper Nº 6108, July, Cambridge, Mass.

Chinn, M. D. and Johnston, L. (1997), ‘Real Exchange Rate Levels, Productivity and Demand Shocks: Evidence from a Panel of 14 Countries’, IMF Working Paper 97/66, May, NBER Working Paper nº 5709, August, Cambridge, Mass.

Chinn, M. D. and Johnston, L. (1999), ‘The Impact of Productivity Differentials on Real Exchange Rates: Beyond the Balassa-Samuelson Framework’. Mimeo.

Coricelli, F. and Jazbec, B. (2001), ‘Real Exchange Rate Dynamics in Transition Economies’, CEPR Discussion Paper Series Nº 2869, July.

De Broeck, M. And Slok, T. (2001), ‘Interpreting Real Exchange Rate Movements in Transition Countries’, IMF Working Paper, Nº 56, May, Washington D. C.

De Gregorio, J., Giovannini, A. And Krueger, T. H. (1994), ‘The Behavior of Nontradable-Goods Prices in Europe: Evidence and Interpretation’, *Review of International Economics*, Vol. 2, Nº 3, pp. 284-305.

De Gregorio, J., Giovannini, A. And Wolf, H. (1994), ‘International Evidence on Tradable and Nontradable Inflation’, *European Economic Review*, 38, pp. 1225-1244.

De Gregorio, J. And Wolf, H. (1994), ‘Terms of Trade, Productivity, and the Real Exchange Rate’, NBER Working Paper Nº 4807, Cambridge Mass.

Drine, I. And Rault, C. (2003), ‘Do Panel Data permit to rescue the Balassa-Samuelson hypothesis for Latin American countries?’, *Applied Economics*, Vol. 35, Nº 3, pp. 351-361, February.

Duval, R. (2001), ‘Taux de change reel et effet Balassa-Samuelson’, *Economie Internationale*, 85, pp. 101-128.

Égert, B. (2002a), ‘Estimating the Impact of the Balassa-Samuelson Effect on Inflation and the Real Exchange Rate During the Transition’, *Economic Systems*, 26(1), pp. 1-16, Spring.

Égert, B. (2002b), ‘Investigating the Balassa-Samuelson Hypothesis in the Transition: Do We Understand What We See? A panel Study’, *Economics of Transition*, 10(2), July, pp. 273-309.

Égert, B., Drine, I., Lommatzsch, K. and Rault, C. (2002), ‘The Balassa-Samuelson effect in Central and Eastern Europe: myth or reality’. William Davidson Institute Working Paper nº 483.

Engel, C. (2002), ‘Expenditure Switching and Exchange Rate Policy’, NBER Working Paper, Nº 9016, June.

Golinelli, R. and Orsi, R. (2001), ‘Modelling Inflation in EU Accession Countries: The Case of the Czech Republic, Hungary and Poland, paper presented at East European Transitional EU Enlargement: A Quantitative Approach’, June 15-21, Gdansk.

Halpern, L. and Wyplosz, C. (2001), ‘Economic Transformation and Real Exchange Rates in the 2000s: The Balassa-Samuelson Connection’, *UNO Economic Survey of Europe*, 1, pp. 227-239.

Heston, A., Nuxoll, D. A. and Summers, R. (1994), ‘The Differential-Productivity Hypothesis and Purchasing-Power Parities: Some New Evidence’, *Review of International Economics*, 2, pp. 227-243.

Hsieh, D. A. (1982), ‘The Determination of the Real Exchange Rate: the Productivity Approach’, *Journal of International Economics*, 12, pp. 355-362.

Ito, T., Isard, P. and Symansky, S. (1997), ‘Economic growth and the real exchange rate: an Overview of the Balassa-Samuelson hypothesis in Asia’, NBER Working Paper, Nº 5979.

Im, K., Pesaran, H. and Shin, Y. (1997), ‘Testing for unit roots in heterogeneous panels’, Discussion Paper, University of Cambridge, June.

Im, K., Pesaran , H. and Shin, Y. (2002), ‘Testing for Unit Roots in Heterogeneous Panels’. Mimeo.

Kao, C. and Chiang, M. H. (1997), ‘On the Estimation and Inference of a Cointegrated Regression in Panel Data’. University of Siracusa.

Kovács, M. A. (2001), ‘Azagyensúlyi reálárfolyam Magyarországon’, MNB *Háttértanulmány* 2001/3, November, Budapest.

Kovács, M. A. (2002), ‘On the estimated size of the Balassa-Samuelson effect in five central and eastern European countries’, National Bank of Hungary working paper Nº 5/2002

Kovács, M. A. and Simon, A. (1998), “Components of the Real Exchange Rate in Hungary”, National Bank of Hungary Working Paper Nº 1998/3, Budapest.

Levin, A. and Lin, C. F. (1993), ‘Unit Root Test in Panel Data: New Results’. Discussion Paper, Department of Economics, University of California at San Diego.

MacDonald, R. and Ricci, L. (2001), ‘PPP and the Balassa-Samuelson Effect: The Role of the Distribution Sector’, IMF Working Paper, Nº 38, March, Washington D.C.

Marston, R. C. (1987), ‘Real Exchange Rates and Productivity Growth in the united States and Japan’, in S. W. Arndt and J. D. Richardson (eds), *Real –Financial Linkages Among Open Economies*, Cambridge, Mass.: MIT Press, pp. 71-96.

Pedroni, P. (1995), ‘Panel Cointegration, Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP hypothesis’, Indiana University Working Papers in Economics, Nº 95-013, June.

Pedroni, P. (1997), ‘Panel Cointegration, Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP hypothesis: new Results’, Indiana University Working Papers in Economics, April.

Pedroni, P. (1999), ‘Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors’, in A. Banerjee (edt) *Special Issue of the Oxford Bulletin of Economics and Statistics*, Oxford.

Rother, P. (2000), ‘The impact of productivity differentials on inflation and the real exchange rate: an estimation of the Balassa-Samuelson effect in Slovenia’. In *Republic of Slovenia: Selected issues*, IMF Staff Country report Nº 00/56, 26-39.

Samuelson, P. A. (1964), ‘Theoretical Notes on Trade Problems’, *Review of Economics and Statistics*, 46, pp. 147-154.

Sinn, H-W, and Reutter, M. (2001), ‘The Minimum Inflation Rate for Euroland’, NBER Working Paper Nº 8085, January, Cambridge, Mass.

SØndergaard (2001), ‘A model for relative price determination in the traded good sector’. Final paper, International Macroeconomics and Finance. Georgetown University.

Strauss, J. (1995), ‘Real Exchange Rates, PPP and the Relative Price of Nontraded Goods’, *Southern Economic Journal*; Vol. 61, Nº 4, April, pp. 991-1005.

Strauss, J. (1996), ‘The Cointegration Relationship between Productivity, RER and PPP’, *Journal of Macroeconomics*, Vol. 18, Nº 2, Spring, pp. 299-313.

Strauss, J. (1999), ‘Productivity differentials, the relative price of non-tradables and real exchange rates’, *Journal of International Money and Finance*, 18, pp. 383-409.

Swagel, P. (1999), ‘The Contribution of the Balassa-Samuelson Effect to Inflation: Cross Country evidence’, Greece: selected Issues, IMF Staff Country Report Nº 99/138, December, Washington, D.C., pp. 29-48.

Tyrväinen, T. (1998), ‘What Do We Know about Productivity Gaps and Convergence in EMU Economies?’, Bank of Finland Discussion Papers Nº 31, Helsinki.

Wu, H.-L. (1996), ‘Testing for the Fundamental Determinants of the Long-Run Real Exchange rate: The Case of Taiwan’, NBER Working Paper Nº 5787, October, Cambridge, Mass.

ABSTRACT:

This paper studies the Balassa-Samuelson hypothesis (BSH) in the context of two areas with strong differences in economic development, twelve OECD countries and twelve Latin American economies, taking the USA as the benchmark. Applying panel cointegration techniques, we find that while the first stage of the hypothesis, which links productivities and prices, is satisfied in each group of countries, the second stage, which relates relative sector prices with the real exchange rate, only holds in the Latin American area. The failure of the latter in the OECD countries as a whole is reflected in departures from PPP in the tradable sectors.