How sure are we about the Balassa-Samuelson hypothesis ? Time Series versus Panel Data Approach for Asian countries

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June 12, 2002

Abstract

This paper tests empirically the Balassa-Samuelson (BS) hypothesis using annual data for 12 OECD countries. We apply new panel data cointegration techniques recently developed by Pedroni (2000) and we compare the results with those obtained with conventional Johansen (1995)'s time series cointegration tests. Whereas standard time series approach turns out to be unable to put in evidence a significant long-run relationship between real exchange rate and economic growth this relationship is largely accepted for all countries using recent advances in the econometrics of non-stationary dynamic panels methods. This result doesn't mean however that the BS is uniformly supported by data for all OECD countries, since actually 4 of them (Australia, Belgium, Canada and the USA) are proved not to follow the BS path. Closer exminations of the three key components of the BS hypothesis enable us to identify clearly the causes of this empirical failure. We find that the absence of a positive long-run relationship between real exchange rate and the relative prices of non-traded goods is the reason for this rejection. A possible explanation is that the PPP may not be confirmed for tradable goods in these countries.

Keywords : Real Exchange Rate, Balassa-Samuelson hypothesis, OECD countries, Panel unit-root and cointegration tests.

JEL Classification : E31, F0, F31, C15.

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1 Introduction

As it is now well-established economists often refer to two alternative theories to explain long-run real exchange rate movements.

The former is the Purchasing Power Parity (PPP) acccording to which real exchange rate must be stationary. This implies there cannot exist persistent deviations from real exchange equilibrium level, but only temporary ones. In this case PPP serves as a good first approximation to long-run behaviour. Recent empirical evidence supporting this proposition under the current float has however been mixed. Parikh and Wakerly (2000) for instance found empirical evidence in favour of this theory, whereas Fleissig and Strauss (2000) rejected it.

The latter, the Balassa-Samuelson (BS) hypothesis, which seeks to explain the persistence of real exchange rates changes, typically focus on the tradebility of goods. According to Balassa (1964) and Samuelson (1964), rapid economic growth is accompanied by real exchange rate appreciation because of differential productivity growth between tradable (T) and non-tradable (NT) sectors. Since the differences in productivity increases are expected to be larger in high growth countries, the BS prediction should be more visible among fast growing countries. In this respect, the postwar Japanese record is generally recognised to have been a prime example of the BS hypothesis.

Much attention has been paid in literature to test the validity of this hypothesis using time series econometric techniques. Early cointegration tests such as Engle and Granger (1987) cointegrating regression and Johansen (1988), (1995)) maximum likelihood (ML) procedures produce mixed results. Rogoff (1992), DeLoach (2001), Bahmani -Oskooee (1992), Bahmani-Oskooee and Rhee (1996) for instance have all investigated whether real exchange rate changes can be explained by relative productivities, but only the latter two managed to put in evidence such a relationship. Using a slightly different approach Asea and Mendoza (1994), De Gregorio and al (1994) find, using annual, sectorial data from OECD countries, that relative prices are explained by relative productivities, but it is unclear whether real exchange rate can be explained by relative productivities. These diverging conclusions may be attributable to the low power of the tests implemented with short spans of data as argued by many researchers, given the fact that we only have less than 25 years of data for the current float.

A possible way of improving the power of these tests is by introducing cross-section variation. This may explain why methods for non-stationary time series panel, including unit root tests (Levin and Lin (1993), Quah (1994), Im, Pesaran and Shin (1997)), and cointegration tests (Pedroni ((1996), (1997), (1999), (2000)) or Blinder, Hsiao and Pesaran (1999)) have been gaining increased acceptance in empirical research. Recent applica-

tions of these panel tests for cointegration include Taylor (1996) to historical episodes of purchasing power parity, Canzoneri and al (1999) (for the OECD countries) and Drine and Rault (2002) (for latin american countries) to productivity and real exchange rate.

The aim of this paper is to investigate empirically the "original" BS hypothesis for six Asian countries which doesn't reduce itself to the existence of a positive relationship between relative prices of NT goods and relative labour productivies as it is sometimes assumed in the litturature. Actually, the relationship tested by Canzoneri and al (1999) only corresponds to one of the third key components of the Balassa-Samuelson's framework. Indeed, in a very schematic way, the Balassa-Samuelson hypothesis can be decomposed into three main assumptions :

(A_1) the differential of productivities between T and NT sector and relative prices are positively correlated,

(A_2) the purchsing power parity is verified for tradable goods,

(A_3) real exchange rate and relative prices of NT goods are positively correlated.

A combination of these assumptions causes real exchange rate appreciation. The interest of proceeding similarly is that in case of refuting empirically the BS hypothesis we can indentify precisely which of the above assumption (s) is (are) responsible for this rejection.

The second difference is on the econometric techniques used for our analysis. In contrast to previous works that implemented the cointegration tests proposed by Pedroni (1996), we employ the most recent development of cointegration techniques in heterogeneous panels developed by Pedroni (2000) and particularly small sample corrections for fully modified parameter estimates, as well as restriction testing on the parameters of cointegrating relationships.

We consider here annual data for 6 Asian economies (India, Indonesia, Korea, Philippines, Singapoor and Thailand) covering the 1983-1997 period, and we compare the panel data econometric results with those that are obtained with conventional unit-root tests and cointegrating techniques. The econometric investigation shows that standard time series cointegration methods support the BS hypothesis, since they turn out to be able to put in evidence a significant long-run relationship between productivity differential and real exchange rate for 5 countries out of 6. On the contrary, the recent panel cointegration techniques of Pedroni (2000) indicate strong evidence against such a relationship for the six Asian countries. This leads us to examine more precisely the reasons for this failure and to analyse carefully the three key assumptions on which rest the BS hypothesis. This additional step permits us to identify clearly the reason for the BS empirical rejection. Indeed, for all countries we find that this rejection is both attributable to

the failure of the existence of a significant positive relationship between real exchange rate and relative prices (assumption A_3) and misalignement par rapport à la PPP for tradable sector.

The remainder of the paper is organised as follows. In Section 2 we briefly review the Balassa-Samuelson framework. Much attention is paid to make explicit where the three key assumptions of this theory intervene. This enables us to derive formally afterwards the different relationships to be tested in the empirical application. In section 3 we expose and comment our econometric results for 6 Asian countries. A final section reviews the main findings.

2 The Balassa-Samuelson hypothesis revisited

Let us consider a small open economy composed of a set of homogeneous firms. The representative firm produces two goods : a tradable commodity on the world market and a non-tradable one for domestic demand. It is supposed besides that tradable goods production requires both capital and labour, whereas non-tradable goods production only uses labour. The competition is supposed to be perfect and it ensures that production factors are paid at their marginal productivity; labour factor mobility ensures equal pay. Labour supply is supposed to be constant and all variables are expressed in terms of tradable goods.

As noted by Obstfeld and Rogoff (1996), in the absence of nominal rigidity, equilibrium real exchange rate will only depend on productivity differential. Thus in what follows we present a partial equilibrium model where the demand side is absent.

2.1 Firm behaviour

The representative firm maximises its intertemporal profit expressed in terms of tradable goods under its constraints of technology and capital accumulation, that is :

$$Max \int_0^{\infty} \left(y_e(k_e, l_e) + p y_n(k_n, l_n) - wl - i)\right) e^{-rt} dt \tag{1}$$

$$sc\ \dot{k} = i - \delta k \tag{2}$$

where,

- y_e denotes the production of tradable goods;
- y_n denotes the production of non-tradable goods;
- p denotes the relative prices of non-tradable goods in terms of tradable ones;
- i denotes investment;
- w denotes wages;

- k denotes capital;
- $l = l_n + l_e$ is labour supply.

2.2 Equilibrium

The equilibrium is defined as follows

$$\frac{\delta y_e}{\delta k_e} = p\frac{\delta y_n}{\delta k_n} = r \tag{3}$$

$$\frac{p\delta y_n}{\delta l_n} = \frac{\delta y_e}{\delta l_e} = w \tag{4}$$

$$\lambda = 1 \tag{5}$$

We thus obtained the following relationship between relative prices and labor productivity ratio :

$$\frac{\frac{\delta y_e}{\delta l_e}}{\frac{\delta y_n}{\delta l_n}} = p \tag{6}$$

For Cobb-Douglas functions, this relation expresses as :

$$p = \frac{\alpha\theta_e}{\beta\theta_n} \tag{7}$$

, where α and β are the production-labour elasticities respectively for tradable and non-tradable sectors and θ_n, θ_e the labour average productions for the two sectors.

Equation (7) indicates that relative prices are a function of the productivity ratio of the two goods. Thus a faster increase of tradable goods productivity than of non-tradable ones leads to an increase in relative prices of non-tradables (Assumption A_1).

Furthermore real exchange rate is defined as[1] :

$$e = \frac{P}{EP^*} \tag{8}$$

where,

E denotes nominal exchange rate,

P denotes general domestic price index,

P* denotes general foreign price index.

If we suppose that the consumer's basket contains two commodities, we can express the general price index as :

$$P = P_e^{\epsilon} P_n^{1-\epsilon} \text{ and } P^* = (P_e^*)^{\epsilon} (P_n^*)^{1-\epsilon} \tag{9}$$

Then, following Balassa and Samuelson and if we suppose that purchasing power parity in the tradable sector (Assumption 2) is verified, we will have :

$$\log(e) = (1-\epsilon)\log(p) - (1-\epsilon) log(p^*) \tag{10}$$

[1] Real exchange rate is defined in the following way : an increase implies an appreciation.

where,

p denotes relative domestic price for nontradable goods,

p* denotes relativel foreign price for nontradable goods.

According to equation (13) real exchange rate is positively correlated to the relative prices of non-traded goods (Assumption A_3).

Taking the above analysis into account (A1, A2, and A3), we obtain the "general" BS relationship :

$$\log(e) = \phi + (1 - \epsilon)[\log(\frac{\theta_e}{\theta_n}) - \log(\frac{\theta_e^*}{\theta_n^*})] \tag{11}$$

This relationship indicates that relative productivity differential determines the long-term real exchange rate behaviour.

3 Empirical investigation

3.1 The data

We include 6 Asian countries in our sample (India, Indonesia, Korea, Philippines, Singapoor and Thailand). The choice of countries is based on data availability. The empirical period starts in 1983 and ends in 1998, corresponding to 15 observations for the time series dimension. The effective real exchange rate (RER) data are taken from the French database of the CEPII and the productivity differential data are taken from World Indicators for . RER is defined as the ratio between the domestic price index and the

foreign price one with respect to the USA deflated by the nominal exchange rate (so an increase of RER indicates an appreciation).The added sectorial value and employement series are taken from the (???). The traded sector is composed of "manufacturing" sector and the "agriculture, hunting, forestry and fishing" sector. The non-traded sectors is composed of the service sector (transport, storage and communication, the finance, insurance, real estate and business services). The traded price index is the added value deflator of each sector. Average productivities for tradable and non-tradable sectors are defined as the added value devided by employment. All variables are expreced vis-à-vis USA.

3.2 Unit-Root test results

We shall report in this sub-section the results of two kinds of unit-root tests : the conventional time series ones and the Im, Pesaran and Shin (IPS, 1997) panel data ones.

The analysis first step is simply to look at the data univariate properties and to determine their integratedness degree. Theoretically a process is either I(0), I(1) or I(2). Nevertheless in practice many variables or variable combinations are bordeline cases, so that distinguishing between a strongly autoregressive I(0) or I(1) process (interest rates are a typical example), between a strongly autoregressive I(1) or I(2) process (nominal prices are a typical example) is far from being easy. We have therefore applied a

sequence of standard time series unit root tests (Schmidt and Phillips test (1992), Kwiatkowsky, Phillips and Shin test (KPSS) (1992) and the efficient unit-root tests suggested by Elliott, Rothenberg and Stock (1996) (which we shall refer to hereafter as the ERS test)), to investigate which of the I(0), I(1), I(2) assumption is most likely to hold. The results of these conventional unit-root tests are not reported here to save space but they can easily be summarised as follows since clear patterns emerge from them[2]. Indeed, they indicate that the unit-root null hypothesis cannot be rejected at the 5% level for the three variables under consideration (RER, productivity differential between tradable and non-tradable sectors, relative prices) and for most of all our Asian countries. The only exception is for Belgium, France, Germany and the Netherlands where the KPSS tests indicate that RER and/or per capita GDP are stationary around a linear trend. However the Schmidt-Phillips and Elliott tests confirm the existence of a unit-root in these series. We have also applied those three tests on the variables taken in first differences and we find evidence in favour of the rejection of the non-stationary hypothesis for RER and per capita GDP, as well as for our two other series. This leads us to conclude that our series are well characterised as an I(1) process, some with non-zero drift for some countries.

As far as the IPS (1997) panel data unit-root test is concerned (which

[2]The results of these tests are available upon request.

we have appplied for a model with a constant, and for both a constant and a trend), it indicates that for all 6 Asian countries the unit-root hypothesis cannot be rejected for all series (see table 1 in Appendix 1).

3.3 Cointegration test results

The following panel data formalisation of the Balassa-Samuelson's framework presented in section 2 is fairly straightforward to derive. Indeed, using previous notations the long-run relationship (corresponding to the BS hypothesis) to be tested can be written as :

$$\log(RER_{it}) = c_i + \gamma_i \log(\frac{\theta_e}{\theta_n} / \frac{\theta_e^*}{\theta_n^*}) + \epsilon_{it} \tag{12}$$

According to BS predictions, we expect γ_i to be positive since an increase of real exchange rate implies an appreciation. As far as the sign of the constant (c_i) is concerned it is *a priori* negative and a rise in tradable goods prices leads to an exchange rate depreciation.

In the same way, if empirical evidence doesn't support the BS hypothesis, the three key assumptions (A1, A2, A3) to be tested in order to identify the reason (s) for this rejection write as follows :

$$A_1 : \quad \log(p_{it}) = c_{1i} + \gamma_{1i} \log(\theta_{eit}/\theta_{nit}) + \epsilon_{1it} \tag{13}$$

$$A_2 : \quad P_T = EP_T^* \tag{14}$$

$$A_3 \ : \quad \log(RER_{it}) = c_{2i} + \gamma_{3i} \log(p_{it}) + \epsilon_{3it} \tag{15}$$

The results of the cointegration analysis are reported in Appendix 1. We consider both time series cointegration tests (see table 2) as well as panel cointegration tests developed by Pedroni (2000) (see table 3), with sample size corrections for small samples like ours. Table 2 reports the results of Johansen ((1988), (1995)) conventional time series cointegration tests. It appears that for 5 countries out of 6 (India, Indonesia, Philippines, Singapoor and Thailand) the hypothesis of the absence of cointegration between real exchange rate and productivity differential can be rejected at a 5% level of significance. Thus the findings of cointegration time series tests are consistent with the BS hypothesis. However, surprisingly the BS hypothesis is not empirically supported for that, since for 2 countries out of 5 the coefficient on productivity differential has a negative sign (See Table 4). Productivity differential in Philippines and Tailand results in a depreciation of real exchange rate (which violates the BS prediction).

The implementation of Pedroni's recent panel data cointegration tests (2000) leads to opposed result since the theoretical long-run relationship

between real exchange rate and productivity differential is now rejected at a 5% level of significance (see Table 3). This result shows the superiority of panel data cointegration tests which are more powerful than conventional time series ones and underlines the necessity to be cautious when interpreting usual time series test results for samples of relatively moderate size.This results suggest that productivity differential doesn't correctly account for long-run real exchange rate movements for our 6 Asian economies. In order to shed some light on where the rejection of the BS hypothesis comes from, our next task is to examine successively each three key components of this hypothesis.

The second key component of the BS hypothesis (A_2) postulates that PPP holds for tradable goods which implies that the nominal exchange rates and PPP exchange rates are cointegrated with a cointegrating slope of 1.0. We investigate using a t-test if the slope in the cointegrating relationship is equal to 1, as predicted by Balassa-Samuelson. To get robust results and avoid well-known small sample problems, we estimate our long-run parameters using small sample corrections recently proposed by Pedroni (2000). The empirical results does not support this unitary theoretical relationship which is rejected by data at a 5 % level of significance, the fully modified OLS slope estimates being only of 0.64 with a T-Ratio of 2.66 for the null hypothesis that $\beta_{1i} = 1.0$. Empirical evidence from Pedroni's panel

cointegration test (2000) reported in Table 5 rejects this assumption at a 5 % level of significance.

We investigate the third key component of the BS hypothesis, that is that real exchange rate and relative prices of non-traded goods are positively correlated. Once again we are not able to put in evidence a long-run statistical relationship between these two variables for all Asian countries (see Table 3).

Thus, the main conclusion which emerges from the above analysis is that the failure of the BS hypothesis for the countries can both be attributed to the rejection of the second and the third key components of this hypothesis. Indeed, empirical evidence clearly indicates that PPA does not hold for tradable goods which explains the absence of long run relationships between real exchange rates and relative prices.

4 Conclusion

So, do recent cointegration techniques of Pedroni (2000) which enable to deal with non-stationary data in heterogeneous panels, as well as with small sample size permit to rescue the Balassa-Samuelson hypothesis ? Evidence from a panel of 6 Asian countries reveals that these new methods do much better than usual time series cointegration ones (see Johansen (1988), (1995)), since unlike the latter, they prove the absence of a signifi-

cant cointegrating relationship between real exchange rate and productivity differential. However, for 2 countries out of 5, this empirical long-run relationship turns out not to reflect the Balassa-Samuelson predictions because the coefficient on productivity différential has a negative impact on real exchange rate. Consequently, these conflicting pieces of evidence made us conclude that this hypothesis is not confirmed for these countries.

One possible reason is that the main assumptions that comprise the BS hypothesis are not verified. Thus, questioning for the reasons of this failure led us to examine separately the validity of each of the three key components of the BS hypothesis. This empirical analysis is rich of teachings and permits us to clearly identify why this theory is not confirmed for one third of Asian economies. We find that the rejection of the BS hypothesis can both be accounted for by the rejection of the expected positive long-run relationship between real exchange rate and relative prices of non-traded goods and the rejection of PPP for tadable goods.

Another possibility of the empirical rejection of the BS hypothesis may simply be that there are additional long-run real exchange determinants that have to be considered.

Aknowledgements

We would like to thank Peter Pedroni for providing us with some RATS codes for the computation of the critical values, making the panel cointegration tests available in this present analysis, as well as for his modified group-fm program for small sample adjustments.

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