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A Reexamination of Balassa's Productivity Bias Hypothesis

Mohsen Bahmani Oskooee
University of Wisconsin--Milwaukee

Farhang Niroomand
University of Southern Mississippi, niroomandf@uhv.edu

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I. Introduction

The purchasing power parity theory (PPP) is an economic theory that has received a great deal of attention in the literature. The theory basically identifies the national price levels in two countries as the long-run determinants of the corresponding exchange rate. Denoting the number of country i's currency per U.S. dollar (the reserve currency) by $R_{i,\text{u.s.}}$, the price level in country i by P_i, and the price level in the United States by $P_{\text{u.s.}}$, the PPP theory postulates that $R_{i,\text{u.s.}} = P_i/P_{\text{u.s.}}$. Many studies have tried to verify whether exchange rates follow the path outlined by the PPP equation. The empirical results, at best, are inconclusive. For example, J. A. Frenkel tested the PPP by drawing data from the 1970s and showed that the PPP failed.[1] On the other hand, N. Davutyan and J. Pippenger criticized Frenkel's work and reversed his conclusion.[2] Both studies used ordinary least squares and two-stage least squares methods. Even recent studies that have used a relatively modern econometric technique (cointegration analysis), have mostly rejected the PPP.[3]

Several reasons have been given in the literature for the failure of the PPP or deviation of the PPP-based exchange rates from equilibrium exchange rates, including lack of free trade; existence of transaction costs; existence of nontradables; simultaneity problems; different weights used in constructing different national price indexes; money and asset prices; and real factors or real variables. Among the real variables, the productivity differential between two countries has received most of the attention in the literature.

If we denote the market-determined equilibrium exchange rate by $R^e_{i,\text{u.s.}}$ and the PPP-based rate by $P_i/P_{\text{u.s.}}$, following the literature we

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can measure the deviation of PPP from the equilibrium exchange rate by $(P_i/P_{\text{u.s.}})/R^e_{i,\text{u.s.}}$, which is nothing but the real exchange rate between country i and the United States. In a path-breaking article in 1964, B. Balassa was the first to claim that the deviation of PPP from the equilibrium rate or the real exchange rate is positively related to the ratio of productivity in country i over that of the United States. As Balassa stated, "If per capita incomes are taken as representative of levels of productivity, the ratio of purchasing-power parity to the exchange rate will thus be an increasing function of income levels."[4] Another interpretation of Balassa's conjecture is that the more productive country will have an overvalued currency in real terms. This notion has been known as the "productivity bias hypothesis in PPP." Following is how Balassa justified his conjecture.

Assuming the United States as his base country, Balassa constructed $(P_i/P_{\text{u.s.}})/R^e_{i,\text{u.s.}}$ for 12 industrial countries (including the United States itself) for 1960 and regressed it on real per capita income of each country in the same year. With 12 cross-sectional observations he obtained a highly significant positive coefficient with an R^2 of 0.92. He then concluded that "the empirical results provide evidence for the validity of my proposition regarding the relationship between purchasing power parities, exchange rates, and per capita income levels."[5]

Subsequent cross-sectional studies, however, provided mixed support for Balassa's hypothesis. M. G. de Vries investigated the depreciation of the nominal and real exchange rates of 109 members of the International Monetary Fund from 1948 until 1967.[6] She found that far more less developed countries devalued their currencies or experienced depreciation in their currencies than did developed countries and she attributed this finding to productivity advances in more developed countries, especially in the production of exportables.[7]

C. Clague and V. Tanzi examined the relevance of other variables in addition to per capita income. Using data from 1960 for the same 12 Organisation for Economic Corporation and Development (OECD) countries and 19 Latin American countries, they found that in the case of the 12 OECD countries, when only per capita income was used as a determinant of the real exchange rate, the Balassa effect received strong support. However, the results for 19 Latin American countries were weaker.[8] J. Grunwald and J. Salazar-Carillo examined the experience of 11 Latin American countries. They used Venezuela rather than the United States as their base country. They concluded, "It appears that without further manipulation Latin American data are not consistent with the Balassa hypothesis and that therefore there are, in this respect, significant differences between the developing and developed countries which Balassa examined."[9]

In addition to per capita income, I. B. Kravis and R. E. Lipsey

considered the relevance of openness and share of nontradable goods in gross domestic product (GDP) of 34 countries in 1975.[10] But it was mostly per capita income that had a significantly positive effect on the real exchange rate. Kravis and Lipsey also obtained similar results when the number of countries was reduced to 10.[11] Using data from the same 34 countries in 1975, Clague examined the effects of trade balance, mineral share in GDP, tourism, education, and money growth.[12] While the results were sensitive to model specification, it was the trade balance, mineral share, and tourism that carried significant coefficients in most of the models. Similar models were also tried by Clague, who, this time, employed data from at most 19 Latin American countries in 1970.[13] While the significance of some of the variables was sensitive to model specification, the real per capita income was significant in all models, supporting the productivity bias hypothesis.

L. H. Officer reexamined the productivity bias hypothesis after modifying Balassa's model.[14] The resulting model was estimated for each year from 1950 to 1973 using cross-sectional data from 15 industrial countries, with Germany serving as the standard country.[15] In none of the years did Balassa's hypothesis receive empirical support. Other modifications in calculating productivity measures did not alter the results. Officer then concluded that "the evidence provided by this study indicates that the productivity bias hypothesis lacks a firm empirical foundation, suggesting that the general acceptance of the hypothesis is unwarranted. With careful attention paid to the experimental design of the test, the productivity bias was found to have no operational impact on the PPP over exchange rate relationship, except in extremely rare cases."[16]

One issue involved in testing the productivity bias hypothesis is whether the equilibrium exchange rates or the PPP-based rates should be used in converting per capita incomes from domestic currencies to the base country currency. In its National Accounts Statistics, the United Nations introduced six conversion factors that they used to convert per capita GDP of more than 100 developed countries (DCs) and less developed countries (LDCs) for each year from 1970 to 1989.[17] With this extensive data base, it is the purpose of this article to reexamine Balassa's hypothesis using cross-sectional data from more than 100 countries for each year. In Section II we formulate the model and introduce the results. Section III has the conclusion.

II. The Model and the Results

In order to test the operational impact of the productivity bias, we adopted the formulation of the hypothesis by Officer as follows:[18]

$$\frac{(P_i/P_{\text{u.s.}})_t}{R^e_{i,\text{u.s.}}} = \alpha + \beta(\text{PROD}_i/\text{PROD}_{\text{u.s.}}) + \epsilon_i, \qquad (1)$$

where P_i = price level in country i measured by GDP deflator (1985 = 100) and collected from different issues of International Financial Statistics of IMF; $P_{\text{u.s.}}$ = price level in the United States measured by GDP deflator (1985 = 100) and collected from different issues of International Financial Statistics of the International Monetary Fund (IMF); $R^e_{i,\text{u.s.}}$ = equilibrium exchange rate defined as number of units of country i's currency per unit of the U.S. dollar. For each country and each year, the rates are collected from different issues of International Financial Statistics of the IMF; PROD_i = productivity of country i measured by per capita GDP in constant U.S. dollars. The data for all countries come from the National Account Statistics of the United Nations;[19] $\text{PROD}_{\text{u.s.}}$ = productivity of the United States measured by per capita GDP in constant U.S. dollars. The data come from the same source as PROD_i; and ϵ is an error term. If a more productive country is to experience an appreciation of its real currency, an estimate of β should be positive and significant.

As indicated above, the United Nations recently used six different conversion factors to convert per capita GDP of more than 100 countries into U.S. dollars. A brief explanation of each factor follows.

The first conversion rate (labeled *MER* in each country page) is based on market exchange rates (MERs). These are the rates that are regularly published by the IMF, and they are basically annual averages communicated to the IMF by the monetary authority of each member country. However, it has been argued that because exchange rates do not adequately reflect differences in international prices (due to capital flow and speculation), they might be even less effective conversion rates for nontraded goods and services. That is why it may be appropriate to employ alternative measures.

The second conversion rate is the PPP-based exchange rate (labeled *PPP* in each country page). For each country it is derived from relative prices of a common basket of goods and services expressed in terms of each country's currency.

The third conversion rate is based on price adjustments of exchange rates, or the so-called PAREs rates. These rates are derived by extrapolating the exchange rates to past and future years by using price indexes from each country. This third measure is labeled *Absolute 1970–89 PARE* in each country page. Its calculations use the average exchange rates for the entire period 1970–89 as a proxy for the relative prices between the United States and other countries.

The fourth conversion rate is the same as the third rate with the difference that it relies on relative PAREs. It is labeled *Relative 1970–89 PARE* in each country page.

The fifth conversion rate is similar to the third measure with the difference that the extrapolation period is 1980–89 and not 1970–89. This measure is labeled *Absolute 1980–89 PARE*.

Finally, the sixth rate is the World Bank Atlas Conversion Rate, denoted by *WA*. It is based on a moving average of three types of conversion rates. For a given year, it is calculated as a simple average of the exchange rate of the present year and a PARE rate for the present year using the exchange rate of 2 years ago as a base.

Using six different measures of per capita income (based on six different conversion rates), we estimated equation (1) using cross-sectional data from 21 DCs and approximately 80 LDCs for a given year, from 1974 to 1989.[20] Note that we followed Officer's procedure, who estimated similar cross-sectional regressions for each year from 1950 to 1973, a relatively fixed exchange rate era. We started with 1974 in order to confine ourselves to a relatively floating exchange rate era and hoped that our finding would be somewhat different. Since we were to determine whether the slope coefficient in equation (1) is significant, we confined ourselves to reporting the t-ratio for the slope and the adjusted R^2 of the regression only. Table 1 reports the cross-sectional results for each year when only 21 DCs were included in each regression. Table 2 reports similar results for approximately 80 LDCs. Finally, table 3 reports the cross-sectional results when both DCs and LDCs were included in the regression.

As shown in all three tables, not only were all t-ratios insignificant, but the adjusted R^2 was negative in almost all cases, providing negative implication for the productivity bias hypothesis. This was the conclusion regardless of which conversion rate was used to convert the per capita income figures from domestic currency to the U.S. dollar. Our results are similar to those of Officer's (tables 2–7), indicating the fact that extending Officer's study beyond 1973 to 1989 and extending his sample size from 15 to more than 100 did not alter his findings.[21]

III. Summary and Conclusion

In 1964 Balassa argued that productivity differentials between two countries contribute to the deviation of PPP from the equilibrium exchange rate, now known as the productivity bias hypothesis. However, most other cross-sectional studies have failed to support this hypothesis. While most studies were restricted to cross-sectional data only for one or two periods, Officer tested the hypothesis by relying on "a moving cross-sectional regression, fitted independently over a number of years (and not pooling data of different years)."[22]

In this article, we tried to verify empirically the productivity bias hypothesis, following Officer's moving cross-sectional regression approach beyond his last year (1973). We tested the hypothesis using cross-sectional data from more than 100 countries (DCs and LDCs) and six different measures of per capita income for each year beginning with 1974 and ending at 1989. The results are in line with

TABLE 1

ESTIMATES OF THE t-RATIO FOR THE SLOPE COEFFICIENT AND ADJUSTED R^2, USING CROSS-SECTIONAL DATA FROM 21 DCs FOR EACH YEAR
(Based on Different Conversion Rates)

	CONVERSION RATE 1		CONVERSION RATE 2		CONVERSION RATE 3		CONVERSION RATE 4		CONVERSION RATE 5		CONVERSION RATE 6	
YEAR	t-Ratio	Adj. R^2	t-Ratio	Adj. R^2	t-Ratio	Adj. R^2	t-Ratio	Adj. R^2	t-Ratio	Adj. R^2	t-Ratio	Adj. R^2
1974	.25	−.05	.36	−.04	.42	−.04	.42	−.04	.52	−.01	.28	−.05
1975	.04	−.05	.39	−.04	−.01	−.05	−.01	−.05	.17	−.05	.06	−.05
1976	.06	−.05	.47	−.04	.05	−.05	.05	−.05	.21	−.05	.08	−.05
1977	−.38	−.04	.31	−.05	−.07	−.05	−.07	−.05	.10	−.05	−.34	−.04
1978	−.58	−.03	.18	−.05	−.20	−.05	−.19	−.05	−.02	−.05	−.59	−.03
1979	−.59	−.03	−.01	−.05	−.36	−.05	−.36	−.04	−.19	−.05	−.59	−.03
1980	−.39	−.04	−.24	−.05	−.52	−.04	−.51	−.04	−.51	−.04	−.41	−.04
1981	.02	−.05	−.06	−.05	−.47	−.04	−.47	−.04	−.32	−.04	−.01	−.05
1982	.16	−.05	.39	−.04	−.54	−.04	−.54	−.04	−.40	−.04	−.23	−.05
1983	.33	−.01	−.09	−.05	−.44	−.04	−.44	−.04	−.30	−.05	.36	−.05
1984	.39	−.04	.03	−.05	−.36	−.04	−.36	−.04	−.22	−.05	.39	−.04
1985	.10	−.05	−.03	−.05	−.42	−.04	−.42	−.04	−.28	−.05	.17	−.05
1986	−.72	−.02	−.27	−.05	−.60	−.03	−.61	−.03	−.47	−.04	−.70	−.03
1987	−.88	−.01	−.28	−.05	−.62	−.03	−.62	−.03	−.48	−.04	−.91	−.01
1988	−.82	−.02	−.27	−.05	−.61	−.03	−.61	−.03	−.47	−.04	−.69	−.03
1989	−.52	−.04	−.21	−.05	−.56	−.04	−.56	−.04	−.41	−.04	−.51	−.04

TABLE 2

ESTIMATES OF THE t-RATIO FOR THE SLOPE COEFFICIENT AND ADJUSTED R^2, USING CROSS-SECTIONAL DATA FROM 80 LDCS FOR EACH YEAR
(Based on Different Conversion Rates)

	CONVERSION RATE 1		CONVERSION RATE 2		CONVERSION RATE 3		CONVERSION RATE 4		CONVERSION RATE 5		CONVERSION RATE 6	
YEAR	t-Ratio	Adj. R^2	t-Ratio	Adj. R^2	t-Ratio	Adj. R^2	t-Ratio	Adj. R^2	t-Ratio	Adj. R^2	t-Ratio	Adj. R^2
1974	−.22	−.01	−.09	−.01	−.09	−.01	−.02	−.01	.04	−.01	−.18	−.01
1975	−.29	−.01	−.07	−.01	−.10	−.01	−.10	−.01	.02	−.01	−.21	−.01
1976	.27	−.01	−.04	−.01	−.10	−.01	−.10	−.01	.03	−.01	−.20	−.01
1977	−.28	−.01	.05	−.01	−.09	−.01	−.09	−.01	.05	−.01	−.19	−.01
1978	−.35	−.01	−.05	−.01	−.13	−.01	−.13	−.01	.01	−.01	−.26	−.01
1979	−.40	−.01	−.29	−.01	−.24	−.01	−.24	−.01	−.14	−.01	−.35	−.01
1980	−.38	−.01	−.16	−.01	−.22	−.01	−.22	−.01	−.22	−.01	−.32	−.01
1981	−.38	−.01	−.19	−.01	−.23	−.01	−.23	−.01	−.13	−.01	−.33	−.01
1982	−.39	−.01	−.21	−.01	−.25	−.01	−.25	−.01	−.14	−.01	−.36	−.01
1983	−.38	−.01	−.22	−.01	−.25	−.01	−.25	−.01	−.12	−.01	−.36	−.01
1984	−.31	−.04	−.21	−.01	−.27	−.04	−.27	−.01	−.15	−.01	−.31	−.01
1985	−.32	−.01	−.18	−.01	−.29	−.01	−.29	−.01	−.17	−.01	−.32	−.01
1986	−.20	−.01	−.23	−.01	−.35	−.01	−.35	−.01	−.21	−.01	−.38	−.01
1987	1.93	.04	−.30	−.01	−.38	−.01	−.38	−.01	−.26	−.01	−.38	−.01
1988	−.62	−.01	−.43	−.01	−.45	−.01	−.45	−.01	−.34	−.01	−.42	−.01
1989	−.05	−.01	−.25	−.01	−.30	−.01	−.29	−.01	−.28	−.01	−.23	−.01

TABLE 3

ESTIMATES OF THE *t*-RATIO FOR THE SLOPE COEFFICIENT AND ADJUSTED R^2, USING CROSS-SECTIONAL DATA FROM ALL DCs AND LDCs COMBINED (Based on Different Conversion Rates)

	CONVERSION RATE 1		CONVERSION RATE 2		CONVERSION RATE 3		CONVERSION RATE 4		CONVERSION RATE 5		CONVERSION RATE 6	
YEAR	*t*-Ratio	Adj. R^2	*t*-Ratio	Adj. R^2	*t*-Ratio	Adj. R^2	*t*-Ratio	Adj. R^2	*t*-Ratio	Adj. R^2	*t*-Ratio	Adj. R^2
1974	−.50	−.01	−.32	−.01	−.39	−.01	−.37	−.01	−.26	−.01	−.47	−.01
1975	−.56	−.01	−.35	−.01	−.39	−.01	−.39	−.01	−.27	−.01	−.49	−.01
1976	−.54	−.01	−.31	−.01	−.39	−.01	−.39	−.01	−.27	−.01	−.47	−.01
1977	−.55	−.01	−.25	−.01	−.39	−.01	−.39	−.01	−.26	−.01	−.47	−.01
1978	−.25	−.01	−.37	−.01	−.45	−.01	−.44	−.01	−.32	−.01	−.54	−.01
1979	−.66	−.01	−.57	−.01	−.53	−.01	−.53	−.01	−.44	−.01	−.62	−.01
1980	−.64	−.01	−.44	−.01	−.51	−.01	−.51	−.01	−.51	−.01	−.59	−.01
1981	−.63	−.01	−.06	−.01	−.51	−.01	−.51	−.01	−.43	−.01	−.58	−.01
1982	−.63	−.01	−.48	−.01	−.54	−.01	−.53	−.01	−.46	−.01	−.60	−.01
1983	−.62	−.01	−.52	−.01	−.54	−.01	−.54	−.01	−.46	−.01	−.62	−.01
1984	−.52	−.01	−.52	−.01	−.55	−.04	−.55	−.01	−.47	−.01	−.57	−.01
1985	−.52	−.01	−.51	−.01	−.57	−.01	−.57	−.01	−.50	−.01	−.58	−.01
1986	−.52	−.01	−.54	−.01	−.59	−.01	−.59	−.01	−.53	−.01	−.61	−.01
1987	.43	−.01	−.60	−.01	−.62	−.01	−.62	−.01	−.56	−.01	−.61	−.01
1988	−.72	−.01	−.69	−.01	−.66	−.01	−.66	−.01	−.61	−.01	−.64	−.01
1989	−.52	−.01	−.62	−.01	−.62	−.01	−.62	−.01	−.62	−.01	−.60	−.01

Officer's, indicating a failure to confirm the productivity bias hypothesis.[23]

Notes

1. Jacob A. Frenkel, "The Collapse of PPP during the 1970s," *European Economic Review* 16 (May 1981): 145–65.

2. Nurhan Davutyan and John Pippenger, "Purchasing Power Parity Did Not Collapse during the 1970s," *American Economic Review* 75 (December 1985): 1151–58.

3. Examples of such studies are Mohsen Bahmani-Oskooee, "Purchasing Power Parity Based on Effective Exchange Rate and Cointegration: 25 LDCs Experience with Its Absolute Formulation," *World Development* 21 (June 1993): 1023–31; Costas Karfakis and Demetrios Moschos, "Testing for Long Run Purchasing Power Parity: A Time Series Analysis for the Greek Drachmas," *Economic Letters* 30 (December 1989): 245–48; Allan P. Layton and Jonathan P. Stark, "Co-integration as an Empirical Test of Purchasing Power Parity," *Journal of Macroeconomics* 12 (Winter 1990): 125–36; Robert McNown and Myles S. Wallace, "National Price Levels, Purchasing Power Parity, and Cointegration: A Test for Four High Inflation Economies," *Journal of International Money and Finance* 8 (December 1989): 533–45; and Mark P. Taylor, "An Empirical Examination of Long-Run Purchasing Power Parity Using Cointegration Technique," *Applied Economics* 20 (October 1988): 1369–81.

4. Bela Balassa, "The Purchasing-Power Parity Doctrine: A Reappraisal," *Journal of Political Economy* 72 (December 1964): 584–96, quotation on 586.

5. Ibid., p. 589.

6. Margaret G. de Vries, "Exchange Depreciation in Developing Countries," *IMF Staff Papers* 15 (November 1968): 560–78.

7. Another reason for rapid depreciation in less developed countries could be that LDCs use exchange rate adjustments as a policy tool more often than developed countries do.

8. Christopher Clague and Vito Tanzi, "Human Capital, Natural Resources and the Purchasing-Power Parity Doctrine: Some Empirical Results," *Economia Internazionale* 25 (February 1972): 3–18.

9. Joseph Grunwald and Jorge Salazar-Carrillo, "Economic Integration, Rates of Exchange, and Value Comparison in Latin America," in *International Comparisons of Prices and Output,* ed. D. J. Daly, National Bureau of Economic Research (New York: Columbia University Press, 1972), pp. 227–80; see esp. p. 264.

10. Irving B. Kravis and Robert E. Lipsey, "Toward an Explanation of National Price Levels," *Princeton Studies in International Finance,* no. 52 (November 1983), esp. pp. 21–28.

11. Irving B. Kravis and Robert E. Lipsey, "Price Behavior in the Light of Balance of Payments Theories," *Journal of International Economics* 8 (August 1978): 193–246; see esp. p. 207.

12. Christopher Clague, "Determinants of the National Price Level: Some Empirical Results" *Review of Economics and Statistics* 68 (May 1986): 320–23.

13. Christopher K. Clague, "Purchasing-Power Parities and Exchange Rates in Latin America," *Economic Development and Cultural Change* 36 (April 1988): 529–41.

14. Lawrence H. Officer, "The Productivity Bias in Purchasing Power

Parity: An Econometric Investigation," *IMF Staff Papers* 23 (November 1976): 545–79.

15. The countries included were Canada, the United States, Australia, New Zealand, Austria, Belgium, Denmark, Finland, France, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom.

16. Officer, esp. p. 575.

17. United Nations, "Trends in International Distribution of Gross World Product," in *National Account Statistics,* Special Issue (New York: United Nations, 1993).

18. Officer, esp. p. 547.

19. United Nations.

20. The reason we say approximately 80 LDCs is because the composition of LDCs slightly differed from one year to another due to a lack of GDP deflator for some years.

21. Officer (n. 14 above)

22. Ibid., p. 553.

23. It should be indicated that David A. Hsieh, "The Determination of the Real Exchange Rate: The Productivity Approach," *Journal of International Economics* 12 (May 1982): 355–62 and Mohsen Bahmani-Oskooee "A Time-Series Approach to Test the Productivity Bias Hypothesis in Purchasing Power Parity," *Kyklos* 45, fasc. 2 (1992): 227–36 are two studies that used time-series data and not cross-sectional data, and they have provided some support for the hypothesis. The fact that these time-series studies support the productivity bias hypothesis or explain the variation in real exchange rates better than most cross-sectional studies (including this one) could be due to country specific factors which are held constant in time-series studies but not in cross-sectional studies.