

## TESTING THE PRODUCTIVITY BIAS HYPOTHESIS FOR BRAZIL

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### ABSTRACT

**Purpose-** Productivity Bias Hypothesis (Balassa-Samuelsom hypothesis) implies that currency appreciates in a relatively more productive country. The focus of this study is to test productivity bias hypothesis for Brazil by employin time series data over the period 1980-2018.

**Methodology-** Time series data is analyzed by Autoregressive Distributed Lag (ARDL) method of cointegration.

**Findings-**Stationarity of the variables are supported by Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests. F bounds test and error correction model suggest that variables are cointegrated.

**Conclusion-** Empirical analysis does not support the evidence in favor of productivity bias hypothesis for Brazil over the selected period.

**Keywords:** Productivity bias hypothesis, Brazil.

**JEL Codes:** C22, F30

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## 1. INTRODUCTION

Purchasing Power Parity (PPP) theory suggests that the exchange rate between currencies of two country is obtained as the ratio of the general price level. In the literature there are many study testing the validity of the theory but the results are not conclusive. Productivity differences across countries arise as one of the important reasons about the deviations of exchange rates from the equilibrium level.

The independent studies of Balassa (1964) and Samuelson (1964) revealed Balassa-Samuelsom hypothesis that is also known as Productivity Bias Hypothesis (PBH). According to the hypothesis, if a country is more productive than the other country then real exchange rate appreciates in the more productive country.

In this study Productivity Bias Hypothesis is tested for Brazil from 1980 to 2018 period. Although there are many studies testing PBH, there is no time series study that tests the validity of the hypothesis in Brazil. This study contributes to the literature in this sense.

The rest of the paper is organized as follows: Section 2 provides a brief literature review. Section 3 presents methodology and empirical analysis. Section 4 concludes.

## 2. A BRIEF LITERATURE REVIEW

The related literature is surveyed by Bahmani-Oskooee and Nasir (2005).

Cross Sectional Studies: Balassa (1964) tested the hypothesis as a first study. The study supports PBH. Other cross sectional studies: Kravis and Lipsey (1983), Clague (1986), Bergstrand (1991), Bergstrand (1992), Bahmani-Oskooee and Nasir (2001).

Time Series Studies: First time series study is conducted by Hsieh (1982) by using data for Germany and Japan for the 1954-1976 period. The findings support PBH. Other time series studies: Rogoff (1992), Egert (2002), Bahmani-Oskooee and Nasir (2004), Chowdhury (2012), Apergis (2013), Cardi and Restout (2015), Halicioglu and Ketenci (2018).

Panel Studies: By employing data of 14 OECD countries from 1970 to 1985 period Asea and Mendoza (1994)'s study was the first panel data study. Other panel data studies: De Gregorio et. al (1994), Canzoneri et al. (1999), Strauss (1999), Bahmani-Oskooee and Nasir (2001), Irandoust (2017).

## 3. METHODOLOGY AND EMPIRICAL ANALYSIS

Following Officer (1976), the relationship between real exchange rate and productivity differentials is expressed in Equation 1.

$$RER_t = a_0 + a_1 PROD_t + \varepsilon_t \quad (1)$$

RER<sub>t</sub> is real exchange rate that is obtained by (P<sub>i</sub>/P<sub>us</sub>)EX. P<sub>i</sub> is price level in country i and P<sub>us</sub> is price level in US and EX the exchange rate. PROD<sub>t</sub> denotes productivity differential. PROD<sub>t</sub>= (PROD<sub>i</sub>/PROD<sub>us</sub>) PROD<sub>i</sub> is productivity in country i and PROD<sub>us</sub> is productivity in US. ε<sub>t</sub> is the error term. Expected sign of slope parameter α<sub>1</sub> is positive. Consumer price index is used for P<sub>i</sub>. Productivity is measured by real GDP per capita. All data are taken World Bank, World Development Indicators Database.

In this study Pesaran et al. (2001) Autoregressive distributed lag model (ARDL) is used. Equation 2 below shows the ARDL representation of the model in Equation 1. ARDL method is invalid when the variables are I(2). When the variables are I(0) or I(1) or mixed the test is valid. In order to check that the variables are not I(2) Dickey and Fuller (1979), Augmented Dickey Fuller (ADF) and Phillips Perron (1988) (PP) tests are used. Table 1 shows the test results and existence of unit root is rejected by both tests for both variables.

$$\Delta RER_{t,j} = \alpha_0 + \sum_{i=1}^{m1} \alpha_{1i} \Delta RER_{t-i} + \sum_{i=0}^{m2} \alpha_{2i} \Delta PROD_{t-i} + \alpha_3 RER_{t-1} + \alpha_4 PROD_{t-1} + v_t \tag{2}$$

**Table 1: Unit Root Test**

	ADF	PP
rer	-2.58**	-3.74*
prod	-2.64***	-2.68***

Null hypothesis is the presence of the unit root. \*, \*\*, \*\*\* denote rejection of the null hypothesis at the 1%, 5% and 10% significance levels respectively

The cointegration relationship between the variables are investigated by the bounds testing that is a Wald statistics (F statistics). The null hypothesis is no cointegration among the variables:

H<sub>0</sub>: α<sub>3</sub>= α<sub>4</sub>=0

H<sub>1</sub>: at least one of α<sub>3</sub>, α<sub>4</sub> ≠ 0

When F statistics is above the upper bound critical values then the null hypothesis is rejected. When the F statistics is below the lower bound critical value then the null hypothesis cannot be rejected. When the F statistics is between critical values then no conclusion can be drawn. Table 2 shows F bounds test results. The computed F statistics is above the upper bound critical value at 10% significance level.

**Table 2: Cointegration F Test**

F-Statistics	90%LB	90%UB	95%LB	95%UB	99%LB	99%UB
4.15	3.02	3.51	3.62	4.16	4.94	5.58

Error correction model (ECM) provides estimates of short run parameters after determining the long run cointegration relationship between the variables. Equation 3 is the ECM representation of the model.

$$\Delta RER_{t,j} = \beta_0 + \sum_{i=1}^{n1} \beta_{1i} \Delta RER_{t-i} + \sum_{i=0}^{n2} \beta_{2i} \Delta PROD_{t-i} + \lambda EC_{t-1} + w_t \tag{3}$$

EC<sub>t-1</sub> is the error correction term and λ is the speed of adjustment parameter. Negative and significant EC<sub>t-1</sub> indicates cointegration among the variables as well.. Table 3 shows ECM estimation results and some regression diagnostics. EC<sub>t-1</sub> is estimated as negative and statistically significant and therefore provides further evidence on the cointegration.

**Table 3: Error Correction Model**

EC <sub>T-1</sub>	t-stat	R <sup>2</sup>	DW Stat.	RSS	Normality	Serial Correlation	Heteroscedasticity
-0.06	-3.66	0.85	1.86	21.95	5.58	0.31	4.51

Table 4 presents ARDL long run results. The slope parameter is estimated as negative and significant. Therefore for the selected period of time in Brazil, no evidence is found to support Productivity Bias Hypothesis. Finally, cumulative sum of recursive residuals and (CUSUM) and cumulative sum of squares of recursive residuals CUSUM<sup>2</sup> tests of Brown et al. (1975) are used. Due to space constraints plots are not included. CUSUM and CUSUM<sup>2</sup> plots suggest stability of the model (S stands for stability).

**Table 4: ARDL Long Run Results**

Model	Coefficient Estimate of Slope Parameter	t-stat	CUSUM	CUSUM <sup>2</sup>
ARDL (4,4)	-88.36	-2.06**	S	S

**4. CONCLUSION**

The purpose of this study is to determine whether Productivity Bias Hypothesis is supported in Brazil over the 1980-2018 period. Autoregressive distributed lag model (ARDL) is used. Firstly, Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests are used to check that none of the variables is I(2). Since ARDL is invalid when one of the variables is I(2). F bounds test suggests cointegration among the

variables. Then Error Correction Model is estimated. Lastly ARDL long run results imply that the slope coefficient is negative and significant. Therefore for the considered period of time no support for PBH is obtained in Brazil.

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