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Testing the Harrod Balassa Sameulson Hypothesis: The Case of Pakistan

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1. INTRODUCTION

In this modern era of globalisation, the stabilisation of exchange rate is very important phenomenon for the financial institutions and for the international trade, especially for a small open economy like, Pakistan. A stable exchange rate may help financial institutions to reduce their operational risk. While a fluctuating exchange rate can affect macroeconomic fundamentals like, prices, wages, interest rate, output etc. That eventually leads to the devaluation of the real exchange rate for the correction of external balance [Parikh and Williams (2008)].

After pioneer study of Cassel (1916) Purchasing Power Parity (PPP) theory has become very famous tool to determine the long run real exchange rate and to asses, whether shocks to real exchange rate are permanent or transitory. It asserts that under the assumptions of perfect markets and free trade, the nominal exchange rate between two countries will be equalised to the ratio of the general price level of the both countries. Due to which, real exchange rate will be constant over time and any shock to the real exchange rate will be transient and mean reverting. In the free trade world with no transaction cost, it is also called "law of one price". Nevertheless, in the real world, the existence of transportation costs, capital flows, speculative expectations and the existence of non-traded goods make the theory more controversial.

In 1933, Harrod criticised this theory and afterward Balassa and Sameulson (1964) did the same by saying that, PPP theory is not the appropriate theory of the exchange rate determination. As real exchange rate can diverge from its long run equilibrium path due to the productivity differences through the channel of non-traded goods' prices that are part of the general price level of a country and which resist the price levels between the two countries to be equalised. These productivity differences can take two forms; productivity differences between tradable and non-tradable goods within the country and the same across the countries. Productivity in the tradable sector is generally higher than the non-traded sector that leads to the increase in prices of non-traded goods and then the general price levels, which leads to the real appreciation of real exchange rate. This theory is commonly known as Harrod-Balassa-Samuelson (HBS) hypothesis.

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Due to the controversies in literature regarding HBS and PPP, both of the theories have been re-evaluated at the empirical ground by using annual time series data for the period of 1972-2008. In addition to the relative productivity fundamental variables, the terms of trade, government consumption, money supply and world oil prices are added as the secondary explanatory variables, which can also be seen as a test of the extended (unrestricted) HBS model.

This paper is distinct from the similar studies at several grounds. Firstly, the paper is different due to two-step method because most of the studies evaluated HBS through one-step method in Pakistan. That is more important for the analysis of the exact reason behind the failure of the hypothesis in Pakistan as most studies have concluded. Secondly, the most important distinction of the study is that it is based on the sectoral data and relative prices of the traded and non-traded sectors are used which, to my best knowledge, have never been used before for the analysis of HBS in Pakistan.

A review of previous studies that have examined the relationship between real exchange rate and productivity, among developed and developing countries provided in Section 2. In Section 3, an economic model of Purchasing Power Parity and Harrod Balassa Sameulson hypothesis is derived using a production function approach. Data description and methodology presented in Section 4 while Section 5 describes the results developed after estimation and Section 6 concludes the paper and discusses some policy implications based on econometric results of the study.

2. REVIEW OF LITERATURE

After dozens of published papers, in 1994, De Gregorio and Wolf integrated the "terms of trade" formally into the BS model. In their influential study, they develop a simple model of a small open economy producing exportable and non-tradable goods and consuming importable and non-tradable goods, and present empirical evidence for a sample of fourteen Organisation for Economic Co-Operation and Development (OECD) countries. Clearly, they conclude, "The evidence from OECD countries broadly supports the predictions of the model, namely that faster productivity growth in the tradable relative to the non-tradable sector and an improvement in the terms of trade induces a real appreciation" [De Gregorio and Wolf (1994), p.1]. After this stream of work, many studies came with the models of additional independent variables. Such as, Broeck and Slok (2001) linked this phenomenon to the transition countries by using additional independent variables like, ratio of broad money to GDP, government balance, openness, fuel and non-fuel prices and terms of trade. Sonora and Tica (2007) also contribute to the verification of the HBS for 11 transition countries by including Government consumption to GDP ratio as an explanatory variable.

Jongwanich (2010) incorporated terms of trade, government spending, productivity differential and capital flows as explanatory variables. Capital flows further separated into three categories, foreign direct investment, portfolio investment, and other investment flows. While Chinn (1998) examined the productivity based explanation for real exchange rate for East Asian countries by using three additional variables; oil prices, government spending and terms of trade. In which only oil prices show the significant contribution in explaining the productivity effect on real exchange rate (RER).

With the passage of time as there have been made different modifications in the model, different econometric techniques were introduced. The first econometric test was a cross-sectional OLS analysis used by Balassa in 1964. In the early 1980s, Instrumental Variables, and Engle-Granger co-integration techniques were used but the mainstream technique was still OLS. In the early nineties, seemingly unrelated regression technique was used widely but in the late nineties Johanson and Juselius co-integration technique became one of the most popular technique in testing the HBS hypothesis. Recently, the auto regressive distributed lag (ARDL) has become very popular also [Tica and Druzic (2007)].

Solanes and Flores (2008) used panel data unit root tests and Pedroni-co-integration technique both for OECD and Latin America as well. They distinct their study by employing two-stage approach and found that the first stage of the hypothesis holds in both of the groups but the second stage which relates relative prices to real exchange rate holds only in LA countries. The same kind of results were found by Egert (2002) which used VAR based co-integration technique to see the effect of HBS in five transition economies. The relationship between productivity growth and relative prices is much stronger than the relationship between relative prices and real exchange rate movements.

To stabilise prices and trade flows many developing countries are trying to manage their real exchange rates by official interventions.

On the other hand, Qayum, *et al*. (2004) tested the validity of Purchasing Power Parity hypothesis for Pakistan by the VAR based Johenson co-integration approach. The results are in favour of PPP in the traded sector by saying that in the absence of shocks, exchange rate and whole sale prices will be adjusted to its equilibrium but the speed of adjustment is very slow. In this regard, Khan and Ahmad (2005) also concluded by using three different types of price indices of the four Asian countries.[1] The long run cointegrating relationship suggests that the long run relationship between nominal exchange rate and prices exists only for the wholesale price index. In this regard Bianco (2008) tested the PPP theory of exchange rate for Argentina as this country has experienced a downfall from developed to developing. The downfall of this once developed country has affected its RER and raised the question about the validity of PPP. The results are less favourable for PPP, as its RER appears as a non-stationary variable, but more favourable for HBS effect.

With the increasing importance of HBS, Chowdhary (2007) used Auto Regressive Distributive Lag (ARDL) approach to estimate HBS for SAARC countries because ARDL approach is free from the problem of the same order of integration. The findings of the ARDL approach show that the BS effect is only working in Bangladesh. The reason might be the exclusion of the other relevant explanatory variables like, interest rate differentials, terms of trade and foreign direct investment etc., which affect real exchange rate besides the productivity differential. So, Choudhri and Khan (2005) examines the BS hypothesis, in which terms of trade together with non-traded and traded goods productivity differentials are used as the explanatory variables, to explain the real exchange rate movements of 16 countries in 1976- 1994 period by employing Dynamic Ordinary Least Squares (DOLS) method. According to the authors, the results of the study provide strong verification of the BS effects for developing countries.

[1]Indonesia, Malaysia, Pakistan and Singapore.

3. ECONOMIC MODELS

3.1. Purchasing Power Parity Model

"The theory states that barring frictional or complicating factors such as tariffs, taxes and transportation costs, the price of an internationally traded good in one country should achieve the identical price in another country, once the price is adjusted to a common currency" [Nguyen (2001), p. 1]. Mathematically, it can be expressed as;

$$P = e.\, P^{*}$$

In the expression above, P is the domestic price, e is the nominal exchange rate defined as the domestic currency units per unit of foreign currency and P^* is the price in the foreign country expressed in foreign currency. If PPP holds, then above equation can be written as,

$$P/\,P^{*} = e \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Or $P/\,P^{*}\ x\ 1/e = 1$

Where, expression (1) describes the **'Absolute PPP'** between two countries and the second expression shows the real exchange rate or the exchange rate that is adjusted for the price levels between two countries that must be equal to one for the PPP to hold.

The empirical or estimated form of the Absolute PPP can be written as;

$$e_t = \beta_0 + \beta_1\,(p - p^{*})_t + u_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where, e_t is the natural log of the nominal exchange rate expressed in the domestic currency per unit of the foreign currency. $(p - p^*)$ is the price differential between domestic and foreign currency in logarithmic form. For the PPP to hold β_0 must be zero and β_1 will be equal to one.

However, to test the absolute PPP for the countries, the deficiency of the proper price level data available for internationally standardised baskets of goods and its inability to capture the inflation differentials between countries, researchers often move to the testing of relative PPP [Rogoff (1996)]. Moreover, restriction on β_1 equal to one will be relaxed in the Equation (2).

The testable form of the relative PPP is as;

$$\Delta e_t = \alpha_0 + \alpha_1\,(\Delta p - \Delta p^{*}) + \varepsilon_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Where, Δ represents the first difference operator indicating that rate of change in log exchange rate is equal to the inflation differential between two countries.

Conversely, in the real world distinction between relative and absolute PPP is not possible because price levels in both the countries are measured assuming unit price in some base year [Bhatti 1996].

3.2. The Basic HBS Model

The HBS hypothesis states that the productivity differences in tradable and non-tradable sectors across countries lead to differentiation of wages, price levels and, hence the real exchange rates. In the other words, this theory offers the supply side explanation of higher inflation and the real exchange rate appreciation in the countries those have higher productivity growth.

In its domestic version, relative inflation is explained by relative productivity growth between tradable and non-tradable sectors. It is observed that usually productivity growth in tradable sector is much higher than the non-tradable sector. Therefore, if wages are equal in both the sectors then higher productivity-driven wages will push the wages in the non-tradable sector as well. As wages have been increased more than its productivity gains in the non-tradable sector, prices will increase. This, in turn, raises the ratio of non-tradable to tradable prices. In literature, it is also known as the 'Penn-effect'.

In the international version, this causal link between productivity growth and relative prices further explains the appreciation of the real exchange rate. As there is assumed to be the PPP in the tradable sector, the productivity-driven inflation differential will cause the appreciation of the real exchange rate (as $R=e.P^*/P$).

3.2.1. *Approaches to Estimate HBS*

In the literature, there are two main approaches to test the HBS hypothesis; one-step approach and the two-steps approach.

One Step Approach

The empirical equation that was estimated by Balassa (1964) in cross-sectional analysis refers to the one-step approach. In which productivity difference is directly related to the real exchange rate.

Two Step Approach

The two-step approach firstly examines the relationship of productivity differences between tradable and non-tradable sectors to their relative prices.

Then in the second step, the existence of PPP in the tradable sector is to be checked. Together, if the two steps show positive results, the real exchange rate is expected to move together with differences in the relative productivity of tradable over non-tradable sectors between countries.

3.2.2. *Formal Exposition of the HBS Model*

It is assumed that an open economy produces two goods: traded and non-traded. Labour is used as an input and outputs are generated with constant-return production functions (CRS):

$$Y^T = A^T F(L^T) \quad \text{and} \quad Y^{NT} = A^{NT} F(L^{NT}) \qquad \ldots \quad \ldots \quad \ldots \quad (7)$$

Where, subscripts T and NT denote tradable and non-tradable sectors, respectively. If, there is used '*' with the same function then it will represent the foreign country. Assuming that both goods are produced by the total domestic labour supply which is constant and equal to

$L = L^T + L^{NT}$.

It is further assumed that the labour market is competitive and labour is mobile across sectors but not across countries. Labour mobility ensures that workers earn the same wage W in either sector. The profit maximisation first order conditions of the Equation (7) says that, Marginal Product of Labour "MPL = w" in both the countries or in logarithmic form;

$$wT - pT = \alpha T \quad \text{and} \quad wNT - pNT = \alpha NT \qquad \ldots \quad \ldots \quad \ldots \quad (8)$$

Thus, the assumption of wage equalisation implies

$$pNT - pT = \alpha T - \alpha NT \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

By subtracting the foreign country

$$(pNT - pT) - (pNT^* - pT^*) = (\alpha T - \alpha NT) - (\alpha T^* - \alpha NT^*) \qquad \ldots \quad \ldots \quad (10)$$

To show the internal mechanism that how productivity differences affects non-tradable prices and then to overall inflation, we can rearrange Equations (9) as;

$$pNT = pT + \alpha T - \alpha NT \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

The overall price inflation in the country is defined as a weighted average of the tradable and non-tradable sectors with 'θ' and '1- θ' used as weights measured as traded and non-traded goods' share in GDP (Gross Domestic Product), respectively.

$$p = \theta\, pT + (1 - \theta)\, pNT \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

Now by substituting the value of pNT in Equation (14) , it will become;

$$p = pT + (1 - \theta)\, (\alpha T - \alpha NT) \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

OR

$$p = pT + (1 - \theta)\, (pNT - pT) \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (14)$$

$$p^* = pT^* + (1 - \theta)\, (pNT^* - pT^*) \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (15)$$

Therefore, according to this mechanism Equation (10) implies that increase in the productivity of traded goods in home than in the foreign will put the upward pressure on the prices of non-traded goods in home country [Egert (2002)].

For the international comparison of the countries' prices,

$$q = e + p^* - p \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (16)$$

Where 'q' is log real exchange rate 'e' is the nominal exchange rate, 'p' and 'p^*' are the logarithmic forms of the domestic and foreign consumer price indices, respectively. These price indices are the geometric averages of the traded and non-traded goods as is the form of Equation (12).

Now by putting Equations (14) and (15) into (16) and assuming θ = β we get;

$$q = e + \{pT^* + (1 - \theta)\, (pNT^* - pT^*)\} - \{pT + (1 - \theta)\, (pNT - pT)\} \qquad \ldots \quad (17)$$

If $pT = pT^*$ then 'e' will be equal to one. To see the equalisation in traded goods' prices, Franses and Dijk (2002) decomposed the 'q' into stationary and a non-stationary component.

$$q = x + y$$

Where, $x = e + \beta pT^* - \theta pT$ … … … … … (18)

And

$$y = (1-\beta)(pNT^* - pT^*) - (1-\theta)(pNT - pT) \quad \ldots \quad \ldots \quad \ldots \quad (19)$$

If 'x' is equal to '1' or is stationary process then,

$$q = (1-\theta)(pNT^* - pT^*) - (1-\theta)(pNT - pT)$$

Alternatively,

$$q = -(1-\theta)[(pNT - pT) - (pNT^* - pT^*)] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (20)$$

It means that whenever prices of non-tradable sector in home relative to foreign will increase, exchange rate will be appreciated in the home country.

OR $q = -(1-\theta)[(\alpha T - \alpha NT) - (\alpha T^* - \alpha NT^*)]$ … … … (21)

3.3. Empirical Formulation of the Models

In order to use these deterministic models in the estimation, firstly they are converted into the empirical one.

Restricted Model

$$\ln(RPRCS)_t = a_0 + a_1 \ln(RPROD)_t + \eta_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (22)$$

$$\ln(RER)_t = b_0 + b_1 \ln(RPRCS)_t + \eta_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (23)$$

$$\ln(RER)_t = \gamma_0 + \gamma_1 \ln(RPROD)_t + \eta_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (24)$$

Where, Equations (22) and (23) are indicating the one-step method while (24) is for two-step approach.

Unrestricted Model

However, after 1994, a strand of literature has been developed for the increasing trend of the inclusion of other explanatory variables in "Restricted Model" that can be name by **"**Unrestricted Model" which is defined as follows;

$$\ln(RPRCS)_t = a_0 + a_1\ln(RPROD)_t + a_2\ln(GEX)_t + a_3\ln(TOT)_t + a_4\ln(WP)_t + a_5\ln(M2)_t + \eta_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (25)$$

$$\ln(RER)_t = b_0 + b_1\ln(RPRCS)_t + b_2\ln(GEX)_t + b_3\ln(TOT)_t + b_4\ln(WP)_t + b_5\ln(M2)_t + \eta_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (26)$$

$$\ln(RER)_t = \gamma_0 + \gamma_1\ln(RPROD)_t + \gamma_2\ln(GEX)_t + \gamma_3\ln(TOT)_t + \gamma_4\ln(WP)_t + \gamma_5\ln(M2)_t + \eta_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (27)$$

The model has been developed by taking into account the importance or significance of the underlying explanatory variables in the modern literature.

3.4. Definition of Real Exchange Rate

The various definitions of the RER can mainly be divided into two groups; the first one is categorised in the PPP and second one is the distinction between tradable and non-tradable prices.

$$RER_{ppp} = e.\, P^*/P$$

Where, increase in the RER_{ppp} means the real depreciation and decrease represents the real appreciation. But the problem with this type of *RER* is the choice of the appropriate price index.

The second definition of the *RER* defined by the relative tradable and non-tradable prices, takes the relative prices as an indicator of the country's competitiveness.

$$RER_r = P_t/P_n$$

Under the assumption that tradable prices are the same in all over the world, the RER_r can be defined as;

$$P_t = e.\, P^*_t$$
$$RER_r = e.\, P^*_t/P_n$$

Where, increase in the RER_r indicates the real depreciation and decrease means the real appreciation.

Therefore, to calculate the PPP for Pakistan, first definition has been used. While, for the analysis of HBS, the second definition of RER has been utilised.

3.5. Variables Description

- lnNER = Nominal Exchange rate is the national currency per U.S. dollar taken as period averages (Equation 1 of PPP).
- lnPD = Price Differential is the GDP Deflator of Pakistan divided by the GDP Deflator of U.S. (Equation 1 of PPP).
- prcntNER = Percentage change in nominal exchange rate
- prcntINF = Percentage change in the prices of both countries that is in other words, the inflation differential between two countries.
- lnRER = Real Exchange rate which is calculated as; the nominal exchange rate of Pakistan in terms of US dollar multiplied by the tradable prices of U.S. divided by the non-traded prices of Pakistan ($e.P^*t/Pn$).
- $lnRER^T$ = Real exchange rate based on the tradable sector prices ($e.P^*_t/P_t$).
- lnRPROD = Relative productivity is calculated as the labour productivity of Pakistan in industrial sector divided by the productivity of Pakistan in services sector then divide this whole term with the labour productivity of U.S. in industrial sector divided by labour productivity in services sector. Where 'Industry' is the proxy for traded goods sector while 'Services is the proxy for

non-traded goods sector and labour productivity is measured as the sectoral output divided by the sectoral employment in each sector of the related country.

- lnRPRCS = Relative prices are the services share of Pakistan in GDP Deflator divided by the industrial share of Pakistan in GDP Deflator then divide this whole term by the services share of U.S. in GDP Deflator divided by the industrial share of U.S. in GDP Deflator. Where, GDP Deflator is calculated by dividing the nominal to real GDP.
- lnWP = World prices are the world average crude oil prices index.
- lnTOT = Terms of Trade is the unit value of exports divided by the unit value of imports.
- lnGEX = Government consumption expenditures as a percent of GDP
- lnM2 = M2 is the proxy for money supply.

3.6. Theoretical Relationships

Terms of trade is reflecting the external price shock. Terms of trade exhibits an income effect and a substitution effect. Therefore, the terms of trade effect is ambiguous. The effect of government consumption depends upon the utilisation of the consumption on traded or non-traded goods. Like the government consumption expenditures, the effect of the money supply on the real exchange rate depends upon whether the people are utilising this money in the purchase of tradables (like, import of machinery and raw materials) or non-tradables. So, the effect of money supply on RER is blurred. For the world prices, it is considered that for the oil exporting countries, an increase in the oil price will result in the appreciation of the RER of the country. While, for the oil importing countries, an increase in the oil price will result in the depreciation of the RER of the country. However, empirically this relationship can be altered [Chinn (1998)].

4. DATA AND METHODOLOGY

4.1. Data Sources and Description

For the empirical estimation of the HBS hypothesis in Pakistan, time series data have been used for the period 1972-2008. Where, United States has been selected as a numeraire country to compare the relative productivities and relative prices data of Pakistan. Although, both the countries are not similar in terms of the per capita income, the comparison has been made at the ground of the highest share of trade in Pakistan with U.S. For traded goods, industrial data is used for both Pakistan and U.S. where industry includes, manufacturing, mining and construction. The composition of the industrial sector is same for both the countries. While, services are the proxy for non-traded goods where, services includes, trade, communication, transportation and all other services.

All the data series are taken from IFS CD-ROM and Online (2010) except for the RPROD, RPRCS, and M2. M2 for Pakistan is taken from the Handbook of statistics issued by State Bank of Pakistan. Relative prices are taken from WDI CD-ROM and Online (2010). For relative productivity of Pakistan, sectoral output is taken from different issues of Economic Survey of Pakistan while sectoral employment is taken from Labour Force Survey. For US, output by sectors is taken from WDI CD-ROM and online, (2010) while sectoral employment data is taken from International Labour Organisation (2010).

To make consistency, all the series are in natural logs, converted into million rupees and based on 2000 (= 100).

Analysis of Data

Table 1

Growth Rates of Sectoral Productivity, Sectoral Prices and Real Exchange Rate

		Average Annual Growth Rates (%)							
		Pakistan				United States			
		Productivity		Prices		Productivity		Prices	
Periods	RER	Industry	Services	Industry	Services	Industry	Services	Industry	Services
1973-77	12.23	1.62	2.78	9.24	7.99	4.61	3.07	8.72	7.69
1978-82	6.83	8.91	2.09	4.57	7.87	5.19	3.86	10.76	7.36
1983-87	13.97	-1.52	8.94	-3.69	-3.75	8.60	11.14	1.12	5.90
1988-92	8.99	7.46	3.91	1.82	1.73	8.59	9.61	2.70	4.35
1993-97	9.92	1.56	-0.38	1.10	1.91	12.52	12.32	0.94	2.52
1998-02	7.70	-1.59	3.79	0.03	1.03	9.84	9.99	0.30	2.29
2003-08	-1.90	4.07	1.61	9.31	8.38	4.04	3.76	3.27	2.64
Total avg.	7.97	2.93	3.25	3.20	3.59	7.63	7.68	3.97	4.68

Source: Based on author's own calculations.

As shown in above Table 1, the productivities in Pakistan are not acting according to the HBS hypothesis , as, average productivity in industrial sector is 0.32 percent lesser than the services productivity for the period of 1973-2008. However, as for as services prices are concerned, it is acting according to the theory and the services prices are 0.39 percent higher than the industrial prices. If relative productivities are lower then services prices must be lower. Thus, the reason for this opposite relation or the upward pressure of the services prices can be demand side of the economy or some external shocks. But, the relationship between relative productivities and RER is showing somehow favourable condition for the HBS, as, relative industrial productivity in Pakistan is less than the relative industrial productivity of U.S. leading towards the depreciation of RER of Pakistan. Therefore, this entire situation leads to the prophecy that countries with high productivity growth will have an overvaluation of their currencies. Moreover, the poorer countries will have the depreciated RER due to the slow GDP growth leading towards the low productivity growth. Because of the real GDP per capita of the developing countries, fall relative to the developed countries [Bianco (2008)].

On the other hand, in United States, productivities and prices are behaving somehow different. Labour productivity in industrial and services sector are almost the same but services prices are 71 percent higher than the industrial prices. However, prices are moving according to the theory. As, relative non-tradable sector prices are lower in the Pakistan than the U.S. leading to RER depreciation of 7.97 percent.

4.2. Methodology

To start the estimation, firstly, the time series properties of RER and relevant fundamentals have been evaluated. If series are proved to stationary, then Ordinary Least Squares (OLS) yields accurate results and standard'‘t’ and ‘F’ statistics can be used as inference. But in case of non-stationary series, 't' and 'F' statistics do not give meaningful results. Thus, the analysis of the time series properties of the variables in question helps to determine an appropriate estimation technique.

Augmented Dickey Fuller (ADF, 1979) Unit Root Test

To see the non-stationary of the series ADF has been implied.

Table 2

Augmented Dickey Fuller Unit-Root Test Results

Variables	Level	First diff	Integration Order
$lnNER_t$	5.793	–2.667*	I(1)
$lnPD_t$	6.006	–90.07*	I(1)
lnRERppp	0.1866	–5.1910*	I(1)
$changeNER_t$	–0.564	–3.176*	I(1)
$changePD_t$	**–2.462**	–4.758*	I(1)
$lnRER_t$	2.360	–7.559*	I(1)
$lnRPRCS_t$	–0.351	–4.863*	I(1)
$lnRPROD_t$	-0.164	–6.004*	I(1)
$lnWP_t$	2.325	–4.735*	I(1)
$lnGEX_t$	4.402	–2.265*	I(1)
$lnTOT_t$	–1.310	–5.430*	I(1)
$lnM2_t$	**–1.317**	–4.335*	I(1)

Notes: (1) * is indicating 1 percent level of significance. (2) All tests are conducted without including any trend or intercept except for the series in bold. (3) Bold series' test is conducted by including 'intercept'. (4) Automatic lag length selection (Schwarz Information Criterion) has been used with maximum 8 lags.

The ADF test has been applied on individual series (in levels) and resulting test statistics are compared with the ADF critical values where, the test statistic is proving to be less than the critical value for each series. Consequently, the null of the non-stationary can not be rejected. Similarly, the application of the test to the first differences of the individual series yields a test statistics which is greater than the critical values for each series indicating that all the series are I (1) process. Thus, all the series are showing the same order of integration. Therefore, it is concluded that all the series are non-stationary in levels but stationary at first difference.

However, in the presence of non-stationary series the standard tests of OLS in not valid due to its spurious results.Therefore, one way to escape from these spurious regressions is to see the co-integration relationship between these non-stationary series.

Co-integration Theory

According to the Engle and Granger (1987), co-integration relationship says that despite the fact that series are individually non-stationary but a linear combination of two or more non-stationary series will become stationary. Moreover, two variables will be co-integrated if they have a long-run relationship between them. However, Engle-Granger two-step approach is more famous for testing the co-integration relationship between two series. If there are more than two series in the regression, then Vector Autoregressive (VAR) based Johansen co-integration approach, developed in (1991, 1995a), is more relevant and practical.

VAR-based Johansen Co-integration

This approach implements a system by assuming a VAR of order 'P'

$$X_t = A_1X_{t-1} + A_2X_{t-2} + \ldots + A_pX_{t-p} + By_t + Z_t \ldots\ldots\ldots\ldots \text{(X)}$$

Where X_t is a k-vector of non-stationary I (1) variables, y_t is a d-vector of deterministic variables, and Z_t is a vector of shocks or innovations. Therefore, this system of VAR can be rewrite as,

$$\Delta X_t = \varphi X_{t\text{-}1} + \eta_i\, \Delta X_{t\text{-}i} + By_t + Z_t \ldots\ldots\ldots \text{(X.1)} \qquad \text{Where, } \varphi = A_i - I, \text{ and } \quad \eta_i = -A_j$$

Granger, (1987) represents it by saying that if the coefficient matrix φ has reduced rank means, $r < k$ (where r is the number of co-integrating relations), then there exists k x r matrices θ and γ each with rank 'r' such that

$\varphi = \theta\ x\ \gamma'$ and $\gamma' X_t$ is I (0)

Where each column of γ is the co-integrating vector and elements of θ are representing the adjustment parameters of Vector Error Correction Model (VECM). Johansen estimates this φ matrix through an unrestricted VAR and tests whether the restrictions implied by the reduced rank of φ can be rejected or not. Furthermore, he estimates the equation (X.1) by Maximum Likelihood method and determines the number of co-integrating vectors or rank of the 'r' by Trace statistics and Maximum Eigen-value (λ-max).

5. ECONOMETRICS RESULTS

5.1. Model Specification and Lag Selection in VAR

As it is mentioned in the previous chapter that, co-integration analysis is sensitive to the specification of the trends and the number of the lags used in the VAR. Therefore, a greater attention has been given to this part to deal with this problem.

Table 3

Results of the Model Specification and Lag Selection

		LR	FPE	SC	AIC	HQ	Preferred Lags	Preferred Model
PPP		1	1	1	1	1	1	2
Restricted Model	Penn-effect	1	2	1	2	1	1	3
	Indirect effect	1	1	1	1	1	1	3
	BS effect	2	2	1	2	2	2	3
Unrestricted Model	Penn-effect	3	3	1	3	3	3	3
	Indirect effect	1	1	1	2	1	1	2
	BS effect	1	1	1	2	1	1	3

Note: Lag selection has been conducted by the k-max = 3. LR: sequential modified LR test statistic (each test at 5 percent level), FPE: Final Prediction Error, AIC: Akaike Information Criterion, SIC: Schwarz Information Criterion, HQ: Hannan-Quinn Information Criterion. Model 3: Linear trends in the level data but not in the VAR.

In Table 3, the selection of the preferred lag(s) has been done according to the decision of maximum criteria.

5.2. PPP Results

To examine whether the nominal exchange rate and the price differential have a long run co-integrating relationship or not, Trace-statistics and Max-Eigenvalue statistics have been used.

Table 4

Results of the Co-integrating Rank for Purchasing Power Parity Model

	Absolute PPP		
Null Hypothesis	r = 0	r ≤ 1	Rank
Trace Statistics	21.39742*	2.333243	1
Max-Eigen Statistics	19.06418*	2.333243	1
	Relative PPP		
Trace Statistics	14.83588	5.078195	0
Max-Eigen Statistics	9.757685	5.078195	0

Note: * is for significance at 5 percent level.

Table 4 is depicting that both nominal exchange rate and price difference are having long run relationship in Pakistan as both of the statistics are in favour of one co-integrating rank for this relationship. However, the results of relative form of PPP are indicating that there is no co-integrating equation in the model.

The below Table 5 is indicating that long run relationship is insignificant in the form of both absolute and relative PPP.

Table 5

Results of the Long run and Short run Coefficients for PPP

	Absolute PPP Long run Co-integrating Coefficients	
lnNER	**lnCPI**	**C**
1.000000	0.630288 (0.94429)	1.053407 (0.37525)
	Short run Adjustment Coefficients	
0.022758 (2.7923)**	0.022728 (4.50059)*	
	Relative PPP Long run Co-integrating Coefficients	
CHANGENER	**CHANGECPI**	**C**
1.000000	0.473355 (1.12770)	4.603331 (2.0684)**
	Short run Adjustment Coefficients	
–0.648720 (3.0595)*	0.015188 (0.12753)	

Note: Values in parentheses are the t values. * and ** are for significant at 1 percent and 5 percent level of significance, respectively.

Table 2 can validate these results, where lnRERppp is a non-stationary variable. Which indicates that for Pakistan, PPP does not hold in the long run. The results are in accordance with the results of the many studies including the developing countries. As, Khan and Ahmad (2005) found no favourable results for PPP in Pakistan using consumer price index and gross domestic product deflator. Testing for thirty developing countries, Holmas (2002) also found no compelling results in favour of PPP. Further, the Sarno and Taylor (2002) conclude that PPP can be of long run phenomena when applied to the bilateral exchange rate of the key industrialised countries.

5.3. Results of Restricted Model

After the rejection of the nominal theory of RER determination in Pakistan, now the analysis has been turned out toward the real theory of RER determination - the HBS hypothesis.

Table 6

Results of the Co-integrating Rank for Restricted Model

Null Hypothesis		r = 0	r ≤ 1	Rank
Penn-effect	Trace	16.73672*	1.836606	1
	Max-Eigen	14.90011*	1.836606	1
Indirect Effect	Trace	27.81613*	1.93708	1
	Max-Eigen	26.62242*	1.93708	1
B-S Effect	Trace	15.62315*	0.195152	1
	Max-Eigen	15.42800*	0.195152	1

Note: '*' indicates rejection of the null hypothesis at 5 percent level of significance.

Table 6 is showing that both Trace and Max-Eigen statistics are favouring the long run relationship for the components of 'restricted model'. As, both the tests are rejecting the null of 'no co-integrating rank' at five percent level of significance and unable to reject the null of 'at least one co-integrating rank'.

However, before further proceeding with the results of the 'restricted model', it is necessary to validate the assumption of the "PPP in tradable sector prices".

Testing the PPP in Traded Sector

To see the stationarity of the RER^T, two types of unit-root tests have been applied. The results of these two tests are given below;

Table 7

Unit-Root Tests Results of $lnRER^T$

	ADF			KPSS	
	Level	1st diff.	Order of Integration	Level	Order of Integration
None	–3.141*	–	I (0)	–	–
Trend and Intercept	–1.393	–7.234*	I (1)	**0.124**	I (0)
Intercept	–1.436	–7.494*	I (1)	**0.688**	I (0)

Note: * is for significant at 1 percent level of significance. Bold values are showing the LM statistics of KPSS which indicating that H_0 cannot be rejected.

Table 7 explains the Unit-Roots of the part of the real exchange rate that includes only tradable sector prices. Unit-Root of the series has been evaluated through two alternative tests ADF and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (1992). KPSS has been selected to verify the results of ADF because where all other four tests of the unit-root assumes non-stationary in the series as a null hypothesis, KPSS assumes 'series is stationary' in the null hypothesis.

In the Table 8, there are five specifications regarding the stationarity of the '$\ln RER^{T}$' where out of five, three results are in favour of that series is stationary or I (0). While favouring the PPP in Pakistan, Khan and Qayyum (2007) give two reasons for the existence of PPP in the tradable sector. One is that since 1990, Pakistan is pursuing trade liberalisation policies and the second one is that economic development of developing countries like Pakistan is highly dependent on the developed countries. It means that part of the real exchange rate, which represents non-tradable sector prices, can be a factor explaining reasoning of non-stationarity in RER.

Table 8

Results of the Long-run and Short-run Coefficients for Restricted Model

Long Run Co-integrating Coefficients					
Penn-effect		Indirect Effect		BS Effect	
lnRPRCS	lnRPROD	lnRER	lnRPRCS	lnRER	lnRPROD
1.000000	–1.178903	1.000000	–11.03334	1.000000	9.635449
	(4.43413)*		(7.05636)*		(4.42206)*
Short Run Adjustment Coefficients					
-0.092810	–0.443301	0.067103	–0.024687	0.009989	0.54263
(1.85929)***	(4.03778)*	(4.97059)*	(2.98152)**	(0.81609)	(4.03742)*

Note: Values in parentheses are the t-values. *, **, *** are significant at 1 percent, 5 percent and 10 percent level of significance, respectively.

In Table 8 the long run normalised co-integrating coefficient value of '*lnRPROD*' is indicating that relative productivity of tradable sector has a significant effect on the relative prices of non-tradable sector and a 1 percent increase in relative productivity will result in 1.17 percent decrease in relative prices. Which means that rather than increasing in the non-tradable prices, as suggested by the HBS hypothesis, it will decrease due to the increase in the relative productivity. Moreover, the short run adjustment parameters are suggesting that in the short run, adjustment will take place in both the variables. However, the adjustment process is very slow following 0.09 and 0.44 for RPRCS and RPROD, respectively.

On the other hand, by looking at the situation of 'Indirect effect' it can be observed that there exists a significant and negative effect of relative prices on the exchange rate. Broadly speaking, one percent increase in the relative prices of non-traded sector in Pakistan relative to U.S. will result in the appreciation of RER of Pakistan by 11 percent. Where, sign is according to theory, but, the elasticity is much higher which can be reduced in the presence of some other economic fundamentals in the model. In the short run, RPRCS will adjust by 0.02 percent to remove any disequilibrium. Again, the short run adjustment parameter is very low indicating that, economy will recover from its disequilibrium only in the long run.

In Table 8, the third part of the hypothesis, which directly relates relative productivities and real exchange rate, is showing significant but positive effect as one percent increase in the relative productivity of tradable sector will result in the 9.63 percent depreciation of the real exchange rate. Where, the short run adjustment parameters are also verifying the long run relationship of the RPROD and RER.

These results are opposite to the results of Egert (2002) which found the strong relationship between relative productivities and relative prices while there was a weak relationship between relative prices and RER of transition economies. But, the results are in favour of Chowdhury (2007) which estimated the BS effect for SAARC countries. On the failure of HBS model, Lafrance and Schembri (2000) said that

> *"Because both the exchange rate and relative productivity depend on a large set of underlying factors, it is highly unlikely that a simple causal relationship between the two variables exists and can be easily detected from the data".*

According to De Gregorio and Wolf (1994), in the time series regressions, it is highly difficult to find a role for supply side effects on the real exchange rate. Therefore, to incorporate the role for relative productivity level one must include demand shocks like government spending. Due to the underlying reasons, it is worthy to estimate an '***Unrestricted model***', which incorporates not only the productivity shocks but also some demand side factors.

5.4. Results of the Unrestricted Model

The long run relationship of the variables is being analysed, again, through the Trace and Max-Eigen statistics.

Table 9

Results of the Co-integrating Rank for Unrestricted Model

Null hypothesis		r = 0	r ≤ 1	r ≤ 2	r ≤ 3	r ≤ 4	r ≤ 5	Rank
Penn Effect	Trace	166.19*	100.461*	50.078	31.299	14.955	3.653	2
	Max-Eigen	65.730*	50.383*	18.778	16.344	11.302	3.653	2
Indirect Effect	Trace	143.01*	87.134	55.167	33.511	15.468	7.203	1
	Max-Eigen	55.869*	31.967	21.656	18.042	8.265	7.203	1
BS Effect	Trace	112.64*	67.686	38.315	18.388	6.441	1.250	1
	Max-Eigen	44.962*	29.371	19.926	11.947	5.1909	1.250	1

Note: *, ** are significant at 1 percent and 5 percent level of significance, respectively.

Results in Table 9 show that there exists a long run relationship between the components of the 'unrestricted model'. As, there are two co-integrating equations in the 'Penn effect' and one in the vectors of 'Indirect effect' and 'BS effect', as well.

Short-run and Long-run Coefficients of Unrestricted Model

The first part of the Table 10, which belongs to the long run co-integrating coefficients of the 'Penn effect', is representing that all the explanatory variables are having significant and positive relationship with relative prices except for the M2 and

TOT. Which is imposing negative impact on relative prices as one percent increase in the M2 will result in the 0.51 percent decrease in the relative prices of non-tradable sector and one percent increase in the TOT will result in the 0.53 decrease in the non-tradable prices. However, the coefficient of relative productivities is fulfilling the requirement of the HBS hypothesis by representing significant and positive impact of relative productivities on relative prices.

Table 10

Results of the Long-run and Short-run Coefficients for Unrestricted Model

Penn – Effect						
Variables	lnRPRCS	lnRPROD	lnGEX	lnTOT	lnM2	lnWP
Long run	1.0000	0.242141	0.412320	–0.539869	-0.516061	0.227453
		(2.593)**	(4.19010)*	(3.92882)*	(6.36728)*	(4.20560)*
Short run	–0.01535	0.523398	0.142836	–0.207035	–0.322628	–0.120785
	(0.2935)	(2.065) **	(0.62885)	(0.89074)	(5.61812)*	(0.18969)
Indirect Effect						
Variables	**lnRER**	**lnRPRCS**	**lnGEX**	**lnTOT**	**lnM2**	**lnWP**
Long run	1.0000	–5.523992	–1.574547	1.331372	1.436149	–0.241788
		(5.57376)*	(2.5874)**	(1.716)***	(3.05306)*	(0.77756)
Short run	0.103398	–0.051485	0.000672	0.017576	0.017135	–0.139697
	(5.1690)*	(4.91848) *	(0.02572)	(0.63525)	(1.42719)	(1.846)***
BS Effect						
Variables	**lnRER**	**lnRPROD**	**lnGEX**	**lnTOT**	**lnM2**	**lnWP**
Long run	1.0000	–0.695969	–1.833554	–1.584440	2.294959	–1.387244
		(2.4231)**	(6.19980)	(4.4188) *	(10.1129) *	(9.4339) *
Short run	0.119828	0.087714	–0.131382	0.092398	0.005605	–0.720870
	(1.7826)	(0.98304)	(2.00615) *	(1.33365)	(0.17988)	(4.3441) *

Note: Values in the parentheses are the t-values. '*, **, ***' are significant at1 percent, 5 percent and 10 percent level of significance, respectively.

If the above results are compared with the results of the restricted model, then it is evident that due to the inclusion of the relevant explanatory variables the relative productivity now has a positive relationship with relative prices, as one percent increase in the relative productivity will be resulted in the appreciation of relative prices in Pakistan by 0.24 percent. GEX is representing that government is spending more on the services, due to which prices of services is increasing by 0.41 percent. WP is capturing the effect of exogenous shock, which is another cause of the positive reception of the relative services prices in Pakistan.

The short run adjustment parameters are showing that, if there is any disequilibrium in the relative prices then, M2 will help to mitigate this disequilibrium. Where, adjustment will take place by 0.32 percent in one time (or year).

The second part of the Table 5.6 contains the results of the 'Indirect effect'. Where, RPRCS and GEX are the sources for the appreciation of the RER. As one percent increase in the RPRCS, RER will appreciate by 5.52 and due to the GEX, RER will appreciate by 1.57 percent. On the other hand, TOT and M2 are depreciating the RER by 1.33 and 1.43 percent, respectively.

The adjustment coefficients are representing that RPRCS and WP will adjust in the short run to come back the RER on its equilibrium. However, the adjustment coefficients are very low, indicating a long run equilibrium process.

The third and the last part of the Table 5.6 is about the BS effect that is the direct relationship of the RPROD and RER in the presence of the macroeconomic fundamentals. This says that one percent increase in the relative productivity will appreciate the RER by 0.69 percent. This estimated B-S effect is also comparable with the coefficient estimated for developing countries. Choudhri and Khan (2005) estimated the B-S coefficient for developing countries, incorporating terms of trade and productivity difference as explanatory variables, between 0.9 and 1.2. For the GEX and WP, it is evident that both the variables are contributing significantly for the appreciation of the RER in Pakistan and signs and magnitudes are according to the theory. M2 is the variable, which is depicting that due to the increase in the money supply RER will depreciate by 2.29 percent. On the other hand, TOT is appreciating the RER of Pakistan by 1.58 percent.

6. CONCLUSION AND POLICY IMPLICATION

The issues of HBS and PPP are addressed a lot of time for the developed, transition, OECD and developing countries. However, due to the different data ranges, methodologies, explanatory variables and the use of the proxies, the different results have been emerged. Some are in favour of PPP for the real exchange rate determination while others are favouring HBS or its extended form.

Taking into account for the issues in literature related to PPP and HBS, both of the theories are re-examined in this study for Pakistan by employing VAR based Johenson Co-integration method, for the period of 1972-2008. Where, the PPP theory does not hold for Pakistan because there is no long run cointegtaing relation between prices and nominal exchange rate. Furthermore, the non-stationarity of the real exchange rate tested by the Augmented Dickey Fuller test is also verifying the divergence of the exchange rate from its long run equilibrium of PPP.

On the other hand, the stationarity of the exchange rate based on the tradable sector's prices is indicating that there is the greater chance of the existence of the HBS in Pakistan. However, the results of the HBS are also not in the favour of the productivity-biased explanation of the higher prices in Pakistan, as there is significant relationship between relative tradable goods' productivity and relative non-traded goods prices but the sign is not positive. However, the relationship between relative non-traded sector prices and relative exchange rate is much stronger following that real exchange rate is appreciating due to the increase in the non-traded goods prices. That is signaling for the presence of some other explanatory variables, along with the productivity-bias for the exchange rate determination.

Therefore, the extended HBS model is estimated based on various macroeconomic fundamentals suggested in economic literature. Now, the results are in favour of HBS, where, in one-step approach, relative productivity, government consumption expenditures, terms of trade and world oil prices are significantly contributing in the appreciation of real exchange rate in Pakistan, while money supply is a significant source for the depreciation of RER. Furthermore, the elasticity of the relative productivity is also in line with the theory. So, money supply is the best rule to decrease the relative non-traded prices and for the depreciation of real exchange rate. In other words, there must be some role of the central bank to reduce the fluctuations of the RER.

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