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Testing the Productivity Bias Hypothesis in Middle East Countries

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Abstract

Divergence of the purchasing power parity from the equilibrium exchange rate is attributed to various factors. Productivity differentials between the countries are said to be one of the main sources, which lead to productivity bias hypothesis. The hypothesis suggests that a relatively more productive country should experience a real appreciation of its currency.
This research aims at testing the hypothesis in Middle East countries using the time series data over the period of 1970-2015 and by employing ARDL approach to cointegration. The econometric results support the hypothesis is only in the case of Bahrain, Kuwait and Saudi Arabia. This research also provides policy recommendations on the basis of empirical results.

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1. Introduction

The Purchasing Power Parity (PPP) is the oldest theory of exchange rate determination which asserts that exchange rate between currencies of two countries is equal to the ratio of the general price level of the said countries. The validity of the PPP has been tested empirically many times and the results are not conclusive, as discussed in Bahmani-Oskooee and Nasir (2005). Divergence of the PPP from the equilibrium exchange rate is attributed to various factors. Productivity differentials between the countries are said to be one of the main sources, which lead to productivity bias hypothesis (PBH).

The PBH, which is also known as Balassa-Samuelson Hypothesis (BSH), simply suggests the appreciation of a currency in a relatively productive country. According to this hypothesis, a country with high productivity growth also experiences high wage growth, which causes a rise in prices and consequently, the real exchange rate appreciates. The origin of the hypothesis lies in the seminal works of Balassa (1964) and Samuelson (1964), where both authors independently observed that differentials of productivity growth lead to real exchange rate appreciations. Balassa (1964) advocated that due to the higher level of productivity in production of tradable goods relative to non-tradable goods (services), the exchange rate will be overvalued in terms of PPP in countries with relatively high production of tradable goods. Prices of non-tradable goods or services will be greater in countries with a higher level of productivity because of the relatively low level of productivity in the service sector. The larger gap between relative productivity gives rise to a greater gap between prices and as a consequence, deviations take place between PPPs leading to currency overvaluation. It is also noted that a more productive country is supposed to have higher standards of living, which causes higher prices of consumed goods and services. As a result, the increasing gap between prices leads to an appreciation of the more productive country's currency. Samuelson (1964) also argued that productivity differentials were a main contributing factor of overvaluation of the US dollar in the 1960s. Since then, many studies have been conducted in an attempt to test the hypothesis.

This study aims to fill empirically the gap in the literature for the Middle East countries by employing time series data and ARDL approach to cointegration. As far as this study is concerned, the PBH has not been exclusively tested in the case of the Middle East countries. This paper is motivated further that the underlining cause of the real appreciation should be understood in depth so that the exchange rate policy can be designed accordingly. Section 2 presents a brief review of the literature. Section 3 outlines the econometric methodology. Section 4 reports the econometric results. Section 5 concludes.

2. A Brief Literature Review

Officer (1976) and Bahmani-Oskooee and Nasir (2005) present comprehensive reviews of empirical studies on the PBH. Officer (1976) investigated operational impact and theoretical underpinning testing the hypothesis, providing examples from the literature. He criticized the general theoretical acceptance of the hypothesis due to the lack of firm empirical evidence. Moreover, he argued that the reason that lies behind the failure to support the hypothesis in the literature is the disregard for quality difference of non-tradable goods among countries. The study of Bahmani-Oskooee and Nasir (2005) conducts the most comprehensive review of the PBH, which categorized empirical studies on the hypothesis into three groups: cross-sectional studies, time series studies and panel studies. Bahmani-Oskooee and Nasir (2005) points out that, by and large, the cross-sectional studies fail to support the hypothesis, while most of studies of the second and third categories are in favour of the hypothesis.

Cross-Sectional Studies

Balassa (1964), who was the first to empirically test the hypothesis, found significant results by comparing ratios of PPPs to exchange rates based on 12 countries from the Organization for Economic Co-operation and Development (OECD). However, De Vries (1968) rejected the hypothesis using the sample of 64 countries. Using the data of 12 OECD and 19 Latin American countries, the study of Clauge and Tanzi (1972) did not find support for the hypothesis. Officer (1976)

presented a new specification using the productivity differentials on a sample of 15 industrial countries and revealed significant results for the hypothesis. Clauge (1988) used the sector-specific model to evaluate the hypothesis for 19 Latin American countries and the results were in favour of it. Falvey and Gemmell (1991) extended the sector –specific models to general equilibrium framework and presented an empirical evidence for the hypothesis. The study of Bahmani-Oskoee and Niraoomand (1996), which adopted the same model as Officer (1976), failed to support the hypothesis. Bahmani-Oskooee and Nasir (2001) tested the hypothesis by pooling cross-sectional data from 68 countries over the 1960-1990 period and the results supported it.

Time Series Studies

Hsieh (1982), using the OLS (Ordinary Least Squares), displayed the first time series evidence for the hypothesis. The studies of Rogoff (1992) and Bahmani-Oskooee (1992), which both employed Engle-Granger (1987) cointegration approach, are particularly notable considering the time series properties of the variables and providing significant results for the hypothesis. Strauss (1995) employed the Johansen and Juselius multivariate cointegration approach for 14 OECD countries and lent support for the hypothesis. Using ARDL approach to cointegration to a data set of 44 countries, Bahmani-Oskooee and Nasir (2004) extended the validity of the hypothesis for 32 countries. In the last two decades, a number of time series studies presented significant empirical results for the hypothesis; see for example DeLoach (2001), Egert (2002), Bahmani-Oskooee and Gelan (2006), Drine and Rault (2008), Garcia-Solanes *et al*. (2008), Chowdhury (2011, 2012), Apergis (2013), Anwar and Ali (2015), Cardi and Restout (2015) and Wang *et al*. (2016).

Panel Studies

The first panel study on the PBH was conducted by Asea and Mendoza (1994), which used the data set of 14 OECD countries over the period of 1970-1985. The research of Asea and Mendoza (1994) used different categories of dependent and independent variables and revealed significant results for the hypothesis. The panel study of Chinn (2000), which consisted of 9 Asian-Pacific countries, supported the hypothesis. Egert *et al*. (2003) investigated the hypothesis by pooling quarterly data

over the period 1995-2000 from 9 transitional countries of Central and European countries and presented significant results for the hypothesis. Bahmani-Oskooee and Miteza (2004) applied the panel cointegration approach of Pedroni for the data of 61 countries and found support for the hypothesis for the entire panel, as well as sub-groups of countries. Genius and Tzouvelekas (2008) allowed country specific estimations in a panel study for 59 industrialized and developing countries and refuted the hypothesis in the case of most African and Latin American countries but supported it in the majority of the developed countries. Irandoust (2017) employed panel VAR cointegration technique to 8 trading partners of New Zealand, concluding it with significant results. The research of Iyke and Odhiambo (2017) implemented the GMM (Generalized Method of Moments) technique in search of validating the hypothesis for 8 middle-income countries in Africa over the period 1960-2009 and extended its support for the hypothesis.

It is evident that empirical results may vary with the econometric techniques, data quality, model specification and data span.

3. Model and Econometric Methodology

This study adopts the model of Officer (1976), hence we form the following long-run relationship between real exchange rates and productivity differentials, in double logarithmic linear form as:

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

where RER_t is real exchange rates, expressed as $(P_i / P_{US})EX$ in which $P_i(P_{US})$ is the price level in country i(US). EX is the equilibrium exchange rates defined as number of i's currency per unit of dollar. $PROD_t$ refers to the productivity differentials defined as $PROD_i / PROD_{US}$. Thus, the productivity of country in i is $PROD_i$ and $PROD_{US}$ is the productivity in US. ε_t is the classical error term. t stands for time period. Equation (1) postulates that if a more productive country is to experience a real appreciation of its currency in the long-run, it is expected that the slope parameter, a_1 should be positive.

The long-run relation in Eq. (1) should incorporate the short-run dynamic adjustment process in order to provide insights of adjustments between time periods. To this extent, Engle-Granger (1987) cointegration approach can be utilized in the first instance. Then, Eq. (1) becomes as follows:

$$\Delta RER_{t,j} = b_0 + \sum_{i=1}^{p} b_{1i}\Delta RER_{t-i} + \sum_{i=0}^{q} b_{2i}\Delta PROD_{t-i} + \gamma\varepsilon_{t-1} + \mu_t \qquad (2)$$

where Δ represents change, γ is the speed of adjustment parameter and ε_{t-1} is the one period lagged error correction term, which is estimated from the residuals of Eq. (1). The Engle-Granger cointegration method requires all variables in Eq. (1) are integrated of order one, $I(1)$ and the error term is integrated order of zero, $I(0)$ for establishing a cointegration relationship. This strict condition of the order of integration seems difficult to be fulfilled in many time series data. Therefore, an alternative and powerful single cointegration technique was proposed by Pesaran *et al.* (2001) which is also known as autoregressive-distributed lag (ARDL). Pesaran *et al.* (2001) approach combines Engle-Granger (1987) two steps into one by replacing ε_{t-1} in Eq. (2) with its equivalent from Eq. (1). ε_{t-1} is substituted by linear combination of the lagged variables as in Eq. (3).

$$\Delta RER_{t,j} = c_0 + \sum_{i=1}^{m1} c_{1i}\Delta RER_{t-i} + \sum_{i=0}^{m2} c_{2i}\Delta PROD_{t-i} + c_3 RER_{t-1} + c_4 PROD_{t-1} + v_t \qquad (3)$$

To obtain Eq. (3), one has to solve Eq. (1) for ε_t and lag the solution equation by one period. Then this solution is substituted for ε_{t-1} in Eq. (2) to arrive at Eq. (3). Eq. (3) is a representation of the ARDL approach to cointegration[1].

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[1] Different applications of the ARDL approach to cointegration can be found in the following studies: Bahmani *et al.* (2017), Bahmani *et al.* (2016), Uslu, *et al.* (2016), Halicioglu and Ketenci (2016), Durmaz (2015), Tayebi (2014), Halicioglu and Karatas (2013), Halicioglu (2013), Pattichis (2012), Catik *et al.* (2011), Andres and Halicioglu (2011), Dell'Anno and Halicioglu (2010), Halicioglu (2007).

Eq. (3) is estimated using an appropriate lag selection criterion after a long-run relationship has been established. At the second step of the ARDL cointegration procedure, the ARDL approach to cointegration also provides the error correction representation model (ECM) of Eq. (1) which presents the speed of adjustment between the dependent variable and independent variables. In order to obtain the ECM representation, the lagged level variables in Eq. (3) are replaced by EC_{t-1} as in Eq. (4):

$$\Delta RER_{t,j} = d_0 + \sum_{i=1}^{n1} d_{1i} \Delta RER_{t-i} + \sum_{i=0}^{n2} d_{2i} \Delta PROD_{t-i} + \lambda EC_{t-1} + \omega_t \tag{4}$$

A negative and statistically significant estimation of λ not only represents the speed of adjustment but also provides an alternative means of supporting cointegration between the variables.

Pesaran *et al.* (2001) cointegration approach has some methodological advantages in comparison to other single cointegration procedures such as: the ARDL approach to cointegration tests the existence of a long-run relationship between the variables regardless of whether the underlying regressors are purely stationary $I(0)$, purely non-stationary $I(1)$, or mutually cointegrated and the small sample properties of the bounds testing approach are far superior to that of multivariate cointegration, as proved in Narayan (2005).

The ARDL cointegration approach involves two steps for estimating the long run relationship. The bounds testing procedure is based on a Wald type (F-statistics) which is also the first step of the ARDL cointegration method. Accordingly, a joint significance test that implies no cointegration under the null hypothesis, (H$_0$: $c_3 = c_4 = 0$), against the alternative hypothesis, (H$_1$: at least one c_3 to $c_4 \neq 0$) should be performed for Eq. (3). The F test used for this procedure has a non-standard distribution. Thus, Pesaran *et al.* (2001) computed two sets of asymptotic critical values for testing cointegration for a given significance level with and without a time trend. One set assumes that all variables are $I(0)$ and the other set assumes that they

are all *I*(1). If the computed F-statistic exceeds the upper bound critical value, then the null hypothesis of no cointegration can be rejected. Conversely, if the F-statistic falls below the lower bound critical value, the null hypothesis cannot be rejected. Lastly, if the F-statistic falls between these two sets of critical values, the result is inconclusive.

W- testing procedures in the Pesaran *et al*. (2001) approach are considered to be pre-testing for cointegration. Moreover, this stage of testing is very sensitive to lag selection criterion and lag lengths. As a consequence, it is quite likely that the establishment of a cointegration relationship may fail due to wrong selection criterion or selected lag length. To overcome this possible shortcoming, we follow Kremers *et al*. (1992) and Banerjee *et al*. (1998) who proved that a negative and significant EC_{t-1} could be used as an alternative evidence of cointegration if the Engle-Granger (1987) approach fails to establish a cointegration relationship among the variables. Therefore, this study will also utilize the results from the error correction model to establish the existence of cointegration should the pre-testing stage of Pesaran *et al.* (2001) fail to do so.

4. Empirical Results

Eq. (3) was estimated for 17 Middle East countries using selected annual data over the period 1970-2015. The data period for each country along with variable definitions and data sources are presented in Appendix.

Unit root testing from different procedures and graphical inspections of the variables prove that the variables in econometric estimations are all stationary either in level or first differenced forms[2]. In order to present the sensitivity of the lag length selection for the F-testing procedure, an initial lag of 2 was imposed on each differenced variable in Eq. (3). Then, the lag length of 3 and 4 were also examined on the differenced variables using AIC (Akaike Information Criterion) to select the optimum number of lags. The results from the bounds F-test are reported

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[2] The results of unit root tests are available on request.

in Table 1. Table 1 demonstrates that F-statistics are indeed sensitive to the selected lag length. However, there is no consistent pattern in the statistics since they seem to go in either direction of increase or decrease. The results in Table 1 display that the calculated F statistic is greater than its upper bound critical value only in the case of Bahrain, Oman, Qatar, and Saudi Arabia. In other cases, where the F statistic reject cointegration, a negative and significant EC_{t-1} is considered to be an alternative way of supporting cointegration. As far as the latter approach suggests, there exists evidence of cointegration in the case of Egypt, Kuwait, UAE, and Yemen. However, in the latter case, the slope estimates of Egypt, UAE and Yemen appear to be negative, indicating that the PBH does not hold for them. In the case of Kuwait, it is seen that the estimated slope coefficient is statistically significant and is greater than zero which validates the PBH.

[Insert Table 1 About Here]

Table 1. Empirical Results of the ARDL Approach

	F-statistic			t-ratio	Coefficient estimate	
	2 lags	3 lags	4 lags	for EC_{t-1}	of slope parameter	
Algeria	3.30	3.56	3.18	2.52	1.61	(6.41)*
Bahrain	9.70**	5.25	2.49	4.06**	0.73	(4.67)*
Egypt	4.48	4.37	4.34	3.02**	-0.57	(0.94)
Iran	2.63	2.60	2.50	2.24	0.75	(0.83)
Iraq	1.25	1.21	1.17	1.45	7.28	(0.73)
Jordan	3.29	1.54	1.52	1.82	0.16	(0.48)*
Kuwait	6.09	3.53	2.75	3.36**	0.08	(1.94)***
Lebanon	0.64	1.13	2.19	0.90	-8.69	(0.43)
Morocco	2.01	2.20	2.44	2.09	0.05	(0.03)
Oman	35.8*	13.1*	6.03	8.06*	-0.33	(1.26)
Qatar	36.5*	20.4*	8.58**	1.96	0.35	(1.25)
Saudi Arabia	22.8*	20.5*	13.9*	6.76*	0.64	(14.4)*
Syria	2.71	2.76	3.70	2.34	-2.51	(4.07)*
Tunisia	5.35	4.68	3.55	1.88	-6.32	(1.94)***
Turkey	1.33	1.86	2.81	1.70	2.22	(1.20)
UAE	30.1*	41.7*	65.7*	7.54*	-0.21	(3.28)**
Yemen	2.60	3.01	5.43	2.99***	-1.05	(1.25)

Notes:

a. *, ** and *** indicate, 1%, 5% and 10% statistical significance levels, respectively. t-ratios for coefficient estimate of slope parameter are presented in parentheses.

b. The upper bound critical value of the F-test for cointegration when there is one exogenous variable is 9.78, 7.42 and 6.33 at the 1%, 5% and level of statistical significance levels, respectively. These come from Pesaran *et al*. (2001, Table CI, Case III, p. 300).

c. The critical value for significance of ECM$_{t-1}$ with one explanatory variable is -3.94, -3.28 and -2.93 at the 1%, 5% and 10% statistical significance levels, respectively. These come from Benarjee *et al*. (1998, Table I, with sample size less than 50. p. 276).

Regarding the results of the ARDL approach to cointegration, the long-run slope estimates of Bahrain and Saudi Arabia are positive and statistically significant, suggesting the existence of the PBH. However, the slope estimates of Oman and Qatar are statistically insignificant, indicating that we cannot draw any statistical inferences on these countries. Hence, we eliminate these countries from further analysis. These results demonstrate that there is only partial support of the hypothesis in the Middle East countries since only 3 out of 17 estimates display statistically significant and positive values of the long-run slope parameters. Within

these three countries, the impact of the PHB is the strongest in the case of Bahrain, showing that 1% rise in the relative productivity leads to 0.73% appreciation in real exchange rates.

Table 2 presents the order of ARDL procedures, value of lagged error correction terms, some standard regression diagnostics such as autocorrelation, functional form, heteroscedasticity, normality and summary results of the overall residual stability tests.

It appears from the results in Table 2 that the diagnostic tests of Bahrain, Kuwait, and Saudi Arabia are also statistically satisfactory which support the reliability of the econometric results. Regarding the lagged error correction terms with significant PBH in Table 2, Saudi Arabia has the highest lagged error-correction term of -0.24 which suggests that any disequilibrium between the currencies of USA and Saudi Arabia will be eliminated within around four years.

[Insert Table 2 About Here]

Table 2. Diagnostics of the Empirical Estimations

	Order of ARDL	EC_{t-1}	F-stat.	$\bar{R}^2$	χ^2_{SC}	χ^2_{FF}	χ^2_N	χ^2_H	CUSM	CUSM²
Algeria	(1,0)	-0.22	3.29	0.09	1.19	4.72	92.1	92.1	S	S
Bahrain	(2,1)	-0.10	34.1	0.69	1.12	1.27	2.80	5.61	S	NS
Egypt	(2,0)	-0.23	5.28	0.22	0.22	2.02	28.9	0.75	S	NS
Iran	(1,0)	-0.21	2.61	0.07	0.53	3.62	515.0	7.40	S	NS
Iraq	(1,0)	-0.11	1.59	0.02	0.05	3.14	247.0	0.91	S	NS
Jordan	(2,1)	-0.13	8.32	0.32	0.15	2.32	2.48	0.13	NS	S
Kuwait	(2,1)	-0.19	8.48	0.33	2.17	2.67	2.38	0.52	S	S
Lebanon	(4,1)	-0.02	4.31	0.27	1.08	6.49	16.75	3.70	S	NS
Morocco	(2,0)	-0.12	3.35	0.14	0.09	3.24	0.24	0.33	S	S
Oman	(1,2)	-0.31	25.9	0.63	1.66	0.03	38.2	0.06	S	NS
Qatar	(1,0)	-0.09	8.82	0.27	0.31	0.18	26.2	0.34	S	S
Saudi Arabia	(2,1)	-0.24	76.6	0.84	2.08	1.72	0.90	8.51	S	S
Syria	(2,1)	-0.24	6.07	0.25	0.05	4.64	176.8	0.56	S	NS
Tunisia	(1,0)	-0.07	4.53	0.14	0.17	0.26	1.54	0.96	S	S
Turkey	(2,4)	-0.09	6.97	0.45	0.01	0.19	0.27	1.05	S	S
UAE	(2,0)	-0.30	40.6	0.73	6.10	15.9	142.3	7.25	S	NS
Yemen	(2,0)	-0.28	4.90	0.35	8.67	5.81	31.0	10.1	NS	NS

Notes:

a. *, ** and *** indicate, 1%, 5% and 10% statistical significance levels, respectively.

b. χ^2_{SC}, χ^2_{FF}, χ^2_N, and χ^2_H are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity, respectively. These statistics are distributed as chi-squared variates with degrees of freedom in parentheses. The critical values for $\chi^2(1) = 3.84$ and $\chi^2(2) = 5.99$ at 5% significance level.

c. CUSM stands for cumulative sums of recursive residuals and CUSM² stands for cumulative sum of squares of recursive residuals of Brown *et al*. (1975). S indicates stability and NS indicates instability.

5. Concluding Remarks

The PPP hypothesis holds providing that none of the assumptions behind it is being violated. However, in the literature, the productivity differentials between the countries have been identified as one major factor for the deviations of the equilibrium exchange rates which gave rise to the PBH. The PBH suggests that there exists a positive association between exchange rates and productivity differentials implying that higher productivity causes a real appreciation of a country's currency.

This research tested the validity of the PBH for 17 Middle East countries using the ARDL approach to cointegration. The econometric results from this research reveal that the PBH is being validated in the case of only 3 Middle East countries, namely Bahrain, Kuwait and Saudi Arabia.

We suspect the failure of the PBH in the rest of Middle East countries may be attributed to some macroeconomics factors such as the impact of globalization and free trade movements that many developing countries have been experiencing, in addition to the consequences of various government policies in the form trade, exchange rate and development, which have not been included in our study.

As far as the policy recommendations are concerned, it is crystal clear that the countries should develop economic policies that would lead to a rise in productivity, especially in the sectors of tradable and non-tradable goods in order to gain international competitive advantage in real exchange rates in the long-run. Those policies should be very comprehensive and sustainable so that the gains from them would last for a long time. Macroeconomic policies aiming at increasing productivity may range from different simple tax incentives to sophisticated education of labour force. To this end, for example, the quality of labour in the sector of tradable goods plays a crucial role for raising international competitiveness. Improving the labour quality with education will also increase the productivity of this production factor. Similarly, research and development expenditures may be utilized specifically to increase the productivity of production factors of capital and technology.

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Appendix

Data Sources and Variable Definitions

All data come from World Development Indicators of the World Bank (WB).

Annual data span (1970-2015) is used for all countries apart from Yemen (1990-2015).

Variables

RER is the natural logarithm of real exchange rate which is defined as $RER = ((P_i / P_{US}) \times EX)$ in which nominator and denominator are represented by home country's and US's Consumer Price Indexes (CPI) and EX is nominal exchange rate, which is defined amount of dollars per country *i*'s currency. Source: WB

PROD is the ratio of $PROD_i / PROD_{US}$ refers to the natural logarithm of productivity differentials between home country and USA. Productivity is measured by *per capita* which is defined as the ratio of real GDP over total employment for home country and USA, respectively. Source: WBI.