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REAL EXCHANGE RATE MOVEMENTS OF DEVELOPING COUNTRIES: A PANEL DATA ANALYSIS OF BALASSA-SAMUELSON THEOREM

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ABSTRACT

In the theoretical literature, the factor that has received the most attention in explaining real exchange rate movements is the productivity bias mentioned in the Balassa- Samuelson theorem. The basic proposition of the Balassa – Samuelson (1964) theorem is that if one country's growth of productivity of the tradable sector relative to non-tradable sector is higher than that of the other, then the former will be experiencing a real exchange rate appreciation. This paper has attempted to have an empirical investigation of the Balassa-Samuelson theorem for a group of twelve developing countries for fifteen years. The panel data analysis has found a significant relationship between productivity growth differential and percentage change in real exchange rate movements but exactly in the opposite direction predicted by Balassa-Samuelson theorem.

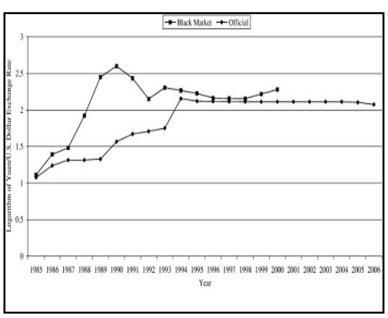
"Foreign trade and currency exchange rates provide a vivid example of the rule - the theory is beautiful, but reality is baffling."

Milton Friedman on Free Trade

KEY WORD: *Real Exchange Rate, Productivity Differential, Panel data.*
JEL Classification: F31, F37, F42, C23

INTRODUCTION

Exchange rate economics is one of the most researched topics of Economics. With the development of world financial market and introduction of exogenous international capital flows international research in this field has increased phenomenally. However, not much success has been achieved in unravelling the determinants of exchange rate movements. The renowned economists of this field at times have expressed their difficulties in successfully explaining the movements in the exchange rates (Dornbush 1987, MacDonald and Taylor, 1992, Harvey 1996). This problem is even acute for developing countries. The empirical testing of the theoretical models came up with such unsound results that on many occasions the mainstream economists have readily admitted their disappointment (MacDonald and Taylor, 1992).



The major factor, which affects the real exchange rate, the factor that has received the most attention in theoretical literature, is the productivity bias as mentioned in the Balassa- Samuelson theorem. The basic proposition of the Balassa – Samuelson (1964) theorem is that if one country's growth of productivity of the tradable sector relative to non-tradable sector is higher than that of the other, then the former will be experiencing a real exchange rate appreciation. This is mainly a supply side argument and while it is a long known explanation, in recent years it has undergone some revival of interest. Although many others had perceived the existence of such a productivity bias, Balassa in 1964 provided the most persuasive analytical argument for this bias.

This paper will attempt to have an empirical investigation of the Balassa-Samuelson theorem for a group of developing countries. This paper will have five sections. The first section discusses the arguments of Balassa and Samuelson that explain how the real productivity bias between countries will be a driving factor in determining the real exchange rate movements of the countries. In Section II, we will have the mathematical exposition of the Balassa-Samuelson theory. The third section describes the various other empirical studies on this theory and their results. In the fourth section, we discuss the methodology to be used in the empirical study of this paper and the description of the data. In Section V we describe our econometric model, mention the econometric results and analyse the results. This section also includes a critical analysis on the success of the Balassa-Samuelson theory in the context of the results obtained in this study.

SECTION I - BALASSA-SAMUELSON THEOREM

The basic proposition of the Balassa – Samuelson (1964) theorem is that if one country's growth of productivity of the tradable sector relative to non-tradable sector is higher than that of the other, then the former will be experiencing a real exchange rate appreciation. A very related prediction of the Balassa-Samuelson theorem is that the faster growing countries will experience real exchange rate appreciation relative to slow growing countries because it is assumed that the country experiencing higher rate of growth is due to higher rate of growth of its tradable sector as the rate of growth of the non-tradable sector is always very low.

The argument goes in the following way.

Assumptions

1. Prices of tradables are equalised across the countries.
2. Money wage rate in a country is determined only by the productivity of the tradable sector.
3. Productivity grows faster in the tradable sector than in the non-tradable sector.
4. Production in both traded and non-traded sector operates under constant return to scale using capital and labour.
5. Capital is highly mobile across sectors and across countries and real interest parity holds.

When a country's income grows faster than its trading partner, it implies that the country with higher income growth is becoming more productive than its partner. Now productivity is not uniform over all the industries. It is assumed that productivity growth in the non-tradable sector (Balassa 1964, has taken services as non-tradable) is very low in all the countries. So it is the productivity growth of the tradable sector of the country over its trading partners, which is driving the higher increase in the per capita income than its trading partners.

In the Balassa – Samuelson (1964) model, it is also assumed that wage rate is actually determined by the productivity of the tradable sector. Now, as productivity in the tradable sector increases, money wage of this sector should increase at least in proportion to the increase in productivity and the prices of the tradable sector will be the same as international price levels. With the increase in money wage in the tradable sector, wage in the non-tradable sector will also increase given the complete mobility of labour and capital. Productivity increase in the non-tradable sector being very low, prices of non-tradables will increase. As the price index consists of both tradables and non tradables, even though non tradables do not enter into international trade, the higher increase in the prices of non tradables in the economy with more rapidly growing per capita income would ensure that the inflation rate in the economy would be higher. Therefore, the country with higher growth rate will experience the real exchange rate appreciation relative to its trading partners. Thus the real exchange rate will be determined strictly by supply side factors and the key relevant factor is the growth in productivity. (Theoretically, productivity implies total factor productivity. But while using empirical examples, Balassa has used labour productivity as a proxy for total productivity as no data for total factor productivity are available).

This paper would like to make an econometric investigation of the validity of the Balassa-Samuelson theorem in explaining the real exchange rate movements of the group of 12 developing countries of our sample for the period 1982-2014. A more comprehensive study consisting of larger numbers of developing countries is not possible owing to serious non-availability of data required to have the desired empirical investigation of the Balassa-Samuelson theorem.

SECTION II - MATHEMATICAL EXPOSITION OF THE THEORY

It is interesting to see the argument more rigorously through a mathematical model. Let us assume that the supply of labour is fixed and it is the only input of production. The production function exhibits constant returns to scale. The average product of labour in traded and non-traded goods sectors are denoted by A_T and A_N respectively. The nominal wage rate W is measured in the local currency. The nominal wage is actually determined in traded goods sector and it prevails over the economy, as labour is mobile between sectors at home. We are also assuming that the nominal exchange rate is determined by the purchasing power parity of tradables. The variable with a star indicates corresponding value in foreign country. With the assumption of perfect competition,

$P_T = (W/A_T)$, $P_N = (w/A_N)$, $P_T^* = W^*/A_T^*$, $P_N^* = W^*/A_N^*$

These figures are in terms of local currency.
Now as we have assumed that purchasing power parity holds, then

$E = \frac{P_T^*}{P_T}$, and from here we can say that $\log E = \log P_T^* - \log P_T$, where E is the domestic currency per unit of dollar i.e. like Rs/$.

Suppose that the price indices of both the countries are as follows:
P = Prices in domestic economy in domestic currency
P* = Prices in foreign country in foreign currency

Let $P = [P_T]^{1-\alpha} [P_N]^{\alpha}$ $0 < \alpha < 1$ eq(1)

$P^* = [P^*_T]^{1-\beta} [P^*_N]^{\beta}$ $0 < \beta < 1$ eq(2)

Real exchange rate is defined as, R = E P*/P. Let, r = log(R)

Taking log of equation 1 and 2 we get

$r = \log(R) = \alpha [\log(A_T/A_N)] - \beta [\log(A^*_T/A^*_N)] + \log(E) + [\log(W/A_T) - \log(W^*/A^*_T)]$ eq(3)

As we have assumed that purchasing power parity holds,

$\log(E) = \log(W^*/A^*_T) - \log(W/A_T)$

$r = \log(R) = \alpha [\log(A_T/A_N)] - \beta [\log(A^*_T/A^*_N)] + [\log(E) + \log(W/A_T) - \log(W^*/A^*_T)]$

or, $r = \log(R) = \alpha [\log(A_T/A_N)] - \beta [\log(A^*_T/A^*_N)]$ eq(5)

If we assume further that people's preferences are same across the countries, *i.e.* the weight of tradables and non-tradables are same across the countries (*i.e.* $\alpha = \beta$), and purchasing power parity holds, then we get,

$$r = \log(R) = \alpha \log \left[\frac{A_T / A_N}{A^*_T / A^*_N} \right] \qquad \text{eq(6)}$$

If, $$\left[\frac{A_T / A_N}{A^*_T / A^*_N} \right] = A \qquad \text{eq(7)}$$

then, $$\frac{1}{R}\frac{dR}{dt} = \alpha \frac{1}{A}\frac{dA}{dt} \qquad \text{eq(8)}$$

Equations 6 and 8 express the main argument of Balassa and Samuelson, *i.e.* relative productivity growth of tradable sector to non-tradable sector between two countries is the determinant of real exchange rate change.

From the above equations we also see that it does not matter whether the exchange rate regime is fixed or flexible and that is why Balassa - Samuelson theory would hold irrespective of the exchange rate regime being followed.

SECTION III - SOME OTHER STUDIES

In the literature, the major empirical success that has been claimed in defence of the Balassa-Samuelson theorem relates to the yen dollar real exchange rate. The appreciation in this is explained by change in the relative productivity differential of the tradables compared to the non-tradables sector between these two countries[1]. Officer (1976b) made one of the most rigorous studies in 1976. He examined, through an econometric exercise, the empirical validity of the Balassa-Samuelson theorem and did not find any support for it. When he used (GDP/EMP_i)[2], as the explanatory variable he got insignificant results. And when he used tradable to non-tradable productivity $(PRODT/ PRODNT_i)$[3] instead of per capita real gross domestic product he found a significant result, exactly in the opposite direction of what Balassa had claimed. Kenneth Rogoff (1996) has undertaken a cross section study where he did not find any significant corroboration of the Balassa-Samuelson theorem. He however used per capita real gross domestic product of the sample countries with respect to USA. Froot and Rogoff (1991) did not find any significant effect for growth differential of tradable sectors across EMS countries for the years 1979-1990. Similar findings were obtained by Patrick Asea and Enrique Mendoza (1994) who applied a general equilibrium model to disaggregate sectoral data for 14 OECD countries over the year 1975- 1990. Their model incorporated adjustment costs to moving factors across

[1] Richard, c. Marston (1987) who put forward a model of the real yen-dollar rate using disaggregated OECD data found that sectoral productivity differential can quantitatively explain the trend in the yen, relative to dollar.

[2] GDP/EMP_i = ratio of GDP (at current process) per employed worker in country i to GDP (at current prices) per employed worker in the standard country, where the numerator is converted from domestic currency to the standard currency by means of the PPP between the two countries.

[3] $(PRODT/ PRODNT_i)$= ratio of "ratio of productivity in the traded sector of the economy of country i to productivity in the non-traded sector" to "ratio of productivity in the traded sector of the economy of the standard country to productivity in non-traded sector," where "productivity" is defined as GDP (at constant prices) originating in the sector per employed worker in the sector.

sectors. They found that sectoral differences in productivity growth helps to explain the trend rise in service prices within OECD countries, but have much less power in explaining real exchange rate movement. A study by Takatoshi Ito, Peter Isard and Steven Symansky (1997) in NBER also found no uniform support for the Balassa-Samuelson theory for the fast growing developing nations of South East Asia. David Heish(1982) found some evidence in favor of the Balassa- Samuelson model using time series data both for Germany and Japan, as did Obstfield (1993). According to Rogoff (1996) "Heish's result however may be somewhat sensitive to his inclusion of the real wage differential, which is closely correlated with the real exchange rate, as a right hand side variable". Sebastian Edwards (1989) for a sample of 12 developing countries for the period 1960-1985, did not find any result in favour of the Balassa-Samuelson theorem. So here we see that even though for developed countries in some cases there is some success for the Balassa-Samuelson theorem, the theorem is found to have no significant impact on real exchange rate movements of developing countries, though the number of studies are much less for developing countries. In any case, we have seen no significant success so far of the Balassa-Samuelson theorem in explaining the long run real exchange rate movements of the developing countries.

Section IV - Methodology and Data Description

The first step in this study is to calculate the real exchange rates for the selected countries in this study.

The real exchange rate (RER) for country i with respect to US is usually defined as below

$RER_i = R_i = (E) \times [WPI^{US}/CPI_i^{DOM}]$

where E is the annual average of nominal exchange rate. E represents units of domestic currency for per unit of dollar i.e. to say for India, E is Rs. per dollar. WPI is the whole sale price index in the US and is the proxy for the foreign price for the tradable and CPI is the consumer price index of country i and is considered as a proxy for the domestic price of non tradable.[4] For India, for instance, the time series of real exchange rate is calculated by taking, for each year, the nominal exchange rate (Rs/$) × WPI(US)/CPI(India). From our index, it is clear that increase in the real exchange rate (R) will actually indicate a depreciation of the domestic currency. In our real exchange rate construction, we have taken a certain year as our base year, and the year the real exchange rate is taken as hundred as 100 and with respect to this base year the whole series is constructed on this basis. The choice of this base year can be arbitrary, as it will not in any way affect the long run picture. However, in our study we have taken 1985=100 as the base year.

The data source of this real exchange rate construction is IFS (International Financial Statistics, published by The International Monetary Fund). All the data that are collected are annual data, i.e., the annual average of nominal exchange rate, CPI, WPI. In the case of WPI of the USA it is the producer price index, which is taken as the WPI.

For the purpose of this study, we will have to construct separate series for the productivity of tradable sectors as well as non-tradable sectors for both the developing countries of our sample and USA. Most studies that are available for developing countries have used per capita labour income or per capita income as the proxy for productivity, which is why it remains true that none of them made an exact test of the theorem except Officer (1976b). The major reason for taking per capita labour income or per capita income as a proxy for labour productivity is due to the non-availability of internationally comparable total factor productivity estimate or labour productivity estimate directly from any source. For an exact test, we need data for productivity of tradable and non- tradable sectors. As it is not possible to get total factor productivity data for developing countries we have used labour productivity as a proxy for total factor productivity. Obviously this is not an accurate measure of total factor productivity but in the absence of proper data, it is the nearest proxy that we can construct and this proxy has been used by many others also in their respective studies (Officer 1976, Chinn 1997). However we should first mention how we have

[4] For China we do not get long run data for CPI or WPI and therefore we have used GDP deflator in place of CPI.

defined "tradables" and "non-tradables". Most studies are done for the developed countries and consider only manufacturing sector as the "tradable", but as our study is for developing countries, we have taken both manufacturing and agriculture as the "tradable" sector. For "non- tradable" sector we have taken only the service sector, where "services" consist of the following:

a. Trade, restaurants, hotels, commerce.
b. Transport, storage, communications.
c. Finance, insurance, real estate, bus services.
d. Community, social and personal services.

The period of study is 1981-1996. This period also is chosen to avoid the phenomenon of large scale exogenous capital inflows/outflows from developed to developing countries since the end of the 1990s and its consequent impact on the volatile exchange rate movements of the developing countries. The period from the end of 1990s to 2010 witnessed both the East Asian Crisis and the International Financial Crisis which had unusual external shocks on the exchange rate movements of the developing countries.

Data for agriculture, manufacturing and services have been collected from Global Development Indicators, for the period 1980-1996, at constant local currencies. As World Table does not give the required data for USA after 1988, we have collected the required data for USA from 'National Account Statistics', published by the United Nations, which also give the above-required data at constant local currencies.

Data for labour however are collected from "Year Book of Labour Statistics", various issues, published by the ILO (International Labour Organization). We have added labour employment of agriculture and manufacturing sector to get the total employment of the tradable sector. Similarly, to get the total employment of the non-tradable sector, we have added the labour employment of the above mentioned four categories under services (as services are taken as non- tradable) to get the total labour employment of the non- tradable sector. As the "Year Book of Labour Statistics" (which is the only source of international data of labour force) does not provide data for Colombia and Uruguay for the years 1982 and 1983, we have used the method of interpolation to obtain the data for labour employment by sectors for these two countries.

Now, in order to get labour productivity data for tradable sector, we have divided the total value added in the tradable sector (agriculture + manufacturing) at constant local prices by total labour employment in the tradable (agriculture + manufacturing) sector. Similarly, we have obtained data for labour productivity in non-tradable sectors also. Taking a base year as 100, we have constructed the labour productivity index for both tradable and non-tradable sectors and for all the countries in our sample including USA.

The developing countries included in this study are India, Pakistan, Sri Lanka, Korea, Malaysia, Indonesia, Thailand, Philippines, Colombia, Costa Rica, Chile, and Venezuela. Only these developing countries have long time series data on labour employment and therefore for only these 12 countries we have been able to construct the data for labour productivity.

As we have data of 12 countries for 15 years, we have concentrated on panel data analysis. Moreover, as the number of years is more than the number of countries, a generalised least square (GLS) method is adopted for panel data regression. Therefore, we do not need to follow the fixed or random effect models for panel data regression. For the purpose of this empirical analysis, the econometric software STATA is used. The problem of heteroskedasticity and autocorrelation if any can also be taken care of in the GLS method in the STATA software.

Section V - Econometric Tests, Results and Major Implications

In order to test the Balassa-Samuelson Theorem we have tested the model

1. $\Delta R = \text{constant} + \Delta A + \varepsilon$ (9)

2. $$\frac{1}{R}\frac{dR}{dt} = \lambda + \frac{1}{A}\frac{dA}{dt} + \varepsilon \qquad (10)$$

The main reason for using these models is that the real exchange rates data are found to be non-stationary when they are used at level. In order to avoid this problem, we have used two separate models - First, using the first difference as mentioned in eq. 9 and second, using the model in term of growth as mentioned in eq. 10. The theoretical argument of the Balassa-Samuelson theorem is almost in line with the second form as mentioned in eq. 10.

As we have long time series data (15 years), for 12 countries we are using Generalized Least Square method for regression. We test for the presence of heteroskedasticity in both the models. In both the cases the result of Cook-Weisberg test for heteroskedasticity showed that there is heteroskedasticity problem in the data. This heteroskedasticity in the data may arise from the fact that there are certain countries which have experienced higher rates of growth than the others over the period. Therefore, in the panel data regression for this paper, in the STATA statistical/econometric software, we have used the Generalized Least Square method for regression with the option for heteroskedastic panel that automatically takes care of the heteroskedasticity problem in the data and therefore the final result is free of heteroskedasticity problem.

There is no reason why productivity growth in one developing country would be correlated with the productivity growth in other countries. Therefore, we have ruled out the possibility of cross sectional correlation. However, as we have quite a long time series data, possibility of auto correlation within a country series can't be ruled out and therefore we will use AR(1) process in the model.

Table 1: Regression of Real Exchange Rate on Relative Productivity Differential by Using the Eq(9)

Model: ΔR = constant + ΔA + $\varepsilon_{t,}$ where all the symbols have been defined earlier in equation (9)
Cross-sectional time-series FGLS regression
Coefficients: generalized least squares
Panels: heteroskedastic
Correlation: panel-specific AR(1)

Estimated covariances = 12 Number of obs = 180
Estimated autocorrelations = 12 Number of groups = 12
Estimated coefficients = 2 No. of time periods = 15
Wald chi2(1) = 2.45
Log likelihood = -606.632 Prob > chi2 = 0.1172

ΔR	Coef.	Std. Err.	Z	P>|z|
ΔA	7.06836	4.511531	1.57	.117
Constant	.7146298	.5816343	1.23	-.425352

ΔR = first order difference of real exchange rate, ΔA = first order difference of A , where A is as defined earlier in the equation (7) (A = Relative proportion of average product of tradable to non-tradable of domestic country to foreign country).

Cook-Weisberg for heteroskedasticity –
Ho: Constant Variance
chi2(1) = 29.43
Prob > chi2 = 0.0000

Table 1 (using eq.9) clearly shows that there is no significant relation between productivity growth differential and real exchange rate depreciation even at 10% level of significance. In fact the sign of the coefficient is the opposite of what the Balassa- Samuelson theorem predicted.

Table 2: Regression of Real Exchange Rate on Relative Productivity Differential by Using the Eq(10)

Model: $\frac{1}{R}\frac{dR}{dt} = \lambda + \frac{1}{A}\frac{dA}{dt} + \varepsilon$

where all the symbols have been defined earlier in equation (10)
Cross-sectional time-series FGLS regression
Coefficients: generalized least squares
Panels : heteroskedastic
Correlation: panel-specific AR(1)

Estimated covariances = 12 Number of obs = 180
Estimated autocorrelations = 12 Number of groups = 12
Estimated coefficients = 2 No. of time periods = 15
Wald chi2(1) = 3.78
Log likelihood = -621.8064 Prob > chi2 = 0.05

Pcreer	Coef.	Std. Err.	Z	P>|z|
Pcddd	.1269012	.0550153	1.94	.052
Cons	1.068399	.6412835	1.67	.096

Pcreer= % change in real exchange rate, pcddd= % change in A, where A is defined in the equation (7) (A = Relative proportion of average product of tradable to non-tradable of domestic country to foreign country)

Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Chi2(1) = 228.11
Prob > chi 2 =.0000

The results of the second regression (eq.10) shown in Table 2, establishes that there is a statistically significant relationship between productivity growth differential and percentage change in real exchange rate depreciation but the relation is exactly in the opposite direction of what Balassa-Samuelson had predicted. Here, the result shows that the higher the relative productivity growth of the tradable sector of country A compared to that of its trading partner B the greater will be the depreciation of its currency, which is exactly the opposite of what Balassa had claimed. In fact using tradable to non- tradable productivity data, Officer (1976b) got a similar kind of result to what we have got. When he used per capita income growth of a country relative to US, as proxy for productivity, he found the relationship between relative productivity growth and real exchange rate movements to be insignificant. But when he used relative productivity of tradable sector to non-tradable sector between the two countries, he got the similar kind of result to what we have got.

The proximate reason for this result is that for the last four decades, many of the developing countries taken in our study have actually experienced higher rates of growth of productivity in the tradable sector compared to their non-tradable sector with respect to the United States. But simultaneously most of these countries also experienced real exchange rate depreciation during this period which contradicts the arguments of the Balassa-Samuelson theorem. There can be other factors than productivity bias, including secular terms of trade deterioration, high current account imbalances, large capital inflows/outflows which may have decisive effects on the movements in real exchange rates of the developing countries. This is why the productivity bias hypothesis of Balassa-Samuelson is empirically not found in this paper.

Now, I would like to mention some of the other plausible causes for the failure of the Balassa-Samuelson theorem in explaining the real exchange rate movements in the developing countries.

a) The major objection is that it assumes that the purchasing power parity holds for the tradable sector. Many people have argued that this actually does not hold even in the long run (Isard 1977, Knetter 1993).
b) As productivity increases in the developed countries, organised workers have been able to increase their money wage exactly in same proportion to the increase in productivity. While for developing countries, where a huge reserve army of labour always exists, trade unions are weaker, and therefore money wage may increase in a much lesser proportion than the increase in productivity. So with the increase in productivity, the prices of tradable goods may decrease relative to the developed countries.
c) The assumption that wage rate will be determined by the productivity of the tradable sector, and not by the overall productivity of the economy, is a very strong and unpersuasive assumption.
d) In recent years, service sector led growth is observed in many developing countries and therefore the wage rate may not be entirely determined by the productivity of the tradable sector. In fact we can question the basic empirical premise that fast-growing countries generally experience extra-rapid productivity growth in the traded goods sector. One might also ask whether the effect, even if it has existed in the past, might continue to operate during the coming century, as technological advances sharply improve labour productivity in many service sectors, such as banking and insurance.
e) It is a completely supply side argument and does not take account of the demand side factors, which may be a cause of the failure of this hypothesis.

CONCLUSION

The empirical investigation of this paper indicates that the argument of productivity differences has no significant impact on the real exchange rate movements of some major developing countries for a long period of time. And in fact, empirical investigation using the data closest to the Balassa-Samuelson theorem reveals that productivity differential has statistically significant impact on real exchange rate movements but in exactly the opposite direction as predicted by the theory.

This brings us to the question of validity of many of the assumptions of the Balassa-Samuelson theorem for developing countries including the existence of purchasing power parity; determination of wage rate by the productivity of the tradable sector, and not by the overall productivity of the economy; the basic empirical premise that fast-growing countries generally experience extra-rapid productivity growth in the traded goods sector etc.

Thus, the productivity bias has failed to explain the real exchange rate movements in the major developing countries. There can be other factors than productivity bias, including terms of trade, current account imbalances, capital inflows/outflows which may have decisive effects on the movements in real exchange rates of the developing countries.

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