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Real Exchange Rates and Economic Growth: A Cross-Country Empirical Analysis

Reel döviz kurları ve ekonomik büyüme: ülkelerarası ampirik bir analiz

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Abstract

The effect of real exchange rates on economic growth is one of the most important issues of the recent policy debate. This paper examines empirically the effect of real exchange rate changes on economic growth using a wide panel data set. To this end, we apply not only the conventional panel data estimation techniques but also recent procedures taking into account the possible common correlated effects such as global shocks. The results suggest that, for industrial countries, the changes in real exchange rate have not any significant effect in the long run. However, for developing countries, real devaluations are found to be contractionary consistent with the balance sheet effect.

Keywords: *Real exchange rate, Growth, Panel data, Balance sheet effect.*

JEL codes: *F43, F31, F34*

Özet

Reel döviz kurlarının ekonomik büyüme üzerindeki etkisi son dönemdeki en önemli politika tartışmalarından biridir. Bu çalışma reel döviz kurlarının ekonomik büyüme üzerindeki etkisini geniş bir panel veri seti kullarak ampirik olarak incelemektedir. Bu amaçla, sadece geleneksel panel veri tahmin yöntemleri kullanılmamış, ayrıca küresel şoklar gibi olası ortak bağıntılı etkileri dikkate alan yeni teknikler kullanılmıştır. Elde edilen bulgulara göre, reel döviz kurlarındaki değişimler gelişmiş ülkelerde uzun dönemde anlamlı bir etkiye sahip değildir. Bunun yanında, gelişmekte olan ülkeler için reel kur değer kayıpları bilanço etkisiyle tutarlı olarak daraltıcıdır.

Anahtar kelimeler: *Reel döviz kuru, Büyüme, Panel veri, Bilanço etkisi.*

JEL kodları: *F43, F31, F34*

1. INTRODUCTION

Since the real exchange rate is a key relative price which affects the economy through many channels, the effect of real exchange rate changes on economic growth is one of the most important issues of the recent policy debate. According to the traditional Mundell-Fleming model, depreciation of the real exchange rate is expansionary via its effects on trade balance assuming that the Marshall-Lerner conditions are satisfied. Dornbusch (1980) is one of the main advocators of this view.[1] On the other side, real devaluations can have contractionary effects on real economy especially in developing countries. Diaz- Alejandro (1963), Krugman and Taylor (1978), Edwards (1986) and Winjbergen (1986) are among the first that give theoretical support to contractionary devaluation mechanism. Inflationary effects of an increase in real exchange rate, income distribution effects, real income effects and negative supply side effects such as increased cost of imported inputs are the main channels emphasized by contractionary devaluation hypothesis. Despite the supply side channels affect output unambiguously negatively, the demand side effects can be negative or positive under different macroeconomic conditions. [2] Since the net effect of a depreciation is not clear theoretically, the empirical evidence on the effects of real exchange rate on economic performance gains importance.

The empirical evidence provided by the earliest studies is generally mixed. Some of those studies such as Cooper (1971) and Edwards (1986) analyzed the effects of devaluation episodes in different countries. Some of them estimated reduced form output equations for a single country or for a pooled sample of countries or constructed VAR models in order to examine the effects of real exchange rate shocks (Edwards, 1986; Agenor, 1991; Morley, 1992; Kamin and Klau, 1997; Kamin and Rogers, 2000; Ahmet et al., 2001). Possibly the earliest paper that study the issue from an empirical perspective is Cooper (1971) which shows that the contractionary effects of devaluation tend to be significant but they have only short-run effects. Consistent with this result, Edwards (1986) showed that devaluations generate a small contractionary effect on output in the first year. However, this negative effect is completely reversed by the second year. Therefore, in his analysis, devaluations are neutral in the long run. Morley (1992), again showed that devaluations reduce output, but it takes at least 2 years to have the full effect in his analysis. According to Kamin and Klau (1997), regardless of the short run effects of devaluation, there appears to be no contractionary effect in the long run. On the other hand, their results fail to confirm the conventional or textbook view that devaluations are expansionary in the long run. Similarly, based on the results of several VAR models, Kamin and Rogers (2000) concluded that real devaluation has led to high inflation and economic contraction in Mexico.

After the wave of financial crises in Latin America (Mexico in 1994-1995 and Argentina in 2001-2002) and East Asia (1997-1998), this literature came into prominence stressing a different problem this time. This new branch of the contractionary devaluation hypothesis emphasized mostly the financial channel of contractionary devaluation hypothesis in the light of the financial dollarization process taking place in a number of emerging economies over the last decades. These studies generally stress the mismatch between foreign currency

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[1] See also Dornbusch and Werner (1994).

[2] See Lizondo and Montiel (1989) for a broad analytical overview.

denominated debt and domestic currency denominated revenues which is referred as *Balance Sheet (BS) effect*. If a considerable amount of agents' borrowing is dominated in foreign currency, the depreciation of the real exchange rate reduces the net worth of agents by weakening their balance sheets and this leads to difficulties in the repayment of debt burden and reduction in investment and output. This balance sheet effect is pointed out as the main mechanism that explains the recessions followed many of the 1990s devaluations (Frankel, 2005; Aghion *et al*., 2001; Calvo *et al*., 2004; Krugman, 1999). However, some authors argued that contractionary balance sheet effect is more likely to dominate standard competitiveness effect under certain economic conditions. Cespedes *et al*. (2002), utilizing from a IS-LM-BP model, showed that negative BS effects dominate competitiveness effect when financial markets are less developed, the ratio of total debt to net worth is high and the share of foreign debt in total debt is high. Using different dollarization measures, for a panel data sample of 57 countries, Bebczuk *et al.* (2006) showed that when dollarization exceeds a level, contractionary effect of devaluation can dominate the expansionary effect which is the case for most of the developing countries. Galindo *et al.* (2006) provided similar results as Bebczuk *et al.* (2006) by concentrating on industrial employment data.[3]

Recently, successful experiences of China and other East Asian countries strengthen the view that maintaining an undervalued or competitive real exchange rate foster economic growth. Especially with the wake of global financial crisis, China's weak currency policy lead academics and policy makers to question the merits of export-led growth strategies. Although there is a great uncertainty about the advanced countries' capacity to continue absorbing developing countries' exports, according to the supporters of this view, tradable sector is the main driver of the economy in which the technology transfer and the learning by doing externalities are relatively rapid. Rodrik (2008) is one of the main advocators of this view. According to Rodrik (2008), by increasing the profitability of the tradable sector which suffers disproportionately from the institutional weaknesses and market failures, undervaluation of the real exchange rate facilitates economic growth in developing countries. Some other studies also provided empirical evidence on expansionary devaluation by justifying different channels. Using the same Balassa-Samuelson adjusted index of undervaluation as Rodrik (2008), Gala (2008) suggested again a positive effect of undervaluation on growth arguing that the channels through which exchange rate levels affect long term growth can be related to investment and technological change. Levy-Yeyati and Sturzenegger (2007) examined the evolution of the exchange rate regimes in recent years and pointed out that there is a tendency to intervene to depreciate local currency which they called as "fear of appreciation". Showing that these interventions managed to preserve a depreciated real exchange rate, they provided empirical evidence that this fear of appreciation leads to higher output and productivity growth which is not only restricted to short term cyclical changes but also leads to higher long term GDP growth. They also argued that this positive effect of fear of appreciation comes from increased domestic savings and investment rather than export-led expansions or import substitution. This saving channel was believed as contractionary by Diaz-Alejandro (1963) due to the negative effect on

[3] There are also firm-level studies especially on Latin American countries which show that the increase in real exchange rate (real depreciation) affects investments, sales and profits negatively in the high dollarized economies (see Galindo *et al.* 2003, Bleakly and Cowan, 2005; Echeverry *et al*. 2003; Forbes, 2002; Aguiar, 2005).

consumers and decline in domestic demand. Levy-Yeyati and Sturzenegger (2007) stressed the financial constraint that firms with foreign currency liabilities are faced in case of a devaluation and combining this modern view with Diaz Alejandro (1963)'s story, they claimed that real devaluations should be expansionary. Real devaluations relax the barrowing constraints binding firms by the means of saving channel in this modern view. Gluzmann *et al*. (2011) is the other study which suggests that real depreciations are expansionary by the channel of savings and investment rather than foreign trade dynamics. However, according to Montiel and Serven (2008), international experience does not provide support for a growth strategy based on the increased saving rate by the help of depreciated real exchange rate. Therefore, despite some authors support the conventional expansionary effects of depreciation, there is not convincing empirical evidence on the channels of this effect-tradable sector and saving channels- yet.

Except these advocators, some authors are more skeptical to the undervalued real exchange rate. For example, Eichengreen (2008) warns about keeping real exchange rate low in that it have costs as well as benefits especially when the economy is sticked with the policy for too long. He emphasizes that a stable and competitive real exchange rate should be thought as a facilitating condition for economic growth and the timing of the exiting the strategy is very important. There is the risk that the cheap currency policy can weaken the efforts for upgrading and productivity growth while increasing the dependence of growth on expansion on foreign markets (Akyüz, 2009).

Despite the bulk of studies on the effect of the changes in real exchange rate on growth, they can significantly differ in the results they reach so the issue of whether depreciation of the real exchange rate is detrimental or beneficial for the economy has not solved yet. With the recent global crisis, it has discussed by policy makers intensively in the context of exchange rate wars and global imbalances. In this study, we aim to investigate the effects of real exchange rate on economic growth mainly addressing some econometric and empirical issues. Using a wide panel data set of countries, we estimate the long run relationship between real exchange rate and real GDP per capita income by differentiating the effects for developed and developing countries. To this end, we apply not only the conventional panel data estimators but also Pesaran (2006)'s Common Correlated Effects (CCE) methodology which controls the effects of common global shocks.

2. LONG RUN RELATIONSHIP BETWEEN REAL EXCHANGE RATES AND REAL GDP PER CAPITA

2.1. Data and The Model

We use the following conventional growth model which is a panel data version of Barro (1991):

$$y_{i,t} - y_{i,t-1} = (\alpha - 1)y_{i,t-1} + \beta' RER_{i,t} + \gamma' X_{i,t} + \mu_i + \varepsilon_{i,t} \qquad (1)$$

where y is the real GDP per capita, RER is the real exchange rate, X is a set of control variables, μ_i is the unobserved country-specific effects, ε is the error term. The subscripts i and t represent the country and time period, respectively. The lagged per capita income, $y_{i,t-1}$, is used as the conditional convergence term in standard growth equations. The control variables other than the initial income per capita are government consumption (GOV), trade openness (TRADE) and financial depth (LIQ) as the macroeconomic policy variables and fixed investment (INV). These are the standard control variables used in empirical growth models.[4] All variables except financial development are from World Bank, World Development Indicators (WDI) Database. The real effective exchange rate, our main variable of interest, is from Bank of International Settlements (BIS) for the countries whose data are not available in WDI. The ratio of liquid liabilities to the GDP is used as the measure of financial development. The data on liquid liabilities are obtained from Beck, Demirgüç-Kunt and Levine (2000). All variables are expressed in natural logarithms and all control variables are defined as ratio to the GDP. The list of variables and their sources are given in Table A1 in Appendix.

Our main variable of interest as explaining economic growth, real exchange rate, has a central importance in our study. As the measure of real exchange rate, we use real effective exchange rates which is the weighted average of bilateral real exchange rates with its trading partners. Since the real effective exchange rate express the national currency in terms of other currencies, an increase in the real effective exchange rate reflects appreciation and a decrease in real effective exchange rate reflects depreciation. We prefer to use multilateral real exchange rates instead of bilateral real exchange rates since they can move in different, and even opposite directions after the collapse of Bretton Woods system.[5] The use of bilateral indexes can result in misleading and incorrect inferences regarding the evolution of a country's degree of competitiveness (Edwards, 1989). Therefore, it is necessary to use a multilateral index of real exchange rate especially when evaluating policy related situations.

Our sample consists of an unbalanced panel of 80 countries over the period 1960 – 2009. These are the countries which we have the data for real effective exchange rates. The sample is composed of 23 industrial and 57 developing countries. We tried to hold the dataset as large as we can, but we had to exclude the countries with the poorest data.

The growth equation above can be rewritten as a dynamic panel data model as in Islam (1995),

$$y_{i,t} = \alpha y_{i,t-1} + \beta' RER_{i,t} + \gamma' X_{i,t} + \mu_i + \varepsilon_{i,t} \qquad (2)$$

There are some econometric issues that we need to deal with when we estimate this regression equation. The first empirical issue to consider is the time series properties of the variables in the equation which is often neglected by the growth literature. Before proceeding to the estimation we need to investigate the integration properties of the variables. If the variables are difference stationary, we should apply panel cointegration techniques in which we estimate the long run relationship among the variables. The other issue that we need to consider is the potential cross sectional dependence. There can be

[4] As Sala-i Martin (1997) indicated, 60 variables can be found that are significant in growth regressions. We selected our control variables following Temple (1999) and some empirical growth studies such as Loayza and Ranciere. (2002), and Levine *et al.* (2000). We do not include terms of trade and inflation because terms of trade is highly correlated with our main variable of interest, real exchange rate and inflation is generally considered as a short term determinant of growth as in Temple (1999).

[5] Among the studies on the real exchange rate-growth relationship, some studies such as Bebzcuk *et al.* (2006), Bleaney and Vargas (2008) and Blecker and Razmi (2008) used the real exchange rate itself but they mostly used the bilateral real exchange rates. Moreover, they used the first difference of the RER which constrains the analysis to the short run effects.

common shocks that affect all countries which will cause cross-section correlation between the regression error terms. Ignoring this cross section dependence can lead to inconsistence estimates (Phillips and Sul, 2003; Coakley, Fuertes and Smith, 2006; Pesaran, 2006). To the best of our knowledge, there is not any other study on the real exchange rate and growth relationship to deal with this important problem. The last issue is the dynamic nature of the regression equation and the possible endogeneity of the real exchange rate and the other control variables. One can use the GMM procedure which provides a consistent estimator for dynamic panel data models with potential endogenous explanatory variables. This is the most common method used in previous empirical studies which investigates the effect of real exchange rate on economic growth (see Rodrik, 2008; Aguirre and Calderon, 2005; Di Nino *et al*., 2011; Gala, 2008; Macdonald and Vieira, 2010; Galiani *et al*., 2003 among others). Consequently, we also consider the GMM estimation method in estimating our growth equation in this paper. Besides its convenience in dealing with the endogeneity and the reverse causation problem, it will also allow us to make comparison with the previous studies' results.

In the light of these econometric issues, first, we estimate the long run relationship between the real exchange rate and the real GDP per capita by setting up the panel cointegration equation due to the time series properties of the data.[6] Secondly, by using Pesaran (2006)'s Common Correlated Effects methodology, we also deal with the cross sectional dependence issue which is ignored by previous studies. Lastly, we employ GMM methodology to our context in order to check for the robustness of our results for endogeneity issues.

2.2. Unit Root and Cointegration Tests

As the above discussion implies, the first step in the analysis is to examine the time series properties of the data. In Table 1, Levin, Lin and Chu (2002), Maddala and Wu (1999), Im, Pesaran and Shin (2003) panel unit root tests are performed. LLC, MW-ADF and IPS are in the class of first generation panel unit root tests which assume cross sectional independence. The difference between LLC and IPS is that the alternative null hypothesis in the former is the stationarity of all series while it is the stationarity of a fraction of series in the latter. MW agrees on the heterogeneity of the alternative null hypothesis as IPS, but MW panel unit root test uses aggregated p-values from individual time series unit roots whereas IPS test uses averaged test statistics across individual panels. In order to account for the potential cross-country dependence in the data, we also employ CIPS test of by Pesaran (2007) which removes the cross section dependence by augmenting the ADF regression with the cross-section averages of lagged levels and first-differences of the individual series. Table 2 reports the results of Pesaran (2007)'s panel unit root test. We report these results for lag orders 0, 1, 2, and 3. All unit root tests are conducted for both levels and first differences of the variables. The results of the first generation tests on the levels of the variables are generally mixed. But for the first differences of the variables, all three tests reject the null hypothesis of unit root at the 5% significance level. According to the CIPS test statistics for different lag orders, the null hypothesis of unit root cannot be rejected for the levels of the variables except for a few lags. However, the first differences of the variables are stationary for all lags.

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[6] Among the panel data studies, the only study which takes the time series properties of the variables into account is Nouira and Sekkat (2012) in this context.

Table 1. Panel unit root tests

Variables	LLC	MW-ADF	IPS
Real GDP per capita	0.446	329.982*	-1.429
ΔReal GDP per capita	-22.046*	1522.08*	-31.013*
real exchange rate	0.807	137.635	-6.076*
Δreal exchange rate	-39.247*	1889.37*	-30.655*
gov. consumption	6.736	114.832	-8.050*
Δgov. consumption	-60.506*	4573.53*	-52.055*
trade openness	7.563	71.977	-5.475*
Δtrade openness	-66.562*	5643.17*	-57.068*
financial development	-0.391	227.449	3.458
Δfinancial development	-33.688*	1449.54*	-31.642*
investment	-1.756*	136.463	-8.305*
Δinvestment	-54.638*	3373.29*	-43.476*

Notes: LLC is the panel unitroot test developed by Levin, Lin and Chu (2002), MW is the Fisher's panel unit root test developed by Maddala and Wu (1999), IPS is the panel unitroot test developed by IM, Pesaran and Shin (2003). Lag lengths are chosen by Schwarts Information Criteria. (*) denotes the rejection of uni troot at the 5% level.

Table 2. Pesaran (2006)'s CIPS panel unit root test statistics

Lags	0	1	2	3
Real GDP per capita	5.551	1.885	5.297	5.304
ΔReal GDP per capita	-31.552*	-23.214*	-14.687*	-11.041*
real exchange rate	-6.112*	-4.946*	-1.731	-1.382
Δreal exchange rate	-27.284*	-19.955*	-11.080*	-11.945*
gov. consumption	-3.800*	-2.799*	0.687	0.793
Δgov. Consumption	-40.671*	26.429*	-16.812*	-12.888*
trade openness	-3.471*	-3.267*	1.006	0.601
Δtrade openness	-38.173*	-26.492*	-14.924*	-9.015*
financial dev.	0.807	-1.619	3.506	5.858
Δfinancial dev.	-23.215*	-18.172*	-9.214*	-1.703*
investment	-4.179*	-6.228*	-1.694	1.531
Δinvestment	-	-	-	-

Note: (*) indicates that the test is significant at the 5% level.

Concluding that the variables are integrated of order one, the next step is to test for the existence of a cointegration relationship among the variables. To this end, we use the standard panel cointegration test of Pedroni (1999). The results of panel cointegration test of Pedroni (1999) are reported in Table 3. The first four of the statistics given in Table 3. represents the within dimension panel cointegration statistics and the last three represents the between dimension panel cointegration statistics. All of the seven statistics reject the null hypothesis of no cointegration. The evidence of cointegration is also confirmed by the significance of the error correction term in error correction models estimated in subsequent parts.

Table 3. Pedroni (1999) panel cointegration test results

Panel v-statistic	-3.457***
Panel rho-Statistic	14.039***
Panel PP-Statistic	3.932***
Panel ADF-Statistic	3.381***
Group rho-Statistic	17.582***
Group PP-Statistic	-2.302***
Group ADF-Statistic	-2.766***

Note: *** denotes the rejection of the null hypothesis at the 5% significance level.

2.3. Empirical Results

Based on the evidence of cointegration among the variables, we construct the long run relationship by estimating the level equation, Equation 2, which is nothing more than a reparametrization of Equation 1. While Equation 2 consists lagged level of GDP per capita, y_{it-1}, as the standard conditional convergence term in growth literature, we exclude it from the cointegration equation since by definition such a lagged variable cannot be included in static cointegration regression.[7] Secondary schooling is also excluded since it is not available annually. A linear time trend is also included in the long run equation.

We first estimate the long run equation for real GDP per capita with fixed effects methodology by splitting our sample into developing and industrial countries. Since the contractionary devaluation hypothesis mainly focused on developing countries in which balance sheet effects can be large, it will be more appropriate to examine the effects of the changes in real exchange rate for developed and developing countries separately. There is not a common conclusion for both developed and developing countries that is agreed upon. For developing countries, while some authors showed that the standard Mundell-Fleming result may hold even in the presence of balance sheet effects, some others suggest that depreciations can be contractionary if the balance sheet effects are large enough. Table 4 shows the fixed effects estimation results of long run equations for three different samples, whole sample, developing countries and industrial countries. The coefficients of the real effective exchange rate are 0.225 and 0.221 and highly statistically significant for whole

[7] y_{it-1} is included as the initial income level into the growth regressions and some studies includes the real per capita income level at the beginning of the period considered as the initial income level. For an unbalanced annual data this approach will not be suitable.

sample and developing countries sample, respectively. Since the increases of real effective exchange rate demonstrate appreciations, these coefficients imply that the appreciation of the real effective exchange rate increases real GDP per capita. In other words, real depreciations are found to be contractionary for whole countries and developing countries sample. This result is in line with the suggestions of the authors like Frankel (2005), Calvo and Reinhart (2001), Bebzcuk *et al.* (2006) which stress the balance sheet effect that exist in most of the developing countries. The third column of Table 4 shows the estimation results for the industrial countries. The coefficient of the real effective exchange rate is 0.053 but not statistically significant. Theoretical and empirical literature mostly argue that the traditional expansionary effects of a real depreciation continue to hold for industrial countries. Unlike developing economies, they can continue to utilize from the competitiveness effect of devaluation since they do not generally face with problems of foreign currency denominated debt. Our results does not support expansionary devaluation hypothesis for industrial countries. According to our estimations, real exchange rate is not a significant determinant of economic growth for industrial countries in the long run. Regarding the control variables, in whole countries and developing countries sample, all control variables except for government consumption are positive and statistically significant as expected. Trade openness, financial development and investment affect real GDP per capita positively as theory predicts. Insignificance of government consumption in the long run is also consistent with economic theory. In industrial countries sample, investment is the only significant variable.

Table 4. Long run Equations-Fixed effects estimation

Dependent variable: Real GDP per capita

	whole sample	**developing**	**industrial**
REER	0.225***	0.221***	0.053
	(0.046)	(0.046)	(0.066)
Gov. Consumption	-0.084	-0.112	-0.054
	(0.070)	(0.076)	(0.116)
Trade Openness	0.235***	0.246***	0.018
	(0.073)	(0.084)	(0.097)
Fin. Development	0.175***	0.231***	-0.022
	(0.055)	(0.069)	(0.044)
Investment	0.166***	0.163***	0.240***
	(0.053)	(0.059)	(0.084)
Trend	0.014***	0.012***	0.021***
	(0.002)	(0.002)	(0.002)
Constant	-20.587***	-17.220***	-32.706***
	(3.199)	(4.676)	(2.927)
Observations	2,024	1,273	751
No. Countries	80	57	23
R-square	0.668	0.567	0.899
LLC	-11.049***	-8.926***	-3.304***
	[0.000]	[0.000]	[0.000]
MW	407.302***	273.235***	44.266
	[0.000]	[0.000]	[0.540]

Notes: Robust standard errors in parentheses. *significant at 10%; ** significant at 5%, *** significant at 1%. LLC and MW denotes the Levin, Lin and Chu (1994) and Maddala and Wu (1999) panel unit root test statistics of the residuals. The values in [.] are the p-values.

The LLC and MW reported at the bottom of the table are the panel unit root test statistics for the residuals of the regressions estimated. They confirm the cointegration relationship among the variables since they all reject the null hypothesis of unit root in the residuals.

2.4. Cross Section Dependence

In recent years panel data econometrics has emphasized the unobserved time-varying heterogeneity induced by unobserved common shocks which affects all individual units differently. These unobserved common factors cause cross sectional correlation or dependence across the errors of the regression. This cross sectional correlation is especially important for macroeconomics in which cross-country studies are widely used. One major source of this cross sectional dependence in cross-country data is global shocks, e. g. oil price shocks and international financial crises. (Bai and Kao, 2005) Except for global shocks, spatial spillover effects and increased financial and trade linkages among the countries cause dependence across countries. The ignorance of this cross section dependence may lead to inconsistent parameter estimates if unobserved common factors are correlated with explanatory variables (Phillips and Sul, 2003; Coakley, Fuertes and Smith, 2006; Pesaran, 2006).

The SUR-GLS approach to dealing with cross section dependence for small N large T panels does not work when N is of the same magnitude or greater than T since the estimated contemporaneous variance-covariance matrix cannot be inverted. In the panel time-series where both N and T are large, the usual approaches have been either to ignore the possibility of cross-section dependence produced by time-specific heterogeneity or deal with it by including period dummies or fixed effects. But this assumes that the global shocks have identical effects on each unit which seems quite restrictive. In recent years, factor models have been largely used to characterize the cross sectional dependence (Bai and Ng, 2002; Coakley *et al*., 2002; Phillips and Sul, 2003; Moon and Perron, 2004; Bai and Kao, 2005; Breitung, 2005; Pesaran, 2006). In these models, the disturbances are assumed to contain one or more unobserved factors which may influence each unit differently.

In this study, we employ the Common Correlated Effects Pooled (CCEP) Estimator introduced by Pesaran (2006). The general factor model that is used by Pesaran (2006) is as follows:

$$y_{i,t} = \alpha_i' d_t + \beta_i' x_{i,t} + \gamma_i' f_t + \varepsilon_{i,t} \qquad (3)$$

where y_{it} is a scalar dependent variable; d_t is a nx1 vector of variables that do not differ across units; x_{it} is a kx1 vector of observed regressors which differ across units; f_t is a rx1 vector of unobserved factors, which may influence each unit differently and which may be correlated with x_{it}; ε_{it} an identically and independently distributed disturbance term.

Pesaran (2006) uses the cross sectional means of the dependent variable and the explanatory variables as the proxies for the unobserved common factors. Thus, he suggests including the means of y_{it} and x_{it} as additional regressors to remove the effect of these factors as follows:

$$y_{i,t} = \alpha_i' d_t + \beta_i' x_{i,t} + \gamma_i' f_t + \delta_{0i} \overline{y_t} + \delta_i' \overline{x_t} + u_{i,t} \qquad (4)$$

Pesaran (2006) showed that the parameters of this auxiliary regression which is constructed by augmenting the original regression by the cross sectional averages of the dependent and explanatory regressors can be consistently estimated by OLS. This estimator is called Common Correlated Effect (CCE) estimator. Pesaran (2006) proposes a pooled version, Common Correlated Effects Pooled Estimator (CCEP) in which the fixed effects estimator is augmented by cross-section averages of the dependent and the independent variables, which we employ in this study.[8] Kapetanios, Pesaran and Yamagata (2006) showed that this estimator is robust to a wide variety of data generating processes and has lower bias than alternative estimation methods. The results of the CCEP estimator are reported in Table 5. The effect of real depreciation on GDP per capita is still negative and significant but somewhat smaller than the FE estimates for whole sample and developing countries. Contractionary effect of depreciation still holds for developing countries after controlling for the unobserved common factors while the coefficient of interest is again insignificant for industrial countries sample.

Table 5. Long run Equations-CCEP estimation

Dependent variable: Real GDP per capita

	whole sample	**developing**	**industrial**
REER	0.215***	0.194***	0.071
	(0.045)	(0.048)	(0.078)
Gov. Consumption	-0.086	-0.111	-0.051
	(0.071)	(0.074)	(0.125)
Trade Openness	0.233***	0.236**	0.023
	(0.081)	(0.091)	(0.121)
Fin. Development	0.167***	0.219***	-0.011
	(0.056)	(0.073)	(0.048)
Investment	0.155***	0.137**	0.231**
	(0.053)	(0.056)	(0.095)
Trend	0.014***	0.005	-0.003
	(0.003)	(0.004)	(0.005)
Constant	-21.173***	-4.778	2.892
	(5.266)	(8.455)	(7.870)
Observations	2,024	1,273	751
No. Countries	80	57	23
R-square	0.672	0.586	0.905
LLC	-11.221***	-8.250***	-0.052
	[0.000]	[0.000]	[0.479]
MW	398.45***	275.155***	69.260**
	[0.000]	[0.000]	[0.014]

Notes: Robust standard errors in parentheses. *significant at 10%; ** significant at 5%, *** significant at 1%. LLC and MW denotes the Levin, Lin and Chu (1994) and Maddala and Wu (1999) panel unit root test statistics of the residuals. The values in [.] are the p-values.

[8] Pesaran (2004) suggested a formal test for cross section dependency. However, we cannot apply this test because of degrees of freedom problems.

2.5. Robustness Check for Endogeneity

Equation 1 is the standard growth regression used in the growth literature. In the previous sections, we estimated the level equation, Equation 2, which is nothing more than a reparametrization of Equation 1. We constructed the panel cointegration relationships based on the time series properties of our variables. Estimation of Equation 1 including the initial income per capita as a control variable is the most common approach used in the growth literature and especially in the literature of real exchange rate and growth relationship. The standard estimators like "fixed effects" (within) estimator will be inappropriate for the estimation of this dynamic model. GMM estimators which are introduced by Holtz-Eakin, Newey, and Rosen (1988), Arellano and Bond (1991), and Arellano and Bover (1995) are generally used as the optimal estimators in dynamic panel data models which accounts for the biases induced by the inclusion of initial income level and controls for the reverse causality and potential endogeneity of the explanatory variables. Therefore, we also employ the GMM method and estimate the growth equation by including the initial income level in order to compare our results with other studies that investigate the effects of real exchange rate on economic growth. Since the GMM estimators are developed for "small T, large N" panel data models, studies generally use the non-overlapping five year averages of the time series. This also helps to smooth business cycle fluctuations and focus on long run growth effects. Therefore, we transform our time series data into non-overlapping five year averages when conducting GMM. The initial income variable is comprised as the first observations of every five-year period.

The "first difference GMM" estimator which is developed by Arellano and Bond (1991) transforms the variables into first differences in order to omit the individual fixed effects, then use the lags of the levels of the variables as instruments. Alonso-Borrego and Arellano (1999) and Blundell and Bond (1998) show that when the explanatory variables are persistent over time, lagged levels of these variables are weak instruments for the regression equation in differences. Therefore, Arellano and Bover (1995) and Blundell and Bond (1997) introduced a "system GMM estimator" that combines the regression in differences and the regression in levels in a system. The instruments for the regression in differences are the same as above. The instruments for the regression in levels are the lagged differences of the corresponding variables. Due to the persistency in our regressors, we employ a system GMM procedure using 5-year averaged data. We chose to use orthogonal deviations transformation instead of first-difference transformation since we have unbalanced panel data.[9] Since the number of instruments increases quadratic in T, we collapsed and restricted the instruments up to three lags. We also include time dummies which partially prevents cross-country correlation.

The results of the system GMM estimations are given in Table 6. The specification tests of Hansen and the second order serial correlation verify the validity of moment conditions and the absence of autocorrelation. The findings do not change when we control for endogeneity

[9] First-difference transformation magnifies the gaps in unbalanced panel data since it subtracts the previos observation from the contemporenous one (Roodman, 2005). Instead, orthogonal deviations transformation subtracts the average of all future available observations.

and reverse causation.[10] The effect of real exchange rate is still positive and significant for whole sample and developing countries sample. That is, GMM estimation results confirm the contractionary effect of depreciation in developing economies. The result for the industrial countries is also unchanged. The real exchange rate has no effect on economic growth for those economies. Among the control variables, investment becomes insignificant for all three samples when we control for the simultaneity problem.

Table 6. System GMM estimation results
Dependent variable: Growth of real GDP per capita

	whole sample	**developing**	**developed**
initial income	-0.047*	-0.0789*	-0.0020
	(0.027)	(0.0418)	(0.0080)
REER	0.344***	0.2869**	0.1121
	(0.116)	(0.1246)	(0.0830)
trade openness	0.201**	0.2836**	0.0564*
	(0.086)	(0.1159)	(0.0331)
government consumption	-0.087	-0.2869*	-0.1880*
	(0.114)	(0.1634)	(0.1006)
financial development	0.119**	0.1270*	-0.0291
	(0.054)	(0.0711)	(0.0217)
investment	0.084	0.0885	0.0636
	(0.076)	(0.1115)	(0.0620)
constant	-2.343***	-1.6182*	-0.1381
	(0.754)	(0.8616)	(0.4910)
Observations	406	256	150
No. Countries	74	52	22
Hansen test (p-value)	0.153	0.161	0.734
2nd order AC (p-value)	0.215	0.272	0.571
1st order AC (p-value)	0.0280	0.0683	0.00594
No. of Instruments	31	31	31

Robust standard errors in parentheses. *significant at 10%; ** significant at 5%, *** significant at 1%.

3. CONCLUSION

The empirical literature on the effect of real exchange rates on growth generally provide mixed results. Despite the contractionary effects of depreciation due to the adverse balance sheet effects in the emerging economies has emphasized by a number of studies, recent evidence seem to be supporting mostly the positive growth effects of the competitive real exchange rates. The latter generally stand on the successful experiences of China and East Asian countries which pursue an undervalued exchange rate. However, the econometric methods used in the empirical analysis can have deterministic effect on the results reached. The growth regressions used by the empirical studies on this issue generally ignore the

[10] We also employed FMOLS estimation which controls for endogeneity problem in panel cointegration procedure. It again gave similar results.

problems that can emerge by the nonstationarity of the variables in the growth equation and the cross sectional dependency among the countries.

The results of the long run equation estimates support that the depreciation of the real exchange rate is contractionary in developing countries consistent with the balance sheet effect. Our main finding provided by fixed effects, common correlated effects and system-GMM estimations is that the depreciation of real exchange rate is contractionary for developing countries while it has not any significant effect on economic growth of industrial countries. This result is in line with the findings of Ahmed *et al.* (2003), Bebzcuk *et al*. (2006), Bleaney and Vargas (2009), Blecker and Razmi (2008) which provide empirical support for the contractionary effect of depreciations with GMM estimations except for Ahmed *et al.* (2003). However, our result is contrary to the findings of Rodrik (2008), Gala (2008), Eichengreen *et al*. (2011) which show that undervaluation of the exchange rate is expansionary in developing countries by using GMM estimations. However, the other common point of these studies apart from employing GMM estimation is their use of Balassa-Samuelson adjusted index of undervaluation as the real exchange rate measure. Their common results of expansionary effect of devaluation for developing countries may be due to their use of undervaluation index as Woodford (2009) suggests.

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APPENDIX

Table A1. Source of Variables

Variable	Source
Real GDP per capita	World Bank, World Development Indicators
Real Effective Exchange Rate	World Bank, World Development Indicators; Bank of International Settlements
Government Consumption (% of GDP)	World Bank, World Development Indicators
Trade (% of GDP)	World Bank, World Development Indicators
Gross Fixed Investment (% of GDP)	World Bank, World Development Indicators
Liquid Liabilities (% of GDP)	"Financial Structure" dataset by Beck and Demirgüç-Kunt (2009) . Data available at http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20696167~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html.

Table A2. Sample of Countries

Developing countries		Industrial Countries	East-Asian Countries
Algeria	Morocco	Australia	China
Argentina	Pakistan	Austria	Indonesia
Armenia	Paraguay	Belgium	Korea
Bahrain	Peru	Canada	Malaysia
Bolivia	Philippines	Denmark	Philippines
Brazil	Poland	Finland	Singapore
Bulgaria	Romania	France	Thailand
Burundi	Russian Federation	Germany	
Cameroon	Sierra Leone	Greece	
Central African Rep.	Singapore	Iceland	
Chile	Slovak Republic	Ireland	
China	Slovenia	Italy	
Colombia	South Africa	Japan	
Costa Rica	Thailand	Luxembourg	
Croatia	Togo	Netherlands	
Czech Republic	Tunisia	New Zealand	
Dominican Republic	Turkey	Norway	
Estonia	Uganda	Portugal	
Gabon	Uruguay	Spain	
Gambia	Venezuela	Sweden	
Georgia	Zambia	Switzerland	
Ghana		UK	
Guyana		US	
Hong Kong			
Hungary			
India			
Indonesia			
Israel			
Korea			
Latvia			
Lithuania			
Malawi			
Malaysia			
Malta			
Mexico			
Moldova			