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Remittances and the Real Effective Exchange Rate

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We examine the long-run relationship between remittances and the real exchange rate for less developed countries using a panel cointegration approach. We employ an innovative method for the measurement of the multilateral real effective exchange rate and we focus on high remittance economies. We find a small inelastic, but significant, long-run relationship which confirms a “Dutch disease” type effect. Short-run confirmation is given by a panel error correction model. Potential asymmetries in this relationship are explored using quantile regression analysis.

JEL Codes: F0, F4, O1.

Keywords: Remittances; Real Effective Exchange Rate; Panel cointegration; Panel error correction; Quantile regression.

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Remittances and the Real Effective Exchange Rate

1. Overview and Introduction

Remittances by immigrant workers are now an important source of funds for many developing countries and their inflows have been rapidly growing. During 2007 and 2008 their growth rate was 15 percent; Ratha et. al., (2009).¹ Barajas et. al., (2009) and Chami et. al., (2008) reported that during 2007 remittances through official channels were \$300 billion in addition to unknown transfers through unofficial channels, which are estimated to be about 40 percent of flows through the official channels. The ratio of remittances to *GDP* exceeds 1 percent in 60 countries. Although a significant proportion of these inflows are for altruistic reasons to support consumption and the living standards of family members, some are also motivated by pecuniary gains and take advantage of the incentives offered by the recipient countries. For example, in India deposits by the non-residents attract higher interest rates and are exempt from income tax. Similarly Pakistan and Bangladesh give incentives to increase remittances. In 2008 India's remittance receipts are the highest at US\$52 billions. Other countries with high remittances are China and Mexico.

Although remittances flow can contribute to the development in the economy, it may come with some costs. There are at least two non-controversial positive aspects of remittances flow, which are as follows. Firstly, a steady flow of remittances reduce volatility in output given that volatility and growth are found to be inversely related in a number of key studies; see Ramey and Ramey (1995), Kroft and Lloyd-Ellis (2002), Hnatkovska and Loayza (2003), IMF (2005), World Bank (2006) and Chami et al (2008). Secondly, there is evidence that remittances improve the development of the financial sector by easing the credit constraints for investments; see Aggarwal et. al. (2006), Gupta, Pattillo, and Wagh (2007) and Giuliano and Ruiz-Arranz (2009). However, this paper studies the negative consequences remittances can produce through its effect on the real exchange rate. It is found that the real exchange rate may appreciate as the inflow remittances rises; see Acosta, Lartey and Mandelman (2007), Amuedo-Dorantes and Pozo (2004), Lopez, Molina and Bussolo (2007) and Lartey, Mandelman and Acosta (2008).

Remittances sent by migrant workers to their home countries correspond to a capital inflow similar to the one analysed by the Dutch Disease theory where the discovery of new resources which is analogous to capital inflow is assessed against their effects on the real exchange rate and the country's international competitiveness (Corden and Neary, 1982). A large inflow of remittances relative to the size of the recipient economy, may bring may some undesirable consequences including the possibility of real exchange rate appreciation and loss of competitiveness in the tradable sector of the economy.

¹ Ratha, D., Mohapatra, S. and Silwal, A. (2009) "Outlook for Remittance Flows 2009-2011: Remittances expected to fall by 7-10 percent in 2009," *Migration and Development Brief*, World Bank.

In a small open economy where an increase in remittances is similar to a permanent increase in the non-labour income of the household, an increase in remittances leads to *spending effects* in both the tradables and non-tradables goods sectors. The spending effect is a function of the increase in disposable income following the inflow of remittances which increases demand in the economy assuming positive income elasticity. Because the supply of non-tradables is constrained by the available resources in the economy, excess demand will increase the price of non-tradables goods whereas the increased demand does not affect the price for tradables goods which are set in the international market leading to an appreciation of real exchange rate. An increase in remittances also leads to a *resource movement effect*. A rise in the relative price of non-tradables makes production in this sector more profitable compared to tradables sector. As a result production expands in non-tradables sector resulting in increased factor demands. Responding to higher factor prices in the non-tradables sector, there is a shift of resources from the tradables to non-tradables goods sector raising real wages and other factor costs of the tradables sector. Because of these spending and resource movement effects, the inflow of workers' remittances can erode the competitiveness of the tradables goods sector causing an appreciation of the real exchange rate.

The interacting effect of remittances inflow and real exchange rate may differ in the long-run compared to the short-run. The appreciation of the real exchange rate and deterioration of the country's competitiveness because of remittances flow may be offset if such flows boost capital accumulation by augmenting savings and investments in the long run which can increase the production of both tradables and non-tradables where the relative increase will vary from country to country depending on the structure of the economies. Whilst many of the current empirical literature provide evidences for the short-run effect of remittances and real exchange rate, there are almost none which tested the long run relationship. In this paper we endeavour to investigate the long-run relationship between inflow of remittances and real exchange in a panel of high remittances recipient economies.

The real effective exchange rate (*REER*) is defined as the relative price of traded goods to non-traded goods produced as in the domestic economy:

$$REER = \frac{P_T}{P_{NT}},$$

where P_T is the domestic currency price index of traded goods and P_{NT} is the domestic currency price index of non-traded goods (Montiel and Hinkle, 1999 and Montiel, 1999)². A fall in *REER* implies a real exchange rate appreciation and an increase in the opportunity cost of the production of tradable

² Montiel, P. and L. Hinkle (1999) Exchange rate misalignment: an overview. In Hinkle, L. and P. Montiel (Eds.), *Exchange Rate Misalignment: Concept and Measurement for Developing Countries*. World Bank Research Publication. Oxford University Press, New York, pp. 264-263

Montiel, P. (1999) The long-run real exchange rate: conceptual issues and empirical research. In Hinkle, L. and P. Montiel (Eds.), *Exchange Rate Misalignment: Concept and Measurement for Developing Countries*. World Bank Research Publication. Oxford University Press, New York, pp. 264-263

goods (Bourdet and Falck, 2008)³. An appreciation of real exchange rate (i.e. a fall in *REER*) is understood as a deterioration of the country's external competitiveness given unchanged relative prices of trading partners. Conversely, a high *REER* (i.e. an increase in *REER*) means real exchange rate depreciation and an improved international competitiveness.

The flow of inward remittances, like any other forms of international transfer, can appreciate the real exchange rate known as the 'Dutch disease' effect. Arrival of remittances will lead to increased spending and create excess demand in the non-tradable goods sector pushing the price of non-tradables upward (Lundahl, 1985)⁴. Because the price of tradable goods are determined in the world market, an increase in P_{NT} cause *REER* to fall causing a real exchange rate appreciation.

In this paper we investigate whether remittances cause *REER* appreciation in our sample of 24 high remittances recipient economies. In section 2 we present a summary of previous studies on this topic followed by section 3 where we discuss the various methodologies adopted in previous works and then outline our econometric model. Section 4 presents the econometric results and in section 5 we conclude.

2. Summary of Literature

There are few previous studies which have estimated the empirical relationship between remittances and real exchange rate with panel data. Amuedo-Dorantes and Pozo (2004) use a panel of 13 Latin American and Caribbean countries and found that remittances appreciates real exchange rate over the time period 1979 – 98. The result was confirmed by Lopez, Molina and Bussolo (2007) for a panel of 20 countries (some of which are Latin American) over the time period 1990-2003. Because real exchange rate is an index variable, in contrast to Amuedo-Dorantes et al (2004), Lopez et al (2007) used change in remittances as dependent variable and the role of remittances in appreciating real exchange rate could be rejected. Whilst the above studies used panel data methodology, Izquierdo and Montiel (2006) obtained mixed result using time series methodology for six Central American countries viz. Dominican Republic, El Salvador, Guatemala, Honduras, Jamaica and Nicaragua. Finally, in a recent paper by Lartey, Mandelman and Acosta (2012), it is found that flow of inward remittances cause real exchange rate appreciation in a comprehensive sample of 109 countries over the time period 1992 – 2003. In Table 1 we present a summary of specifications, dependent and independent variables, and estimators used in these papers for the convenience of the reader.

³ Bourdet, Y. and H. Falck (2008) Emigrants' remittances and Dutch Disease in Cape Verde. *International Economic Journal*, 20:3, 267 – 284

⁴ Lundahl, M. (1985) International migration, remittances and real incomes: effects on the source country. *Scandinavian Journal of Economics*, 87, pp. 647-657

Table 1
Summary of Studies on Remittances and Real Effective Exchange Rate

<i>Study</i>	<i>Specification</i>	<i>Dependent Variable</i>	<i>Independent Variables</i>	<i>Estimator</i>	<i>Data Period</i>	<i>Instruments</i>
Amuedo-Dorantes and Pozo (2004)	$REER = \beta_0 + \beta_1 REM + \beta_2 Z + u$	Log of real exchange rate	Log of workers' remittances, log of foreign aid, log of GDP per capita log of terms of traded, log of government expenditure and US interest rate	FE-IV	Panel; 1979 - 1998	external
Lopez, Molina and Bussolo (2007)	$\Delta REER = \beta_0 + \beta_1 \Delta REMRAT + \beta_2 Z + u$	Change in log of real effective exchange rate	Change in remittances (% of GDP), per capita GDP growth, change in terms of trade, government consumption (% of GDP), US - 6 month interest rate	FE & FE-IV	Panel	external
Lartey, Mandelman, Acosta (2012)	$REER = \beta_0 + \beta_1 REMRAT + \beta_2 Z + u$	Real effective exchange rate	Remittances to GDP, FDI (% of GDP), Non FDI private inflow (% of GDP), government expenditure growth, GDP per capita, M2 (% of GDP), terms of trade, export plus import (% of GDP), growth of GDP	System GMM	Panel; 1992 - 2003	internal, external
Izquierdo and Montiel (2006)	$REER = \beta_0 + \beta_1 REMRAT + \beta_2 Z + u$	Real effective exchange rate	Workers' remittances to GDP, average labour productivity, net international investment position (% of GDP), government consumption (% of GDP), terms of trade and export plus import (% of GDP).	VAR	TS; 1960 - 2004	--

In addition to the abovementioned studies, a limited number of investigations explore the possibility of a long-run equilibrium relationship between real exchange rate and remittances flows using panel cointegration techniques. For example, Fayissa and Nsiah (2012) find that financial development, exchange rate stability, and the size of migrant stock have positive and statistically significant effects on remittances. Their methodology is based on Pedroni FMOLS cointegration analysis. Özcan (2011), on the other hand, finds no support that workers' remittances generate Dutch disease effect in a sample of ten countries. Indeed, Table 3 in this paper suggests that workers'

remittances cause the real exchange rate to *depreciate*. The methodology is also based on Pedroni FMOLS cointegration analysis.

3. Empirical Methodology

Our methodology is different from the papers summarised in Table 1. We estimate a long run relationship between real exchange rate and remittances using a panel cointegrating equation based on the following variables:

$$Q_{it} = f(W_{it}, GY_{it}, Alpha_{it}, TOT_{it}, R_t) \quad [1]$$

where i refers to the country and t refers to the time period 1987 – 2010. Q refers to real effective exchange rate which is defined as relative price of tradable goods over non-tradable goods. Data on prices of tradable and non-tradable goods are not readily available which is why it is proxied by taking the respective country's nominal exchange rate adjusted for differences in price level, i.e.,

$E\left(\frac{P_f}{P_d}\right)$; where E is nominal exchange rate defined as the domestic price of foreign currency, and P_f

and P_d are foreign and domestic price indexes. However, rather using a proxy, in this section we have

created a new and a direct measure for *REER* for all countries in our sample by constructing $\frac{P_T}{P_{NT}}$

series from the available data on the agriculture, industry, manufacturing and service sectors (see Figure 1 below).

W is workers' remittances in current US dollars (see Figure 2 below). Remittances being large official transfer are assumed to cause real appreciation by increasing prices for non-tradable goods sector. In equation [1], an appreciation is indicated by a negative coefficient on W because a fall in Q is an appreciation. The other variables included are control variables that have been found to be useful in the literature. The definitions of these variables and their expected signs are discussed below:

- a) *Alpha* (-): Log of per capita GDP. This is used as a proxy measure for differential technological progress. Technological progress is more likely to take place in the traded goods sector of the economy relative to the non-traded sector. Increases in the productivity in the traded goods sector raises the wages in that sector, leading to a resource shift from the non-tradable goods sector. This increase in the relative price of the non-traded goods sector causes an exchange rate appreciation.
- b) *GY* (+/-): Government expenditure to GDP ratio. If government expenditure is more geared towards the non-tradable sector, the relative price of non-tradable

goods will increase causing *REER* appreciation. On the other hand if government spending is directed towards the traded goods sector, *REER* will depreciate.

- c) *R* (+/-): US six-month interest rate, This is a proxy to measure the world interest rate. A high world interest rate causes net external lending and improves the country's net creditor position with respect to rest of the world, and hence appreciate *REER*. Alternatively, in the short run, high interest rate may lead to less domestic spending and cause the relative price of the non-tradable to decline leading to depreciation of real exchange rate.
- d) *TOT* (+/-): Log of terms of trade. This is defined as price of exports relative to imports. If price of exports rise relative to imports, resources move from the non-tradable to tradable good sectors and cause an *REER* appreciation. However, since an increase in the terms of trade will raise purchasing power, consumers will shift from consuming exportables and non-tradable goods to the consumption of importable goods causing the price of non-tradable goods to fall and cause an *REER* depreciation.

Finally, we include a time trend to capture the effect of several other factors that may cause appreciation of real exchange rate other than those outlined above.

Our empirical procedure is divided into two approaches. The first part includes the panel cointegration analysis and the second part includes quantile regression analysis. Panel regression analysis is composed of panel unit root and panel cointegration tests in addition to panel-type error correction model (ECM) based on dynamic OLS (DOLS) residuals. In the case where a panel cointegration relationship exists, a panel-type ECM model is established as follows:

$$\Delta Q = \Gamma_{0i} + \sum_{j=1}^k \Gamma_{1i} \Delta Q_{it-j} + \Phi_i (Q_{it-1} - f(W_{it-1}, GY_{it-1}, Alpha_{it-1}, TOT_{it-1}, R_{it-1})) \quad [2]$$

The parameter Φ_i is the adjustment speed of error correction term- $ecm_{it-1} = (Q_{it-1} - f(W_{it-1}, GY_{it-1}, Alpha_{it-1}, TOT_{it-1}, R_{it-1}))$; a negative and significant Φ_i will give evidence that a short-run disequilibrium may be adjusted into a long-run equilibrium through the ECM process. To carry out a check for the robustness of the results obtained in the first part, we present the quantile regressions to examine the relationship between real exchange rate and remittances flows controlling for other variables, under different quantile level of real exchange rate. This allows us to ascertain whether the relationship between these two variables varies according to the level of real exchange rates in the panel of countries in our sample.

4. Data, Empirical Procedure and Results

4.1. Data

In our panel we first included 40 high remittances recipient countries with remittances to GDP ratio more than 1% over the time period 1960 – 2010. However, hardly any country had remittances data from 1960 and there were other many missing observations. Therefore to undertake balanced-panel study we reduced our sample to those countries and time period for which we have had continuous observations without gaps. Hence our data is from 1987 – 2010 for 24 developing countries. These countries are Bangladesh, Bolivia, China, Colombia, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Guatemala, Honduras, India, Indonesia, Jordan, Kenya, Malaysia, Mexico, Morocco, Pakistan, Paraguay, Philippines, Senegal and Tunisia. The behaviour of real exchange rate and workers' remittances over these countries during the data period can be viewed in Figures 1 and 2.

Our construction of the index for real exchange rate differs significantly from those in earlier papers. In a key departure from the literature, we employ an alternative measure of the real exchange rate. The traditional measurement method employed by all the previous studies is one of multiplying the nominal exchange rate with the ratio of some measures of the domestic and foreign price levels vis-à-vis the US dollar. However, this is actually a bilateral real exchange rate and when used in this manner, it can be a bad proxy for real effective exchange rate. Instead, we employ a more direct and an innovative method for the measurement of the multilateral real effective exchange rate which follows Rao and Hassan (2012). Bearing in mind that the real effective exchange rate is the relative price of traded to non-traded goods produced in the domestic economy (Montiel and Hinkle, 1999 and Montiel, 1999), we construct price deflators for the agricultural, industrial, manufacturing and service sectors in the respective economies of our sample. A weighted average of these price deflators for agricultural, industrial, and manufacturing sector gives a measure for the tradable goods sector and the price deflator for the service sectors gives a measure for the non-traded goods sector. We then construct multilateral real exchange rate by taking the ratios of these two price deflators.⁵

⁵ With regards to the abovementioned paper by Özcan (2011) our investigation differs in a number of crucial ways. First, our choice of sample is less ad hoc because we only included high remittances economies. The results reported in Özcan (2011) might be sensitive to the choice of African countries employed. Second, we employ a different measurement of *REER*.

Figure 1. Real Exchange Rate 1987 - 2010

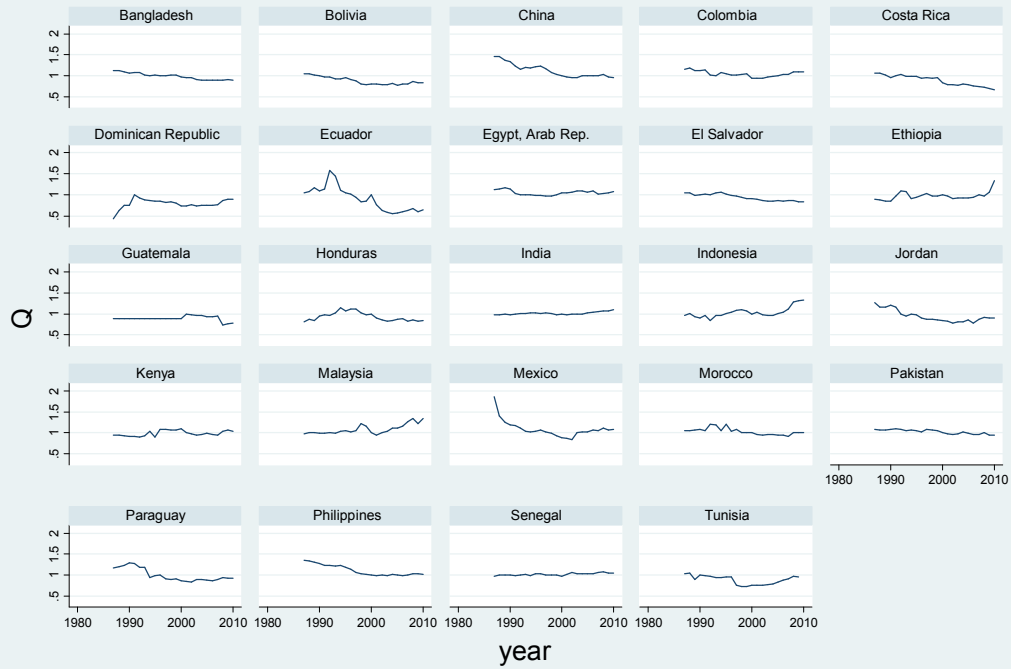
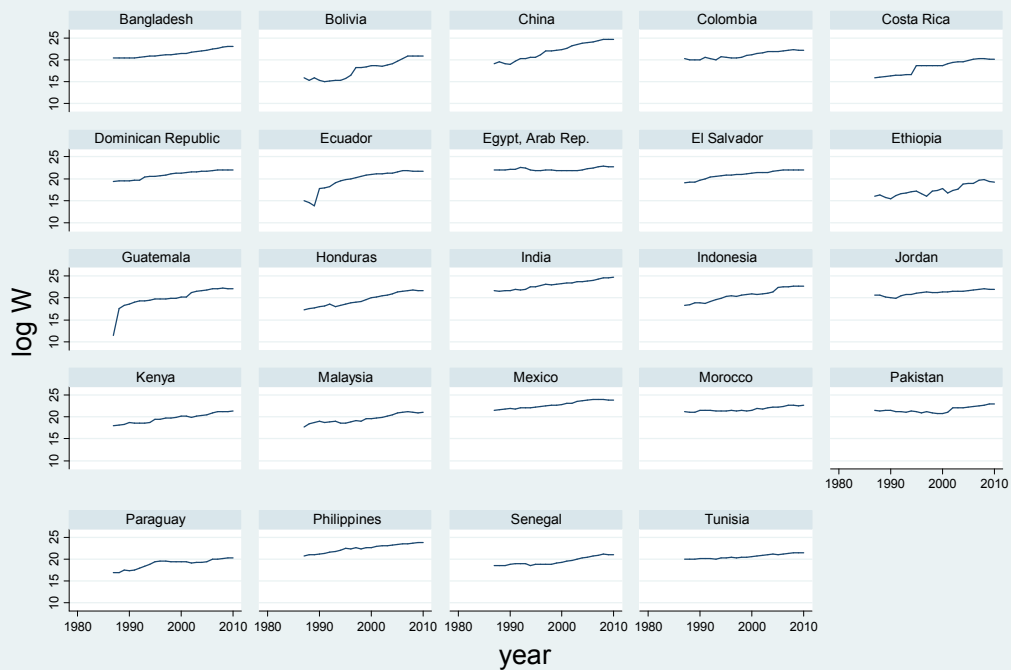


Figure 2. Workers' Remittances 1987 - 2010



4.2. Empirical procedure and results

The empirical analysis of this paper, which is divided into two parts as discussed above follows five steps. First, we conduct the panel unit root testing. Second, we test for cointegration among panel data employing the panel cointegration tests by Pedroni (1999, 2004). Third, the long-

run equilibrium relationship is estimated using the Panel DOLS (Mark and Sul, 2003), Panel FMOLS (Pedroni) and Panel Group Mean (Pesaran) procedures, where we estimate three variants of a long-run equation in which the real effective exchange is explained by workers' remittances as well as some other control variables. Fourth, once the panel cointegration is established, we estimate a panel-type ECM in order to test for the causality between W and $REER$. Finally, as a robustness check, we apply quantile regression analysis in order to estimate quantile panel-type ECM model.

4.3. Panel unit root test

Levin et al. (2002) initiated research on the panel unit root testing with heterogeneous dynamics, fixed effects, and an individual specific determinant trend. However, their assumption was the presence of a homogenous autoregressive root under the alternative. In contrast Im et al. (2003) proposed the between-group panel unit root tests that permit heterogeneity of the autoregressive root under the alternative hypothesis. Table 1 presents the results of the panel unit root tests based on Im et al. (2003). At the 1% significance level, there is strong evidence in support of the presence of unit roots in all the series except GY which is government expenditure to GDP ratio. The statistics reject the null hypothesis of non-stationarity in the Im et al. (2003) test of Q , W , TOT , $Alpha$ and R in the first difference form. Using this result, we proceed towards testing whether there exists a long-run cointegration relationship among the variables in equation (1) where we include then exclude the GY variable.

Table 1. Panel Data Unit Root Tests

Q	-0.683	DQ	-17.072***
W	-1.497	DW	-23.002***
GY	-3.755***	DGY	-16.219***
TOT	3.673	$DTOT$	-22.724***
$Alpha$	2.298	$DAlpha$	-16.008***
R	8.954	DR	8.954??
Notes for Table 1. These are panel data unit root tests advocated by Im <i>et al.</i> (2003). These statistics tend to a standard normal distribution as $N, T \rightarrow \infty$. *** denotes rejection of the null of joint non-stationarity at the 1% significance level with a critical value of -2.33. The 5% critical value is -1.64. All tests include time dummies.			

4.4. Panel cointegration test

The procedure for computing the test statistics for panel data non-cointegration involves estimating the hypothesized cointegration regression described in (1) and using the residuals to estimate the appropriate autoregression. Pedroni advocates two statistics both based on a group-mean approach. *Group PP* is non-parametric and analogous to the Phillips-Perron t statistic and *Group ADF* is a parametric statistic and analogous to the ADF t statistic.⁶ These two statistics are referred to as *between-dimension* statistics that average the estimated autoregressive coefficients for each country.

⁶ This latter statistic is analogous to the Im, Pesaran and Shin (2003) test for a panel unit root applied to the estimated residuals of a cointegrating regression.

Under the alternative hypothesis of cointegration, the autoregressive coefficient is allowed to vary across countries. This allows one to model an additional source of potential heterogeneity across countries.⁷ Following an appropriate standardization, both of these statistics tend to a standard normal distribution as $N, T \rightarrow \infty$ diverging to negative infinity under the alternative hypothesis and consequently, the left tail of the normal distribution is used to reject the null hypothesis of non-cointegration. Table 2 presents the results of Pedroni (1999, 2004) panel cointegration test based on *Group PP* and *Group ADF* statistics for the full model between each Q , W , GY , TOT , $Alpha$ and R and a partial model that excludes GY . The results strongly advocate that a long-run cointegrating relationship exists for both of these models because the null of non-cointegration is rejected at 1%.

Table 2. Panel Data Cointegration Tests

	A: Pedroni Cointegration Test	
	Full model	Model that excludes GY
<i>Group PP</i>	-4.371***	-3.580***
<i>Group ADF</i>	-4.719***	-3.421***
	B:Westerlund (2007) ECM panel cointegration test	
<i>Gt</i>	-2.853***	
<i>Ga</i>	-1.618*	
<i>Pt</i>	-1.997**	
<i>Pa</i>	-2.989***	
Notes for Table 2. These are the Pedroni tests for panel cointegration [discussed in Pedroni [(1999), (2004)] between each <i>Q</i> , <i>W</i> , <i>GY</i> , <i>Tota</i> , <i>Alpha</i> and <i>R</i> . These estimates include common time dummies. Individual lag lengths are based on the Akaike information criterion. These statistics tend to a standard normal distribution as $N, T \rightarrow \infty$. ***, ** and * denote rejection of the null of non-cointegration at the 1, 5 and 10% significance levels critical values of -2.33, -1.64 and -1.28 respectively. Westerlund (2007) is bi-variate panel cointegration test between <i>Q</i> and <i>W</i> . Individual lag and lead lengths are based on the Akaike information criterion. ***, ** and * denote rejection of the null of non-cointegration at the 1, 5 and 10% significance.		

We also check for cointegration between Q and W by implementing the four panel cointegration tests developed by Westerlund (2007) and the results are shown in panel B of Table 2. The underlying idea is to test for the absence of cointegration by determining whether the individual panel members are error correcting. The Ga and Gt test statistics are based on a weighted average of the individually estimated short-run coefficients and their t-ratio's, respectively. The Pa and Pt test statistics pool information over all the cross-sectional units to test the null of no-cointegration for all cross-section entity. The tests are very flexible and allow for an almost completely heterogeneous specification of both the long- and short-run parts of the error-correction model, where the latter can be determined from the data. The series are allowed to be of unequal length. We can see from results

⁷ Pedroni also proposes four *within-dimension* statistics (*panel v*, *panel ρ* , *panel t* and *panel ADF*) that effectively pool the autoregressive coefficients across different countries during the unit root tests. In these tests, a common value for the autoregressive coefficient is specified under the alternative hypothesis of cointegration.

of Westerlund (2007) tests, the null of no error-correcting relationship was rejected according to all four tests.

4.5 Estimation of long-run relationship

Having confirmed the existence of cointegration for our panel, we now turn to estimate the parameters of the long-run equilibrium relation among the variables in equation (1). In particular, the long-run equilibrium relationship is estimated using Panel DOLS (Mark and Sul, 2003), Panel FMOLS (Pedroni) and Panel Group Mean (Pesaran) procedures, where we estimate three variants of a long-run equation in which the real effective exchange is explained by workers' remittances as well as some other control variables which includes government expenditure to GDP, terms of trade, per capita real GDP and US six-month interest rate. The results of these are presented in Table 3. We are mostly interested in the estimated sign on the variable workers' remittances, i.e., W . An appreciation of the real exchange rate is indicated by a fall in Q , as a result if the estimated long-run coefficient on W is both negative and statistically significant, it will give us support to claim that remittances cause real exchange rate appreciation in our panel of countries. The panel DOLS results are reported in column one followed by panel FMOLS and panel group mean in columns two and three respectively. It can be readily seen that the estimated coefficient on W is negative as well as significant at the level of 1% in all three methods of estimation. Whilst the estimated signs are same in all the three methods, the estimated magnitude for the coefficient W differs. This is estimated to be -0.048 in the panel DOLS which is slightly higher than that estimated in panel group mean which stands to be -0.064. The highest magnitude was estimated in panel FMOLS which is -0.005.

Table 3. Estimation of Long-Run Coefficients

	Panel DOLS	Panel FMOLS	Panel Group Mean
W	-0.048*** (-14.230)	-0.005*** (-5.022)	-0.064*** (-4.400)
GY	-0.022*** (-14.316)	-0.032*** (-12.397)	-0.016** (-2.594)
TOT	-0.000 (1.721)	0.000*** (3.375)	-0.000*** (-2.294)
$Alpha$	-0.072*** (-3.042)	-0.196 (-0.098)	0.209** (2.481)
R	-0.001** (-2.847)	0.002 (1.511)	-0.014*** (-9.506)
Notes for Table 3. These estimates include common time dummies. Each slope estimate is accompanied by t -statistics in parentheses based on the null of a zero slope.			

With regard to the other control variables in Table 3 which are found important in explaining real exchange rate behaviour, the a priori expected signs as given in theory for GY , TOT and R are indeterminate as a result these could be either positive or negative. But for $Alpha$, there is a definitive expected sign according the famous Balassa-Samuelson effect. $Alpha$ stands for real per capita GDP as a proxy measure for differential technological progress. Technological progress is more likely to

take place in the traded sector of the economy relative to the non-traded sector. Increases in the productivity in the traded goods sector raises the wages in that sector, leading to a resource shift from non-tradable goods sector. As a result this increases the relative price of non-traded sector because of increase in their factor price, thereby causing exchange rate appreciation. Hence, the expected sign of Alpha is negative. So it can be seen that only panel DOLS and panel FMOLS have the correct sign of Alpha, although in the latter it is not statistically significant from zero. The estimated sign for Alpha is positive in the case of the panel group mean estimator. As a result it can be seen that the panel DOLS results give us the results where all variables contain the correct signs on the estimated coefficients in addition to having most of the statistically significant variables. Therefore, we choose the panel DOLS as our preferred estimate of the long-run equilibrium relation of workers' remittances and real exchange rate.

4.6 Panel-type ECM model

As we have found the existence of long-run cointegrating relationship between Q and W , and have confirmed the estimated signs of the long-run coefficient of W and control variables in the panel cointegration equation conform to those expected a-priori from theory, we estimate the panel-type ECM model of equation (2) using ΔQ_{it-1} as the dependent variable. We obtain the residuals from the estimations based in panel DOLS which is our preferred long-run estimator.

Table 4. Panel Error Correction Model

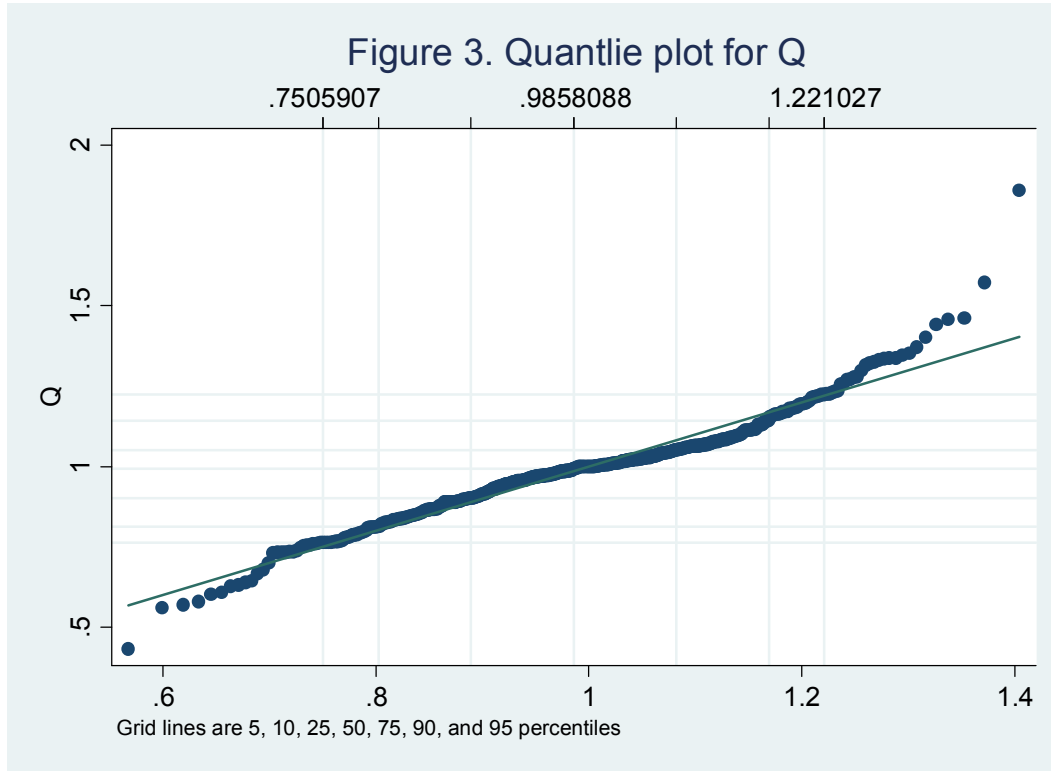
Variables	Estimates
ECM_{it-1}	-0.171*** (0.033)
ΔW	-0.012* (7.0E-003)
ΔGY	-0.011*** (3.5E-003)
$\Delta ALPHA$	-0.225*** (0.087)
$\Delta TOTA$	-7.9E-010** (3.9E-010)
ΔR	7.7E-004 (2.1E-003)
ΔQ_{it-1}	0.048 (0.055)
R-sq	0.114
Se	0.055
LM	1.326
The lagged disequilibrium error is based on the earlier panel DOLS results. The estimates here are from fixed effects estimation where *, ** and *** respectively denote significance at the 1, 5 and 10% significance levels based on the figures in parentheses which are robust standard errors. LM is an LM test for first order serial correlation of the residuals.	

Table 4 reports the estimated result of panel-type ECM. The AIC criterion was used to determine the lagged period that is suitable for the model. It can be seen that the error correction term

ECM_{it-1} negative and highly significant at 1% level. This suggests, through error correction, a short-run disequilibrium can eventually be turned into a long-run equilibrium and the adjustment is stationary. The magnitude of the estimated speed of adjustment coefficient which equals -0.17 suggests that approximately 17% of the short-run disequilibrium is adjusted towards the long-run equilibrium value per year. Hence half of any misalignment will be completely adjusted for in about three years. Also important to note from Table for that the short-run relation between ΔQ and ΔW is also negative and significant at the level of 10%, suggesting that inflow of workers' remittances tend to appreciate real exchange rate even in the short run. Given that the coefficient of short-run exchange rate appreciating effect of workers' remittances is estimated to be -0.012, we conclude that this is stronger than the long-run effect which is estimated to be -0.048 based on our preferred panel DOLS results. Thus the panel-type ECM establishes a uni-direction causality running from ΔW to ΔQ in the short-run. Although there may be possibility of a bi-directional causality between these variables, we do not pursue this here. It might be noted at this point that, panel-type ECM based on OLS estimator is the average estimation result and it neglects the fact that different levels of real exchange rate within the countries in the panel may result in different causal relationships and influence between ΔW and ΔQ . Therefore the OLS estimation of the ECM model may not give us a clear picture as much as quantile type regression will permit.

4.7 Quantile panel-type ECM model

In this section, we estimate quantile panel-type ECM model which permit us to see if the causal effect of ΔW on ΔQ varies according to the different levels of ΔQ within our sample. For example if we look at Figure 3, we can see that the countries in our sample can be grouped in terms low, medium and high values of ΔQ . At low values are those countries below the 5th percentile and at the high levels are those who are above 95th percentile. As a result it is possible that ΔQ responds to ΔW according to quantiles. A quantile panel-type ECM will therefore allow us to further understand the results in different quantiles by dividing the quantile regimes and testing causality between ΔW and ΔQ in the short-run. We perform the estimation by using the quantile regression method which permits different parameters across different quantiles of the dependent variable (see Koenker and Basset, 1978; and Koenker and d'Orey, 1987). Following Buchinsky (1998), we employ the design matrix bootstrap method to obtain estimates of standard errors for the parameters in the simultaneous quantile regressions using 1,000 bootstrap replications. This method performs well for relatively small samples and remains valid under numerous forms of heterogeneity.



In Table 5 we present the results of quantile-type panel regressions of the ECM model at the 5th, 25th, 50th, 75th and 95th quantile by estimating these simultaneously by using our preferred panel DOLS residuals. Columns 2, 3, 4, 5 and 6 represents these regressions across the quantiles. Some interesting results can be observed. It can be seen that causal effect of ΔW on ΔQ is not present in all quantiles. In particular, we can see that in the short-run, workers' remittances cause Q to appreciate for those countries which are at low level of ΔQ , i.e. those at 5th quantile and for those countries which are at middle and upper middle level of ΔQ , i.e. those at 50th and 75th quantile. In contrast, in the short-run workers' remittances do not cause an appreciation countries with high level of ΔQ (i.e. 95th quantile) and lower middle level of ΔQ (i.e. 25th quantile). Also interesting to note that, the magnitude of this effect is uniform at around -0.02 across 25th to 95th quantile, but it is estimated to be much lower in the 5th quantile equalling -0.08.

Table 5. Estimates of Quantile-Type ECM Model.

Dependent Variable: ΔQ	Quantiles:				
	0.05 th	0.25 th	0.50 th	0.75 th	0.95 th
ΔW	-0.082 (-2.43)**	-0.020 (-1.26)	-0.021 (-1.87)*	-0.024 (-1.94)*	-0.22 (0.33)
ΔAlpha	-0.659 (-2.66)***	-0.102 (-0.76)	-0.083 (-0.71)	-0.234 (-1.72)*	-0.676 (-2.91)***
ΔTOT	-1.32E-09 (-0.94)	-4.03E-10 (-0.65)	-8.07E-10 (-1.24)	-6.13E-10 (-1.24)	-3.49E-10 (-0.65)
ΔGY	-0.013 (-2.25)**	-0.005 (-1.28)	-0.010 (-2.09)**	-0.009 (-1.50)	-0.003 (-0.33)
ΔR	0.076 (3.64)***	0.029 (1.69)*	0.011 (0.64)	0.018 (1.21)	-0.017 (-0.74)
ECM_{it-1}	-0.342 (-0.68)	-0.215 (-0.93)	-0.264 (-1.18)	-0.140 (-0.42)	0.980 (1.94)*
N=	360	360	360	360	360
Pseudo R ²	0.27	0.10	0.08	0.11	0.23

Note: Simultaneous quantile regression with bootstrap standard errors. All regressions include time dummies and t-statistics on parentheses where *, ** and *** respectively denote significance at the 1, 5 and 10% significance levels

5. Conclusion

The steady rise of workers' remittances flow and its stability and resilience even at the face of global recession has brought many researchers to study the macroeconomic consequences of it. Many studies have already pointed out the positive contribution remittances can make on the development of the recipient economies. However, large inflow of remittances can also bring negative consequences by eroding the competitiveness of the tradable-goods sector via causing appreciation of real exchange rate. This paper studies the long-run real exchange rate appreciating effect of workers' remittances using a panel co-integration framework. We obtain new measure of real exchange rate by taking the ratio of prices of tradables to non-tradables goods sector, and then show that workers remittances' contributes to the real exchange rate appreciation in the long-run. Using a panel ECM estimates we show that there is causality running from remittances to real exchange rate in the short run, and this short run effect is stronger than that of the long run. Finally using a quantile panel-type ECM model, we show that the short run effect varies according to the different levels of real exchange rate appreciation within the countries in our sample. The short-run causal appreciating effect remittances is weaker for countries with a low level of real exchange rate appreciation but stronger for those with higher level.

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