The effects of real exchange rate misalignment and real exchange volatility on exports

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Abstract

This paper uses panel data cointegration techniques to study the impacts of real exchange rate misalignment and real exchange rate volatility on total exports for a panel of 42 developing countries from 1975 to 2004. The results show that both real exchange rate misalignment and real exchange rate volatility affect negatively exports. The results also illustrate that real exchange rate volatility is more harmful to exports than misalignment. These outcomes are corroborated by estimations on subsamples of Low-Income and Middle-Income countries.

<u>Keywords:</u> *real effective exchange rate; misalignment; volatility; exports; pooled mean group estimator*

<u>JEL Classification:</u> *F13, F31, F41*

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Introduction

Theoretically, real effective exchange rate (REER) misalignment has a negative effect on economic performance. In fact, it reduces the export of tradable goods and the profitability of production. REER misalignment deteriorates domestic investment and foreign direct investment, consequently growth, by increasing uncertainty. REER misalignment leads also to a reduction in economic efficiency and a misallocation of resources (*Edwards (1988)*, *Cottani, et al. (1990)* and *Ghura and Grennes (1993))*. Studies have also shown that undervaluation can improve growth. *Levy-Yeyati and Sturzenegger (2007)* state that undervaluation increases output and productivity through an expansion of savings and capital accumulation. *Rodrik (2009)* illustrates that undervaluation rises the profitability of the tradables sector, and leads to an extension of the share of tradables in domestic value added. Larger profitability encourages investment in the tradables sector and helps economic growth. *Korinek and Serven (2010)* illustrates that real exchange rate undervaluation can increase growth through learning-by-doing externalities in the tradables sector.

Real effective exchange rate (REER) volatility has also a negative impact on economic performance. In fact, higher REER instability raises uncertainty on the profitability of producing tradable goods and of long-run investments. Higher REER volatility sends confusing signals to economic agents (*Grobar (1993), Cushman (1993)* and *Gagnon (1993)).* Some authors, like *Aghion et al. (2009),* have argued that the impact of exchange rate volatility on economic performance is function of the level of financial development. Others states that the effect of exchange rate variability on economic performance depends on the complementarity between macroeconomic stability and political factors *(Eichengreen (2008)).*

Many studies have investigated the empirical link between exchange rate misalignment, REER volatility and economic performance in general and between REER misalignment and exports in particular. *Cottani et al. (1990), Razin and Collins (1997)* and *Aghion et al*. (2009) show that there exists a negative correlation between REER volatility or REER misalignment and economic performance. For the link REER misalignment-export, using a panel data of 53 countries *Nabli and Véganzonès-Varoudakis (2002)* found a negative relationship. The same results were found by *Jongwanich (2009)* for a sample of Asian developing countries. *Sekkat and Varoudakis (2000)* found that REER volatility does not have a systematic negative impact on manufactured export while REER misalignment exerts a significant negative influence on export for a panel of Sub-Saharan African countries. *Jian (2007)* also found that exchange rate misalignment has a negative influence on China's export.

This paper fits in these researches of the links between the REER misalignment, REER volatility and economic performance. It specifically analyzes the relationship between exchange rate misalignment, REER volatility and total exports. It distinguishes itself by using panel data cointegration techniques and a measurement of REER volatility which have not been used in previous works. The sample studied contains 42 developing countries from 1975 to 2004. We use panel data cointegration techniques because our time span is too large: 30 years. This raises the question of the existence of potential unit root in the variables studied and leads to the issue of cointegration. The application of panel data cointegration techniques has several advantages. Initially, annual data enable us not to lose information contrary to the method of averages over subperiods. Then, the addition of the cross sectional dimension makes that statistical tests are normally distributed, more powerful and do not depend on the number of regressors in the estimation as in individual time series. Among the panel data cointegration techniques, we utilize

Pesaran et al. (1999) Pooled Mean Group Estimation of Dynamic Heterogeneous Panels estimator. The microeconomic panel data methods: random effects, fixed effects, and GMM oblige the parameters (coefficients and error variances) to be identical across groups, but the intercept can vary between groups. GMM estimation of dynamic panel models could lead to inconsistent and misleading long-term coefficients when the period is long. *Pesaran et al. (1999)* suggest a transitional estimator that permits the short-term parameters to differ between groups while imposing equality of the long-run coefficients.

The paper is organized as follow: section 1 presents the econometrics estimations methods, section 2 analyze the data, section 3 shows how the variables of interests are measured, section 4 and 5 deal with the panel data tests and main estimations results respectively, section 6 carry out some robustness analysis and the last section concludes.

1. Econometrics models and estimations methods

To estimate the effect of exchange rate misalignment, REER volatility on total exports, the method of *Pooled Mean Group Estimation of Dynamic Heterogeneous Panels* of *Pesaran et al. (1999)* is applied. In this model, the long-run variation of export and other regressors are supposed to be identical for countries but short-run movements are expected to be specific to each country. The estimated model is an $(\text{ARDL})(p,q_1,...,q_k)$ representation of the form:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij} X_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (1)$$

Where $i = 1, 2, ..., N$ is the number of groups; $t = 1, 2, ..., T$ is the number of periods; X_{it} is the $k \times 1$ vector of regressors; δ_{ij} are the $k \times 1$ coefficient vectors; λ_{ij} are scalars and μ_i is the fixed effects.

Equation (1) can be rewritten as error correction model of the form:

$$\Delta y_{it} = \phi_i \left(y_{i,t-1} - \theta'_i X_{it} \right) + \sum_{j=1}^{p-1} \lambda^*_{ij} \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \delta'^*_{ij} \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (2)$$

Where $\phi_i = -\left(1 - \sum_{j=1}^{p} \lambda_{ij} \right)$; $\theta_i = \sum_{j=0}^{q} \delta_{ij} / \left(1 - \sum_k \lambda_{ik} \right)$; $\lambda^*_{ij} = -\sum_{m=j+1}^{p} \lambda_{im} \quad j = 1, 2, ..., p-1$ and $\delta^*_{ij} = -\sum_{m=j+1}^{q} \delta_{im} \quad j = 1, 2, ..., q-1$.

The parameter ϕ_i is the error correction term. This parameter is supposed to be significantly negative since it is assumed that the variables return to a long-term equilibrium. The long-run relationships between the variables are in the vector θ'_i. To estimate equation (2) *Pesaran et al. (1999)* propose a PMG estimator. This estimator constrains the long-term coefficients to be equal through the groups but forces short-term coefficients and error variances to be different through the groups. *Pesaran et al. (1999)* use the maximum likelihood method to estimate the parameters in equation (2) given that this equation is nonlinear. The log-likelihood function is given by:

$$l_T(\theta', \varphi', \sigma') = -\frac{T}{2}\sum_{i=1}^{N} \ln\left(2\pi\sigma_i^2\right) - \frac{1}{2}\sum_{i=1}^{N}\frac{1}{\sigma_i^2}\left\{\Delta y_i - \phi_i \xi_i(\theta)\right\}' H_i \left\{\Delta y_i - \phi_i \xi_i(\theta)\right\} \quad (3)$$

Where $i = 1,...,N$; $\xi_i(\theta) = y_{i,t-1} - X_i\theta_i$; $H_i = I_T - W_i\left(W_i'\ W_i\right)W_i$, I_T is an identity matrix of order T and $W_i = \left(\Delta y_{i,t-1},...,\Delta y_{i,t-p+1}, \Delta X_i, \Delta X_{i,t-1},...,\Delta X_{i,t-q+1}\right)$.

The estimated long-run relationship between REER misalignment, REER volatility, the control variables and exports is:

$$\begin{aligned} Log(EXPGDP_{it}) = \theta_0 + \theta_1 MISAL_{it} + \theta_2 RERVOL_{it} + \theta_3 Log(MVADGDP_{it}) + \theta_4 Log(GDPTP_{it}) + \\ \theta_5 Log(TOT_{it}) + \theta_6 Log(RGDP_{it}) + \theta_7 Log(INVGDP_{it}) + \upsilon_{it} \end{aligned} \quad (4)$$

Where θ_i are the long-term parameters, $Log(EXPGDP_{it})$ is Log Exports to GDP, $MISAL_{it}$ is REER misalignment, $RERVOL_{it}$ is REER volatility, $Log(MVADGDP_{it})$ Log Manufactured value added to GDP, $Log(GDPTP_{it})$ Log GDP of trade partners, $Log(TOT_{it})$ Log Terms of trade, $Log(RGDP_{it})$ Log Real GDP and $Log(INVGDP_{it})$ Log Investment to GDP. Table 1 gives the definition, expected signs and sources of all variables of the study and Table 2 shows the summary statistics on the variables. If we assume that all variables in equation (4) are *I(1)* and cointegrated then υ_{it} is *I(0)*. The error correction representation of equation (4) is given by:

$$\Delta Log(EXPGDP_{it}) = \phi_i[Log(EXPGDP_{it-1}) - \theta_0 - \theta_1 MISAL_{it} - \theta_2 RERVOL_{it} - \theta_3 Log(MVADGDP_{it}) - \theta_4 Log(GDPTP_{it}) - \theta_5 Log(TOT_{it}) - \theta_6 Log(RGDP_{it}) - \theta_7 Log(INVGDP_{it})] + \delta_{1i}\Delta MISAL_{it} + \delta_{2i}\Delta RERVOL_{it} + \delta_{3i}\Delta Log(MVADGDP_{it}) + \delta_{4i}\Delta Log(GDPTP_{it}) + \delta_{5i}\Delta Log(TOT_{it}) + \delta_{6i}\Delta Log(RGDP_{it}) + \delta_{7i}\Delta Log(INVGDP_{it}) + \varepsilon_{it} \quad (5)$$

The parameter ϕ_i is the error-correcting speed of adjustment term. As mentioned above, we expect this parameter to be significantly negative implying that variables return to a long-run equilibrium.

2. Data and Variables

To study the effect of REER misalignment and REER volatility on exports, we utilize annually data from 1975 to 2004 of 42 developing countries. The data are from World Development Indicators (WDI) 2006, International Financial Statistics (IFS), April, 2006 and Centre D'études Et De Recherches Sur Le Développement International (CERDI) 2006. Table 3 gives the list of all countries used in the study.

The REER is calculated according to the following formula:

$$RER_{i/j} = \prod_{j=1}^{10}\left(NBER_{j/i}\frac{CPI_i}{CPI_j}\right)^{\omega j} \quad (6)$$

Where:

$NBER_{j/i}$: is the nominal bilateral exchange rate of trade partner j relative to country i

CPI_i: represents the consumer price index of country i (IFS line 64). When the country CPI is missing, the growth rate of the GDP deflator is used to feel the data;

CPI_j: corresponds to the consumer price index of trade partner j (IFS line 64). When the country CPI is missing, the growth rate of the GDP deflator is used to feel the data;

ω_j: stands for trade partner j weight (mean 1999-2003, PCTAS-SITC-Rev.3). Only the first ten partners are taking (CERDI method). These first ten partners constitute approximately 70% of trade weights. The weights used to generate the REER are *(Exports + Imports) / 2* excluding oil countries. Weights are computed at the end of the period of study in order to focus on the competitiveness of the most recent years.

An increase of the REER indicates an appreciation and, hence a potential loss of competitiveness.

3. Measurement of variables of interest

In this section, we will present how the variables of interest are calculated.

3.1. Measurement of REER Misalignment

Before calculating the REER misalignment, we first compute the equilibrium real exchange rate (EREER). The economic literature on exchange rate states that REER is affected by its determinants called "fundamentals" *(Williamson (1994), Edwards (1998))*. We use the PMG estimator to estimate the relationship between REER and its fundamentals. The long-run estimated equation is:

$$Log(REER_{it}) = \theta_0 + \theta_1 Log(TOT_{it}) + \theta_2 Log(GDPCAP_{it}) + \theta_3 Log(OPEN_{it}) + \upsilon_{it} \quad (7)$$

Where $Log(REER_{it})$ is the logarithm of real effective exchange rate, $Log(TOT_{it})$ the log of terms of trade, $Log(GDPCAP_{it})$ the log of real GDP per capita and $Log(OPEN_{it})$ is the log of export and import over GDP.

We expect that a rise in terms of trade ameliorates trade balance, the income effect dominating the substitution effect, hence θ_1 is expected to be positive. GDP per capita captures the *Balassa-Samuelson* effect which states that productivity increases faster in tradable than in non-tradable sectors. This phenomenon augments wages in the tradable sector, consequently wages in the non-tradable sector. This implies an increase in domestic inflation and an appreciation of the REER. Hence we expect θ_2 to be positive. Restricted trade has a downward effect on the relative price of tradable to non-tradable goods, leading therefore to an appreciation of the REER. Thus θ_3 is supposed to be negative.

If we assume that all variables in equation (7) are *I(1)* and cointegrated then υ_{it} is *I(0).* The error correction representation of equation (7) is given by:

$$\begin{aligned}\Delta Log(REER_{it}) = \phi_i\left[Log(REER_{it-1}) - \theta_0 - \theta_1 Log(TOT_{it}) - \theta_2 Log(GDPCAP_{it}) - \theta_3 Log(OPEN_{it})\right] \\ + \delta_{1i}\Delta Log(TOT_{it}) + \delta_{2i}\Delta Log(GDPCAP_{it}) + \delta_{3i}\Delta Log(OPEN_{it}) + \varepsilon_{it} \qquad (8)\end{aligned}$$

The parameter ϕ_i is the error-correcting speed of adjustment term. As mentioned above, we expect this parameter to be significantly negative implying that variables return to a long-run equilibrium. Of particular importance are the parameters θ_i which capture the long-term relationship between REER and the fundamentals. The results of the estimation of equation (8) are given in Table 4.

Table 4 shows that all parameters have the expected signs and are statistically significant. In particular the Adjustment coefficient is negative. This relationship between REER and the fundamentals is also cointegrated. For example the *Pedroni (1999)* panel data cointegration Panel-PP statistic and Group PP-statistic are respectively 0.0121 and 0.0178. This result and the negative sign of the Adjustment coefficient mean that the long-run value of REER stays around its equilibrium value. After estimating equation (8), we multiply the parameters θ_i by the corresponding three year moving average of the corresponding fundamental. This result gives us the equilibrium REER (EREER). Then REER misalignment is then computed according to the following formula:

$$Misal_{it} = \frac{Log(REER_{it})}{Log(EREER_{it})} - 1 \qquad (9)$$

In equation (9), a positive value of $Misal_{it}$ represents an overvaluation.

3.2. Measurement of REER Volatility

We compute real exchange rate volatility using ARCH family methods. Specifically we apply the asymmetric EGARCH (1, 1). The asymmetry implies that positive values of residuals have a different effect than negative ones. This is formulated as below:

$$Log(REER_t) - Log(REER_{t-1}) = \beta_0 + \varepsilon_t$$

$$Log(\sigma_t^2) = \gamma_0 + \gamma_1 \frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} + \delta_1 Log(\sigma_{t-1}^2) + \theta_1 \frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} \qquad (10)$$

Where ε_t are distributed as $N(0, \sigma_t^2)$, σ_t^2 the variance of the regression model's disturbances, γ_i the ARCH parameters, δ_1 the GARCH parameter, θ_1 the asymmetric EGARCH parameter. With this parameterization, a negative value of θ_1 means that non positive residuals produce higher variances in the near future. We measure the exchange rate volatility as the square root of the variance of the regression model's disturbances.

4. Panel data tests

In this section, we will successively present the panel unit root tests and the cointegration tests.

4.1. Panel Unit Root Tests

Table 5 gives the results of the unit root tests for all variables expressed in level. In all tests, the null hypothesis is that the series contains a unit root, and the alternative is that the series is stationary. The *Levin, Lin and Chu* and the *Breitung* tests make the simplifying assumption that the panels are homogenous while the other tests assume that the panels are heterogeneous. Excluding Log Investment to GDP and REER volatility which are stationary[2], the tests show that all the other variables may contain unit root. Moreover Table 6 illustrates that these other variables are potentially *I(1)*. This last result leads us to the issue of cointegration among these variables.

4.2. Panel Cointegration Tests

Table 7 shows the panel data cointegration tests for the equations used in the main estimation results[3]. Among the panel cointegration tests, we utilize the *Pedroni (1999)* and *Kao*

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[2] The Misalignment variable can also be considered as stationary because two tests out of four show that it is stationary.
[3] See Table 8 for the main estimation results.

(1999) panel cointegration tests. In the *Pedroni (1999)* tests, the first three tests present the within dimension while the others give the between dimension. For the *Kao (1999)* tests, only the Dickey-Fuller type tests are shown. In all these tests, the Null Hypothesis is that there is No cointegration. Overall, the results illustrates that there exist a cointegration relationship for all equations.

5. Estimation Results

Table 8 presents the main estimation of the long-term coefficients that interest us. We know that the PMG estimator constrains the long-run elasticities to be equal across all panels. This PMG estimator is efficient and consistent while the Mean Group (MG) estimator, which assumes heterogeneity in both short-run and long-run coefficients, is consistent when the restrictions are true. If the true model is heterogeneous, the PMG estimator is inconsistent while the MG estimator is consistent. We run a *Hausman* test to test for the difference between these two models in our sample of study. The P-values for the *Hausman* test in Table 8 show that we do not reject the Null hypothesis that the efficient estimator, the PMG estimator, is the desired one. The speed of adjustment parameter is negative and highly significant in all regressions and is approximately stable in magnitude. As mentioned above, this result suggests that the variables return to a long-run equilibrium.

All eight equations in Table 8 illustrate that REER misalignment and REER volatility are statistically significant and have the expected signs. We notice that the magnitude of REER misalignment is too low compared to that of REER volatility. This suggests that REER volatility is more harmful to exports than misalignment in our sample of study. The impact of REER volatility is very high. Referring to regression 4, an increase in REER volatility by one standard deviation reduces the ratio of exports to GDP by an amount approximately equivalent to 24%. These results corroborate those found by several studies like *Ghura and Grennes (1993)* and *Grobar (1993)*. The absolute value of the REER volatility coefficient diminishes by half when we introduce the logarithm of GDP of trade partners in regressions 1, 2 and 5, suggesting that the effect of volatility on exports may pass through the GDP of trade partners.

The results also highlight that exports are positively influenced by manufactured value added to GDP, GDP of trade partners, Real GDP and Investment to GDP. The Terms of trade, when they are significant, are also positively related to exports. The positive value of the coefficient of GDP of trade partners means that when the trade partners experience high growth, this results in a pulling effect on the exports of the home country. The positive effect of Real GDP and Investment to GDP means that exports increase when the productive capacity of a country rises.

6. Robustness Analysis

Table 9 and 10 give the estimations of the effects of REER misalignment and REER volatility on exports for the low income and middle income developing countries respectively. The results in the two table show that both REER misalignment and REER volatility affect negatively exports. This confirms the findings of our main estimations results. Also as in the main estimations, we observe that REER volatility has is more harmful to exports than Misalignment.

Conclusion

We studied the effects of REER misalignment and REER volatility on exports for 42 developing countries from 1975 to 2004. Using new developments on panel data cointegration techniques, we found that both REER misalignment and REER volatility have a strong negative impact of exports. But the effect of REER misalignment is smaller than that of REER volatility. The impact of REER volatility is very high: an increase in REER volatility by one standard deviation reduces the ratio of exports to GDP by an amount approximately equivalent to 24%.

Although the results found were informative, some caveats remain. First, we did not analyze the effect of REER misalignment and REER volatility on manufactured exports and for developed countries. Second, the fact that REER misalignment is a generated regressor could cause some bias in the estimation results, especially in the standards errors of the regressions.

From policy perspectives, the results show that macroeconomic instability, in particular exchange rate volatility could have negative impacts on exports and that efforts made to reduce them might relaunch exports and productivity.

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<u>Table 1:</u> Definitions and methods of calculation of the variables

Variables	Definitions	Expected Sign	Sources of data
Log Exports to GDP	Total Exports divided by GDP		
Log Manufactured value added to GDP	Logarithm of Manufactured value added over GDP	Positive	World Bank, World Development Indicators, 2004
Log GDP of trade partners	Logarithm of the GDP of trade partners. The trade partners are the same as those used to calculate the REER	Positive	Author calculations
Log Terms of trade	Logarithm of the terms of trade	Positive or Negative	World Bank, World Development Indicators, 2004
Log Real GDP	Logarithm of the real GDP	Positive	
Log Investment to GDP	Logarithm of the total Investment to GDP	Positive	

<u>Table 2:</u> Summary statistics on variables

Variables	Obs.	Mean	Std. Dev.	Min	Max
Log Exports to GDP	1259	-1.4201	0.6245	-3.5422	0.2184
Misalignment	1136	23.2513	896.0622	-8108.7380	27431.8100
REER volatility	1241	0.1531	0.3056	0.0003	7.1438
Log Manufactured value added to GDP	1185	-1.9430	0.4992	-3.6892	-0.8988
Log GDP of trade partners	1260	30.3331	1.1001	26.5335	32.3573
Log Terms of trade	1249	0.0517	0.2627	-0.9333	1.8050
Log Real GDP	1260	22.9255	1.9825	18.5565	28.1704
Log Investment to GDP	1258	-1.5386	0.3572	-3.3880	-0.3080

<u>Table 3:</u> List of 42 countries

No.	World Bank Code	Countries
1	ARG	Argentina
2	BDI	Burundi
3	BEN	Benin
4	BFA	Burkina Faso
5	BGD	Bangladesh
6	BOL	Bolivia
7	CHL	Chile
8	CHN	China
9	CIV	Cote d'Ivoire
10	CMR	Cameroon
11	COG	Congo, Rep.
12	COL	Colombia
13	CRI	Costa Rica
14	DOM	Dominican Republic
15	DZA	Algeria
16	ECU	Ecuador
17	GAB	Gabon
18	GHA	Ghana
19	GMB	Gambia, The
20	GNB	Guinea-Bissau
21	GTM	Guatemala

No.	World Bank Code	Countries
22	HND	Honduras
23	HUN	Hungary
24	IDN	Indonesia
25	IND	India
26	KEN	Kenya
27	LKA	Sri Lanka
28	LSO	Lesotho
29	MAR	Morocco
30	MEX	Mexico
31	MLI	Mali
32	MRT	Mauritania
33	MWI	Malawi
34	MYS	Malaysia
35	NIC	Nicaragua
36	PER	Peru
37	PHL	Philippines
38	PRY	Paraguay
39	SEN	Senegal
40	SWZ	Swaziland
41	TGO	Togo
42	THA	Thailand

<u>Table 4:</u> Estimation of Equilibrium Real Exchange Rate (EREER)

Dependent Variable: Log(REER)	
Regressors	
Adjustment coefficient	-0.136***
	(-7.470)
Log Terms of trade	0.343***
	(8.811)
Log Real GDP per Capita	0.156*
	(1.911)
Log Openness	-0.268***
	(-4.432)
Constant	0.487***
	(7.151)
Observations	1,085

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Panel unit root tests (Level of variables)

Variables	Levin, Lin and Chu t	Breitung t-stat	Im, Pesaran and Shin W-stat	Maddala Wu ADF-Fisher Chi-square
Log Exports to GDP	0.4990	-12.8756	-1.1752	70.0695
	(0.6911)	(0.0000)	(0.1200)	(0.8618)
Misalignment	-1.1166	-4.2965	-14.4034	16.3843
	(0.1321)	(0.0000)	(0.0000)	(0.1743)
REER volatility	-19.5993	-12.8756	-15.7458	277.0994
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Log Manufactured value added to GDP	-1.0035	1.5786	-1.0080	103.0233
	(0.1578)	(0.9428)	(0.1567)	(0.0014)
Log GDP of trade partners	1.3394	3.7455	3.4090	53.9241
	(0.9098)	(0.9999)	(0.9997)	(0.9956)
Log Terms of trade	-1.1245	-0.0145	-2.5253	111.3942
	(0.1304)	(0.4942)	(0.0058)	(0.0032)
Log Real GDP	-1.0386	-0.2293	1.9469	87.8968
	(0.1495)	(0.4093)	(0.9742)	(0.3080)
Log Investment to GDP	-5.4324	-3.9206	-5.7130	178.3153
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

P-values in Brackets. The Null hypothesis is that the panels contain unit roots

<u>Table 6:</u> Panel unit root tests (First Difference of variables)

Variables	Levin, Lin and Chu t	Breitung t-stat	Im, Pesaran and Shin W-stat	Maddala Wu ADF-Fisher Chi-square
Log Exports to GDP	-18.1706	-0.1404	-15.2702	274.9849
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Misalignment	-18.3933	-12.2606	-19.0620	408.2912
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
REER volatility	-23.7210	-16.2836	-23.4247	607.5081
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Log Manufactured value added to GDP	-12.5258	-14.1484	-16.2908	250.0973
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Log GDP of trade partners	-9.2737	-11.3343	-14.8460	330.2056
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Log Terms of trade	-10.1566	-11.7080	-18.8771	411.0109
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Log Real GDP	-7.2227	-10.8260	-15.3636	255.9766
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Log Investment to GDP	-10.6587	-13.2450	-19.2599	472.4241
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

P-values in Brackets. The Null hypothesis is that the panels contain unit roots

Table 7: Panel data cointegration tests

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Pedroni Panel Cointegration Tests	Within Dimension	Panel rho-Statistic	0.1571	0.1571	-0.0279	-0.5009	0.6601	-2.0830	-2.1244	0.2260
			(0.5624)	(0.5624)	(0.4889)	(0.3082)	(0.7454)	(0.0186)	(0.0168)	(0.5894)
		Panel PP-Statistic	-5.0846	-5.0846	-2.9607	-4.3886	-7.0129	-5.6516	-7.1082	-7.3083
			(0.0000)	(0.0000)	(0.0015)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
		Panel ADF-Statistic	-3.5449	-3.5449	-0.0721	-2.4110	-5.9029	-3.7485	-4.3161	-7.6276
			(0.0002)	(0.0002)	(0.4713)	(0.0080)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
	Between Dimension	Group rho-Statistic	1.3613	1.3613	0.5603	2.6506	2.4616	0.0200	1.5413	2.3543
			(0.9133)	(0.9133)	(0.7124)	(0.9960)	(0.9931)	(0.5080)	(0.9384)	(0.9907)
		Group PP-Statistic	-5.6116	-5.6116	-4.7888	-3.8288	-9.1940	-6.3894	-6.1122	-8.7235
			(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
		Group ADF-Statistic	-3.4324	-3.4324	-1.5013	-2.1624	-6.9145	-4.1617	-2.8691	-7.1556
			(0.0003)	(0.0003)	(0.0666)	(0.0153)	(0.0000)	(0.0000)	(0.0021)	(0.0000)
Kao Panel Cointegration Tests		DF t-Statistic	-3.7431	-3.7431	-1.8391	-4.2065		-4.2902	-5.0981	-4.0746
			(0.0001)	(0.0001)	(0.0329)	(0.0000)		(0.0000)	(0.0000)	(0.0000)
		DF* t-Statistic	-2.1313	-2.1313	-0.9426	-2.6841		-2.6884	-3.5300	
			(0.0165)	(0.0165)	(0.1729)	(0.0036)		(0.0036)	(0.0002)	

P-values in parentheses.
The Null Hypothesis is that there is No cointegration

<u>Table 8:</u> Panel data cointegration estimation results

Dependent Variable: Log Exports to GDP

Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Adjustment coefficient	-0.220***	-0.220***	-0.181***	-0.210***	-0.206***	-0.245***	-0.216***	-0.245***
	(-6.202)	(-6.202)	(-4.292)	(-5.556)	(-5.519)	(-6.374)	(-5.026)	(-7.140)
Misalignment			-0.000783***	-0.000734***	-0.000334**	-0.000358***	-0.000569***	-0.000199*
			(-8.440)	(-8.830)	(-2.559)	(-2.677)	(-4.441)	(-1.890)
REER volatility	-0.350***	-0.350***	-0.584***	-0.778***	-0.434***			
	(-4.597)	(-4.597)	(-5.800)	(-8.214)	(-4.892)			
Log Manufactured value added to GDP	0.196***	0.196***			0.0627			0.0587*
	(3.705)	(3.705)			(1.604)			(1.726)
Log GDP of trade partners	0.586***	0.586***		0.784***	0.814***	0.797***	0.868***	0.641***
	(10.30)	(10.30)		(17.52)	(16.40)	(19.29)	(21.79)	(6.686)
Log Terms of trade	-0.00340	-0.00340	0.261***	0.0357	0.122***	0.0981***	0.153***	0.144***
	(-0.0494)	(-0.0494)	(15.79)	(1.483)	(3.263)	(2.698)	(4.978)	(5.063)
Log Real GDP								0.241***
								(3.228)
Log Investment to GDP							0.126***	
							(3.573)	
Constant	-4.149***	-4.149***	-0.246***	-5.303***	-5.356***	-6.295***	-5.989***	-6.479***
	(-6.158)	(-6.158)	(-3.169)	(-5.497)	(-5.450)	(-6.276)	(-4.957)	(-7.081)
Observations	1,111	1,111	1,068	1,068	1,012	1,085	1,085	1,029
Hausman Test	6.05	6.05	0.63			1.43	0.39	0.24
P-value	[0.1958]	[0.1958]	[0.7283]			[0.4885]	[0.5305]	[0.622]

z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 9: Estimation Results for Low-Income Countries

Dependent Variable: Log Exports to GDP

Regressors	(1)	(2)	(3)
Adjustment coefficient	-0.306***	-0.281***	-0.318***
	(-4.197)	(-3.562)	(-2.832)
Misalignment	-0.000691***	-0.000772***	-0.000694***
	(-8.450)	(-8.084)	(-3.657)
REER volatility	-1.008***	-0.527***	-0.828***
	(-8.787)	(-4.803)	(-4.971)
Log GDP of trade partners	0.731***		
	(15.30)		
Log Terms of trade		0.266***	
		(15.89)	
Log Real GDP			0.861***
			(23.72)
Log Investment to GDP			0.182***
			(4.335)
Constant	-7.232***	-0.413***	-6.828**
	(-4.119)	(-2.598)	(-2.507)
Observations	455	451	455

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Estimation Results for Middle-Income Countries

Dependent Variable: Log Exports to GDP

Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Adjustment coefficient	-0.218***	-0.227***	-0.0815**	-0.0957**	-0.243***	-0.217***	-0.203***	-0.191***
	(-5.914)	(-5.229)	(-2.402)	(-2.484)	(-6.499)	(-5.969)	(-5.500)	(-4.671)
Misalignment	-0.000576***	-0.000745**	-0.00165***	-0.00449**	-0.000457***			
	(-3.752)	(-2.572)	(-2.622)	(-2.491)	(-3.917)			
REER volatility	-0.549***	-0.585***	-0.738***	-0.924***		-0.411***	-0.567***	-0.345***
	(-2.870)	(-2.667)	(-3.927)	(-2.827)		(-2.699)	(-3.841)	(-3.433)
Log Real GDP	0.355***	0.493***			0.535***	0.387***	0.292***	
	(6.489)	(11.55)			(15.57)	(7.014)	(2.884)	
Log Manufactured value added to GDP		0.283***	0.485**		0.240**			0.762***
		(2.738)	(2.564)		(2.560)			(10.80)
Log Investment to GDP			0.647***	0.593***				
			(7.271)	(4.418)				
Log GDP of trade partners				0.896***			0.564***	1.101***
				(11.31)			(3.490)	(19.18)
Log Terms of trade				-0.159	-0.313***			0.145*
				(-0.950)	(-2.956)			(1.948)
Constant	-2.038***	-2.797***	0.0777***	-2.685**	-3.335***	-2.196***	-5.149***	-6.526***
	(-5.857)	(-5.074)	(2.952)	(-2.498)	(-6.366)	(-6.102)	(-5.697)	(-4.724)
Observations	619	596	596	617	599	660	660	632

z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1