Impact of Exchange Rate Volatility on India's Bi-lateral Exports-A Panel Study

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Abstract

This paper examines the effect of real exchange rate volatility on India's bilateral export growth using panel data from 2005Q2 to 2015Q2.This study uses GARCH measure of exchange rate volatility and utilizes panel GMM-IV technique to analyze the relationship among export growth and explanatory variables. The study finds while India's bilateral export growth is positively affected by growth in foreign income, growth in trend level of domestic income, infrastructure growth and real exchange rate; it is negatively influenced by volatility of real exchange rate and domestic demand pressure. The empirical results indicate that real exchange rate and volatility of real exchange rate do not significantly affect India's bilateral export growth.

1. Introduction

In the current era of globalization, international trade plays a crucial role in an economy's growth. Furthermore, last two decades have seen an increase in exchange rate volatility. Since exchange rate risk is an integral determinant of both export demand and export supply, volatility of exchange rate can significantly affect export growth. As a consequence, government intervention in the foreign exchange rate market has become recurrent in both developed and developing economies. Hence, a thorough analysis of the impact of exchange rate volatility on international trade is crucial for the policy decisions taken by the government and for all other economic agents linked with the international trade.

As per the traditional economic theory (Akhtar and Hilton (1984),Demer (1991)) high durable and persistent spells of volatility in home currency against major invoicing currencies of the world generates destabilizing effects and thus adversely affects international trade. However, many studies like Franke (1991) and Sercu (1992) assert that exchange rate volatility positively affect international trade. Thus, theoretically, the effect of exchange rate volatility on international trade is ambiguous[2]. Furthermore, as observed by Auboin and Ruta (2013) and Tsen(2014) , the effect of exchange rate volatility on trade is empirically ambiguous . For India too, existing empirical studies such as Panda and Mohanty (2015), Grier and Smallwood (2013), and Dashmana (2012) provide mixed results on the effect of exchange rate volatility on exports.

The existing empirical literature on India has primarily focused on the conventional determinants of export growth, viz. foreign demand, relative price and exchange rate volatility. However, it has been broadly recognized in literature that these traditional determinants are far being able to entirely explain the export behavior (Sertic et al., 2015, p.389). There are two sets of factors that affect export growth, viz. internal and external factors. External factors are broadly represented by foreign demand while internal factors are related to the supply-side conditions such as production capacity and domestic demand.

[2]Studies like Bailey, Talvas, Ulan (1987), De Grauwe (1988), Viaene and de Vries (1992),Dellas and Zilberfarb (1993) prove that the effect of exchange rate volatility on international trade is ambiguous. See section 2 for details.

At this backdrop, the purpose of this study is to examine the effect of exchange rate volatility on growth in India's bilateral exports to its 12 major trading partners[3], viz. U.S.A, China, Hong Kong, Singapore, Eurozone, U.K, Japan, Indonesia, Brazil, South Africa, Malaysia and Thailand, using panel data from 2005Q2 to 2015Q2. We use a hybrid export growth model[4], where all likely determinants of exports demand and exports supply are considered as the explanatory variables. Thus, in addition to relative price and exchange rate volatility, our model contains foreign income as a measure of foreign demand, domestic income and infrastructure growth as measures of export supply capacity and domestic demand pressure. Volatility of real exchange rate is estimated from GARCH[5] (1, 1) model. Panel GMM-IV is used to estimate the model as it does not make any assumption about the variance-covariance matrix of residuals and allows for endogenous variables.

This paper contributes to the literature in three different aspects. It is the first study that examines the effect of exchange rate volatility on India's bilateral exports to 12 major trading partners. Second, we utilize a hybrid model that covers broad set of factors determining export growth which is in contrast to the existing literature that examine determinants of export demand and export supply separately. A final novel feature of this study is that the econometric methodology used in this analysis explicitly considers the cross-sectional dependence of variables usually ignored in existing panel studies on this issue.

The rest of this paper is organized as follows: Section 2 briefly discusses the theoretical and empirical literature pertaining to determinants of export growth. Section 3 describes the data and econometric methodology while Section 4 presents the model used for the analysis. Section 5 discusses the empirical results and Section 6 outlines concluding remarks.

2. **Relationship between Exchange rate volatility and Exports**

[3] In the first step, the countries are ranked on the basis of their average share in India's exports of last five years (2010-2015), ten years (2005-2015) and fifteen years (2000-2015) where the average share has been calculated from the share of countries in total exports (obtained from the online database of India's Directorate General of Foreign Trade) in each respective year. Thereafter, the common set of first 12 countries having average share of more than 1% is selected as India's major trading partners. United Arab Emirates ranked second but it is not included in the analysis because of the non-availability of data.

[4] Damijan (2015), Jongwanich(2010),Gayraranov (2013), Tran et al. (2012) and Fugazza (2004) have used hybrid export models to analyze the effect of exchange rate volatility on exports.

[5]GARCH stands for Generalized Autoregressive Conditional Heteroscedasticity.

In this section, we present a brief literature review of the theoretical and empirical relationship between exchange rate volatility and exports. The conventional theoretical literature, propounded by Clark (1973) and Hooper and Kohlhagen (1978) establish that exchange rate volatility is detrimental to trade. The main argument is that exchange rate uncertainity makes prices and profits indeterminate that adversely affect export volumes. However, this view was based on several strong assumptions such as perfect competition, the large role of the invoicing currency, the absence of imported inputs, the high aversion to risk, and the absence of exchange rate hedging financial instruments (Auboin and Ruta, 2013). Dropping some or all of these assumptions makes the relationship between exchange rate volatility and exports ambiguous that can be observed in the five categories of models appraised by Auboin and Ruta (2013). For instance, in the first category, De Grauwe (1988) and Dellas and Zilberfarb (1993) developed models in which the effect of increased volatility of exchange rates on trade depends heavily on the level of risk aversion of traders. According to their models, if a producer is sufficiently risk averse, an increase in exchange rate risk raises the expected marginal utility of revenue inducing them to increase their exports while if producers are not very risk averse, an increase in exchange rate risk reduces the expected marginal utility of revenue leading them to decrease their exports.

Tsen (2014) provides an excellent up to date review of the empirical research conducted in this field. His survey indicates that large gamut of studies have been carried out to examine the impact of exchange rate volatility on developed , emerging and developing economies. The survey finds that " empirically there is no general consensus about the impact of international trade on exchange rate volatility although various measures of exchange rate volatility , different data sets either the aggregated or disaggregated data and various statistical methods such as cointegration and panel data analysis have been tried". Thus, in general, the impact of exchange rate volatility on international trade is theoretically and empirically ambiguous.

Majority of the empirical studies have used time series data[6] to analyze the effect of exchange rate volatility on international trade. The time series analysis, however, has certain limitations such as difficulty in inference procedures arising from non-availability of sufficient

[6] These studies are either based on the total exports of a particular country to rest of the world or bilateral exports of a country vis-à-vis its major trading partner.

data or presence of multicollinearity among explanatory variables (Hsio(2014)). Thus, more sophisticated studies such as Byrne et al. (2008), Tatre and Porjai (2012),Cheung and Sengupta(2013) and Situ(2015) have employed panel data techniques[7] to overcome the problems arising in time series analysis. In the Indian context too, bulk of the studies like Panda and Mohanty (2015), Grier and Smallwood (2013), Srinivasan and Kalvaini (2012) have used time series data to examine the impact of exchange rate volatility on trade. Overall, the time series studies on India give mixed results on the impact of exchange rate volatility on India's trade. However, very few panel data studies (Gautam et al. (2013), Cheung and Sengupta (2013) and Situ (2015)) are based on India. All these studies find that the impact of exchange rate volatility on India's trade is negative and significant.

3. Methodology and Data :

In this section, we describe the econometric methodology adopted and the data utilized for the analysis.

3.1 Methodology

As in time series literature, unit root testing is becoming increasingly important in panel data studies. Since this study is based on macro-panel data that has long time dimension, non-stationarity deserves more attention (Baltagi, 2001) .We utilize Fisher (2001) ADF, Hadri (2000), Breitung and Das (2005), and Pesaran(2007) panel unit root tests to analyze the stationarity properties of our variables where the latter three unit root tests are robust in the presence of cross sectional correlation[8]. In the second step, we use Pedroni (1999, 2000 and 2004) cointegration test to verify the existence of long-run relationship between exports and its determinants. The test involves seven test statistics out of which four are based on the within-dimension statistics that assumes homogenous cross-sectional units and three are based on

[7] Most of the panel studies like Klien(1990), Tatre Jantarakolica and Porjai Chalermsook (2012), Dashmana(2012) examine the effect of exchange rate volatility on the exports and /or imports of a particular country to a set of countries (its major trading partners).On the other hand, there are some panel studies such as Dellarica(1999) ,Byrne et al(2008),Situ(2015) that study the effect of exchange rate volatility on the exports and /or imports of a set of countries to a particular country.

[8] As explained in next section, our model also contains three time series variables that are constant across cross sections. So, to confirm the stationarity properties of these variables, we also conduct four standard unit root tests: Augumented Dickey Fuller (1979), Phillips perron (1988), KPSS (1992) and Ng-Perron (2001).

between-dimension statistics that allow for heterogeneity. If out of the seven statistics, at least four tests are in favour of cointegration, we conclude that cointegration exists in the model. If more than four tests support cointegration, we infer that there is strong cointegration in the model.

As explained in Hsaio (2014, p.12 and p.340), ignoring heterogeneity and cross-sectional dependence in panel data can cause substantial bias in the estimates. Thus, in the third step, we employ Swamy's (1970) test for testing heterogeneity and Pesaran (2004) CD test for testing cross-sectional dependence in our panel data. In the final step, we employ panel GMM-IV estimator to estimate our model as it does not make any assumption about the variance-covariance matrix of residuals and allows for endogenous variables. Cross sectional dependence, group-specific heteroscadsticity and endogenous variables are commonly found in macro panel data. Panel GMM-IV technique with appropriately chosen weighting matrix and instruments produces consistent estimates in these cases. For diagnostic testing, we use Cumby-Huizinga general test for serial autocorrelation, Pagan-Hall heteroskedasticity test, Durbin-Wu-Hausman endogeneity test, Hansen J test of overidentifying restrictions and Sanderson-Windmeijer underidentification test.

3.2 Data

This study is based on secondary data at quarterly frequency. The sample under study is from 2005Q2 to 2015Q2. Export variable is measured by exports value in U.S dollar million[9] obtained from CEIC database. Foreign income is measured as real GDP sourced from CEIC database in the currency of trading partner, later converted into U.S dollar million. India's income is measured by real GDP in U.S dollar million taken from CEIC database. The bilateral real exchange rate between India and trading partner i is calculated by $(P_i^*.E_i)/P$, where P* and P are the foreign and domestic foreign price indices, respectively(2010=100), and E is the bilateral nominal exchange rate which is measured as the number of rupees per unit of trading partner's currency. The nominal exchange rates at daily frequency are collected from

[9] Due to problems in obtaining an appropriate price deflator for bilateral exports, many studies like Bahmani-Oskooee and Goswami (2004), Nazilugu (2013) and Baek(2013) use value of exports.

www.exchangerate.com, converted into quarterly frequency using averages and consumer price indexes are obtained from CEIC database.

Volatility of real exchange rate is measured as conditional volatility from GARCH (1, 1) model. Trend level of India's GDP is measured using Hodrick Prescott filter. Domestic demand pressure is measured by central government fiscal deficit as a percentage of GDP. Central government fiscal deficit is obtained at monthly frequency from indiastat.com, converted into quarterly frequency using averages. Data on growth in India's infrastructure index is collected from CEIC database.

The descriptive statistics of main variables[10]export growth, first difference of real exchange rate and volatility of real exchange rate are presented in table 1. Among the 12 countries, the real exchange rate of Japan exhibits the highest volatility while china has the second most volatile real exchange rate during the sample period. Furthermore, we find that the correlations between exchange rate volatility and exports are negative for Euro, U.S, U.K, South Africa and Hong Kong.

4. **The Model**

In order to empirically analyze the relationship between exchange rate volatility and bi-lateral export growth, we utilize a hybrid model in which the factors influencing both export demand and export supply are included as explanatory variables. The model is given below:

$$\dot{X_{it}} = \alpha_{i0} + \alpha_1 \Delta REX_{it} + \alpha_2 V_{it} + \alpha_3 \dot{Y_t} + \alpha_4 \dot{Y_{it}} + \alpha_5 CFD_t + \alpha_6 \dot{INFR_t} + \varepsilon_{it} \quad (1)$$

where $\dot{X_{it}}$= Growth in value of exports from India to country i

ΔREX_{it} = First difference in real exchange rate of rupee vis-à-vis country i

V_{it} = Volatility in real exchange rate of rupee vis-à-vis country i

$\dot{Y_{it}}$ = Growth in real income of country i

[10] The panel unit root test results described in section5 reveal that we have a mix of stationary and non-stationary variables. Thus, we estimate transformed model described in section 4 where main variables are export growth, first difference of real exchange rate and volatility of real exchange rate.

$\dot{Y}_t$ = Growth in India's trend level of real income

CFD_t = India's Central government fiscal deficit to GDP ratio

$IN\dot{F}R_t$ = Growth of infrastructure in India

An increase in India's trend GDP growth and infrastructure growth increases the supply capacity of exports while an increase in foreign GDP growth increases the demand for exports. The real depreciation of rupee vis-à-vis other currencies makes India competitive in the world market thereby increasing export growth. Thus, in the above specification $\alpha_1, \alpha_3, \alpha_4, \ and \ \alpha_6$ are expected to be positive. CFD_t is a proxy for domestic demand pressure. α_6 is expected to be negative since an increase in domestic demand decreases export supply. The effect of real exchange rate volatility on export growth is uncertain and thus the sign of $\alpha_2$is ambiguous.

As per the standard macro-economic theory, an economy's trade balance is a major determinant of both real exchange rate and GDP. Furthermore, RBI intervenes in the foreign exchange market to contain exchange rate volatility that can stimulate trade. Thus, in the above specification, first difference in real exchange rate, volatility in real exchange rate and growth in India's trend level of real income are expected to be endogenous apriori.

In the pooled specification, $\alpha_{i0} = \alpha_0$, i.e intercept is same for all cross sections while in the fixed effects specification intercepts are allowed to differ across cross sections .Slope coefficients are assumed to be same for all cross sections. Furthermore, we assume that all coefficients in (1) are constant over time.

In addition to the above model, we estimate dynamic panel data model where lagged export growth is added as explanatory variable:

$$\dot{X}_{it} = \alpha_{i0} + \alpha_1 \dot{X}_{it-1} + \alpha_2 \Delta REX_{it} + \alpha_3 V_{it} + \alpha_4 \dot{Y}_t + \alpha_5 \dot{Y}_{it} + \alpha_6 CFD_t + \alpha_7 IN\dot{F}R_t + \varepsilon_{it} \qquad (2)$$

5. RESULTS:

5.1 Unit Root and Cointegration Tests

As explained in the last section, the time dimension of panel data used in this study is relatively long. In order to avoid the problems of spurious regression, we first verify the existence of long run relationship among the variables. The results and inferences from panel unit root tests are presented in table 2 and table 3. The tests by majority rule indicate that exports, domestic demand pressure variable, infrastructure growth and volatility of real exchange rate are stationary while domestic income, foreign income and real exchange rate series are non-stationary. The results and inferences from time series unit root tests on domestic income, infrastructure growth and domestic demand pressure variable are given in tables 4-7. These tests confirm the results obtained from the panel unit root tests. The seven statistics obtained from Pedroni cointegration test are reported in table8. The statistics suggest that the null of no cointegration is rejected in all the cases except Group rho. Therefore, there is strong evidence in support of the existence of long run relationships among the variables used in our analysis.

5.2 Panel Estimation Results:

Since we have a mix of stationary and non-stationary variables, we cannot use standard panel data estimation techniques on level variables. Thus, we transform non-stationary variables and estimate specification (1) where all the variables are stationary[11] . The result of Swamy's specification test is given in table 9. Null hypothesis of homogeneity is not rejected and thus it suggests pooled specification for carrying out the analysis. Pesaran's CD test on variables is shown in table 10. As expected, the test shows presence of considerable cross sectional dependence in our data.

From the results of pooled GMM-IV estimation reported in table 11, it is seen that the coefficient of exchange rate volatility is negative and statistically insignificant. Turning to other parameters in (1), we find that the coefficient of growth in foreign income and India's infrastructure growth is positive and statistically significant at 10% and 5% respectively. This suggests that growth in foreign income and India's infrastructure growth have positive impact on India's export growth. Further, table 6 indicates while the coefficient of real exchange rate is

[11] The unit root test results on the transformed variables is given in table 2.

positive and statistically insignificant, the coefficient of growth in India's trend level of GDP is positive and statistically significant[12]. This implies that growth in India's trend level of GDP and real exchange rate depreciation positively affects India's export growth. It is noteworthy that the estimated coefficient of India's trend GDP growth is higher than that of foreign GDP growth. This indicates that India's export growth is more responsive to change in its export supply capacity as compared to changes in foreign demand[13]. Finally, from the reported results in table6, it is seen that the coefficient of domestic demand pressure variable is negative and statistically significant[14].

The diagnostic tests reveal no serial correlation and heteroscedasticity in residuals. Hansen's J statistic is small and insignificant which shows that all instruments utilized are relevant. Rank condition is satisfied as the under identification test on all the variables rejects the null hypothesis.

The results of GMM-IV estimation with fixed effects is reported in third column of table 11. The estimated coefficients and their P-values are slightly different from pooled GMM-IV estimates. Further, the estimates of model (2), viz., Dynamic GMM-IV with fixed effects [15]are shown in fourth column of table 11. The estimated coefficient of lagged export growth is negative and statistically significant. However, other estimates are marginally different from model (1). This implies that our results are robust to the inclusion of fixed effects and lagged dependent variable in the model.

6. **Concluding Remarks :**

The existing studies on determinants of India's exports ignore the effect of domestic fundamentals that determine supply of exports. It stands to reasons that ceteris paribus, a country

[12] The estimated coefficient of growth in India's trend level of GDP is not significant at standard 5% or 10% level of significance. However, since the sign is positive and the t-statistic is greater than 1, this variable contributes to export growth.
[13] This result is in contrast to the findings of other studies on India such as Sharma (2000), Roy (2002) and Shah (2013).
[14] The estimated coefficient of domestic demand pressure variable is not significant at standard 5% or 10% level of significance. However, since it is correctly signed and the t-statistic is greater than 1, this variable is an important determinant of export growth.
[15] As time span of data used in this study is large, Santos and Barrios (2011) show that bias arising from the inclusion of lagged dependent variable is negligiable.

that has strong infrastructure and high income has higher capacity to export. The present study attempted to incorporate this aspect into the analysis. We examined the determinants of India's bilateral export growth[16], particularly focusing on the impact of exchange rate volatility on growth in India's bilateral exports to its 12 major trading partners viz., U.S.A, China, Hong Kong, Singapore, Eurozone, U.K, Japan, Indonesia, Brazil, South Africa, Malaysia and Thailand.

The empirical model used related growth in India's bilateral exports to real exchange rate, growth in India's trend level of GDP, growth in exporting partner's GDP, India's infrastructure growth and India's central fiscal deficit as a percentage of GDP. GMM-IV estimation results suggest while India's export growth is positively affected by growth in foreign income, growth in trend level of domestic income, infrastructure growth and real exchange rate, it is negatively influenced by volatility of real exchange rate and domestic demand pressure. However, we find that real exchange rate and volatility in real exchange rate do not significantly affect export growth.

The policy implications of this study are instinctive. Our findings illustrate that in a developing economy like India, growth in foreign demand as well as growth in export supply capacity are pivotal for export growth. Furthermore, our results show that real exchange rate and volatility in real exchange rate are not crucial for India's export growth. Thus, India's trade policy should be centered towards increasing export supply capacity and foreign demand via non-price measures such as development of infrastructure and domestic GDP.

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[16] We consider 12 major trading partners viz., U.S.A, China, Hong Kong, Singapore, Eurozone, U.K, Japan, Indonesia, Brazil, South Africa, Malaysia and Thailand

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APPENDIX

Table1: Descriptive Statistics of the Main Variables

	$\dot{X_{it}}$		$\Delta \mathrm{REX_{it}}$		V_{it}		Correlation Between $\dot{X}_{ijt-1}$ and V_{it}
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	
Euro	0.027	0.125	-0.035	3.247	0.002	0.001	-0.06
U.S	0.027	0.094	-0.223	2.339	0.001	0.001	-0.008
U.K	0.026	0.102	-0.114	4.039	0.002	0.001	-0.02
Indonesia	0.034	0.239	0.000	0.000	0.002	0.000	0.04
Malaysia	0.034	0.286	0.015	0.558	0.001	0.000	0.09
China	0.044	0.314	0.047	0.428	0.003	0.002	0.12
Thailand	0.030	0.200	0.008	0.056	0.001	0.000	0.11
South Africa	0.047	0.314	0.008	0.349	0.002	0.001	-0.01
Brazil	0.051	0.336	0.144	1.356	0.003	0.002	0.11
Singapore	0.043	0.293	-0.022	1.640	0.002	0.000	0.2
Japan	0.021	0.192	-0.006	0.034	0.004	0.002	0.1
Hongkong	0.030	0.204	-0.069	0.379	0.002	0.002	-0.12
All Countries	0.03	0.23	-0.02	1.75	0.002	0.001	0.02

Table2: Panel Unit Root Tests: Test Statistics (P-values)

Variable	Breitung Test	Hadri Test	Fisher –ADF Test	Pesaran Test*
X_{it}	-1.8684 (0.0309)	16.4194 (0.0000)	87.4303 (0.0000)	-4.198
Y_{it}	0.5926 (0.7233)	35.9870 (0.0000)	16.6902 (0.8616)	-1.822
REX_{it}	-0.0998 (0.4603)	45.7349 (0.0000)	29.4287 (0.2044)	-2.523
V_{it}	-5.6332 (0.0000)	24.6896 (0.0000)	84.0750 (0.0000)	-3.493
$\dot{X_{it}}$	-14.9937 (0.0000)	-3.7452 (0.9999)	353.188 (0.0000)	-6.191
$\dot{Y_{it}}$	-8.2593 (0.0000)	1.8162 (0.0347)	191.933 (0.0000)	-4.489
ΔREX_{it}	-5.4486 (0.0000)	-0.5798 (0.7190)	193.335 (0.0000)	-5.830
CFD_t	-3.5337 (0.0002)	-0.7751 (0.7809)	47.6310 (0.0028)	1.700
$\dot{INFR}_t$	-1.2071 (0.1137)	5.0536 (0.0000)	53.8460 (0.0004)	1.700
Y_t	-1.0713 (0.1420)	24.1465 (0.0000)	28.5871 (0.2361)	1.700
$\dot{Y_t}$	-4.6236 (0.0000)	-0.6789 (0.7514)	70.1030 (0.0000)	1.700

*Critical values of Pesaran's test are: -2.53(10%),-2.62(5%) and -2.76(1%)

Table 3: Panel Unit Root Tests: Inferences

Variable	Breitung Test	Hadri Test	Fisher –ADF Test	Pesaran Test	Conclusion
X_{it}	*I(0)*	*I(1)*	*I(0)*	*I(0)*	Stationary
Y_t	*I(1)*	*I(1)*	*I(1)*	*I(1)*	Non-Stationary
Y_{it}	*I(1)*	*I(1)*	*I(1)*	*I(1)*	Non-Stationary
REX_{it}	*I(1)*	*I(1)*	*I(1)*	*I(1)*	Non-Stationary
V_{it}	*I(0)*	*I(1)*	*I(0)*	*I(0)*	Stationary
CFD_t	*I(0)*	*I(0)*	*I(0)*	*I(1)*	Stationary
$IN\dot{F}R_t$	*I(0)*	*I(0)*	*I(0)*	*I(1)*	Stationary
$\dot{X_{it}}$	*I(0)*	*I(0)*	*I(0)*	*I(0)*	Stationary
$\dot{Y_t}$	*I(0)*	*I(0)*	*I(0)*	*I(1)*	Stationary
$\dot{Y_{it}}$	*I(0)*	*I(0)*	*I(0)*	*I(0)*	Stationary
ΔREX_{it}	*I(0)*	*I(0)*	*I(0)*	*I(0)*	Stationary

Table4: ADF and PP (AR spectral-GLS detrended) Tests

TESTS VARIABLE	**Null: γ=0 in Eq. (3) τ_τ**	**Null: γ=0, α=0 in Eq. (3) ϕ_1**	**Null: γ=0 in Eq.(2) τ_μ**	**Null: γ=0, α=0 in Eq. (2) ϕ_1**	**Null: γ=0 Eq. (1) τ**	**RESULTS (UNIT ROOT PRESENT)**
Y_t - ADF	-4.72					No
$Y_t - PP$	5.14	78.91				Yes
$\dot{Y}_t$-ADF	-1.26	3.46	-2.66	2.38	-3.05	No
$\dot{Y}_t$-PP	-1.23	0.17	-0.49	53.65	-4.34	Yes
CFD_t-ADF	-1.86	1.88	-1.92	1.89	-0.45	Yes
CFD_t-PP	-6.76					No
$INFR_t$-ADF	-3.17	2.19	-3.14	2.4	-1.1	No
$INFR_t$-PP	-2.95	5.54	-2.99	5.01	-0.90	No
	Critical Values					
10%	-3.13	5.34	-2.57	3.78	-1.62	
5%	-3.41	6.25	-2.86	4.59	-1.95	
1%	-3.96	8.27	-3.43	6.43	-2.58	

Table5: NG-Perron TEST (AR spectral-gls detrended):

Variable	**MZ_a Statistic**	**MZ_t Statistic**	**Conclusion(unit root Present)**
Y_t	2.01	5.09	I(1)
$\dot{Y}_t$ (without trend)	-53.22	-5.09	I(0)
CFD_t	-19.7	-3.09	I(0)
$INFR_t$	-44.71	-4.69	I(0)

Asymptotic critical values for MZ_a: -23.8 at 1%,-17.3 at 5% and -14.2 at 10%
Asymptotic critical values for MZ_t : -3.42 at 1%,-2.91 at 5% and -2.62 at 10%

Table6: KPSS Test (Barlett kernel):

Variable	l=0	l=1	l=2	l=3	l=4	l=5	l=6	l=7	l=8	Conclusion(Unit Root Present)
Y_t	0.97	0.51	0.35	0.27	0.23	0.20	0.18	0.16	0.15	Yes
$\dot{Y}_t$ (without trend)	0.45	0.24	0.17	0.13	0.11	0.10	0.10	0.09	0.09	No
CFD_t	0.05	0.06	0.07	0.10	0.08	0.07	0.08	0.09	0.09	No
$INFR_t$	0.13	0.08	0.07	0.06	0.06	0.06	0.07	0.08	0.09	No

Table7: Inferences from ADF, PP, Ng-Perron and KPSS tests:

Variable	ADF	PP	KPSS	Ng-Perron	Conclusion
Y_t	I(0)	I(1)	I(1)	I(1)	I(1)
$\dot{Y}_t$	I(0)	I(1)	I(0)	I(0)	I(0)
CFD_t	I(1)	I(0)	I(0)	I(0)	I(0)
$INFR_t$	I(0)	I(0)	I(0)	I(0)	I(0)

Table8: Pedroni Cointegration Test:

Statistics	
Panel v	-2.551*
Panel rho	-1.86*
Panel t	-9.29*
Panel adf	-2.624*
Group rho	-.8673
Group t	-10.82*
Group adf	-4.341 *

*significant at 5% since right tail critical value is 1.63 and left tail critical value is -1.6.

Table9: Specification Test: Swamy's Test(1970)

Null Hypothesis	Test Statistic (P-value)	Result
Common Intercept and Slope	76.86 (0.4829)	Do not Reject Null Hypothesis

Table10: Pesaran's Cross-Sectional Dependence Test:

Variable	CD Test Statistic	P-Value
$\dot{X_{it}}$	12.66	0.0000
$\dot{Y_{it}}$	60.25	0.0000
ΔREX_{it}	3.92	0.0000
V_{it}	19.65	0.0000

Table11: Panel Least Squares and Panel GMM-IV Results**

$Dependent\ Variable: \dot{X_{ijt}}$

	Pooled GMM-IV	GMM-IV with Fixed Effects	Dynamic GMM-IV with Fixed Effects
Constant	-.0874199 (0.041)		
$\dot{X_{ijt-1}}$			-.3425093 (0.000)
$\Delta \mathrm{REX_{it}}$	.0059779 (0.790)	.0076013 (0.725)	.0196586 (0.45)
V_{it}	-2.904513 (0.738)	-.6586107 (0.972)	-2.694915 (0.881)
$\dot{Y_{it}}$	.250742 (0.098)	.2541497 (0.105)	.1684677 (0.368)

$\dot{Y}_t$	1.414669 (0.139)	1.37652 (0.199)	2.319603 (0.062)
CFD_t	-.0044924 (0.252)	-.0044271 (0.261)	-.0021992 (0.616)
$IN\dot{F}R_t$	.0196053 (0.016)	.0200022 (0.015)	.0252251 (0.014)
Heteroscedasticity Test (Pagan-Hall test)	2.77 (0.2504)	N.A*	N.A
Serial Correlation Test(at lags=6) (Cumby-Huizinga test)	8.273 (0.2188)	N.A	N.A
Hansen's J Test*	0.251 (0.8822)	0.288 (0.8659)	0.217 (0.8973)
Hausman's endogeneity Test	0.854 (0.8364)	0.743 (0.8631)	1.324 (0.7235)
Under identification Test (Sanderson-Windmeijer test)	ΔREX_{it}:2.32(0.06) V_{it}:24.72(0.00) $\dot{Y}_t$:3835.18(0.00)	ΔREX_{it}:6.83(0.07) V_{it}:24.81(0.000) $\dot{Y}_t$:40.49(0.000)	ΔREX_{it}:6.90(0.0751) V_{it}: 24.81 (0.00) $\dot{Y}_t$:41.09 (0.00)

*N.A means not available for the particular estimation method.

**Instruments used in Panel 2SLS and Panel GMM estimation: $V_{it-1}, \Delta REX_{it-1}, \Delta REX_{it-2}, \Delta REX_{it-3}, \dot{Y_{t-1}}$