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The Impact of Exchange Rate Volatility on Real Total Export and Sub-Categories of Real Total Export of Malaysia

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Abstract**—**This study aims to investigate the impact of exchange rate volatility on real export in Malaysia. The moving standard deviation with order three (MSD(3)) is used for the measurement of exchange rate volatility. The conventional and partially asymmetric autoregressive distributed lag (ARDL) models are used in the estimations. This study finds exchange rate volatility to have significant impact on real total export and some sub-categories of real total export. Moreover, this study finds that the positive or negative exchange rate volatility tends to have positive or negative impact on real export. Exchange rate volatility can be harmful to export of Malaysia.

Keywords**—**Exchange rate volatility, autoregressive distributed lag, export, Malaysia.

I. Introduction

AFTER the breakdown of the Bretton Woods system of fixed exchange rate in 1973, exchange rate generally is volatile for country or economy adopts a flexible or manage floating exchange rate regime. Exchange rate volatility is argued to have an adverse impact on export [3]-[5], [9]. An increase in exchange rate volatility will have both the income effect and the substitution effect. For a very risk adverse exporter, the income effect dominates the substitution effect and therefore an increase in exchange rate volatility will lead to an increase in export [11]. There are studies which report insignificant impact of exchange rate volatility on export. This can be due to incomplete exchange rate pass-through or exporters hedged themselves the forward market or the futures market. Bahmani-Oskooee and Hegerty [3] and Wong [23], amongst others, provide a literature review of the impact of exchange rate volatility on international trade. There are some studies investigating the impact of exchange rate volatility on export in Malaysia [2], [24]-[25]. Generally, there is no consensus in the empirical study of the impact of exchange rate volatility on export [1]-[5], [9]-[11], [15], [18], [21]-[25].

This study examines the impact of exchange rate volatility on real total export and sub-categories of real total export by standard international trade code (SITC) from 0 to 9 of Malaysia using monthly data for the period from January 2010 to November 2015. The impact of exchange rate volatility on export can be different from industries because some industries are less sensitive or inelastic to exchange rate change. The use of monthly data can capture better exchange rate volatility compared with the use of yearly or quarterly data. Exchange rate volatility is computed by the MSD(3).This measure of exchange rate volatility is used commonly in the literature to examine its impact on export [24]-[25]. The export demand model is estimated as a function of relative price, real foreign demand and exchange rate volatility. The ARDL and partially asymmetric ARDL approaches are used. The ARDL approach is applicable irrespective of whether the regressors are I(1) or I(0). Thus, this approach allows the impact of long-run and short-run exchange rate volatility on export to be examined [12]. The partially asymmetric ARDL approach enables the investigation of positive and negative impact of exchange rate volatility on export. There is limited study in the literature examining positive and negative impact of exchange rate volatility on export [9].

II. Exports by SITC of Malaysia

Total export of Malaysia increased over the time but growth rate of total export was fluctuated from 2010 to 2015. In 2010, total export was Malaysian ringgit (RM) 638,822.5 million and increased to RM697,861.9 in 2011 or growth rate of total export was about 9.2%. In 2012 and 2013, total exports of Malaysia were RM702,641.2 million and RM719,992.4 million, respectively and growth rates of total exports in the same periods were about 0.7% and 2.5%, respectively. In 2014, total export was RM765,416.9 million or growth rate of export was about 6.3%. In 2015, total export increased to RM779,946.6 million or growth rate of export was about 1.9% [13].

SITC 0 is for food and live animals. SITC 1 is beverages and tobacco. SITC 2 is crude materials, inedible, except fuels. SITC 3 is mineral fuels, lubricants and related materials. SITC 4 is animal and vegetable oils, fats and waxes. SITC 5 is chemicals and related products. SITC 6 is manufactured goods classified by material. SITC 7 is machinery and transport equipment. SITC 8 is miscellaneous manufactured articles. SITC 9 is commodities and transactions not classified elsewhere in SITC [26].

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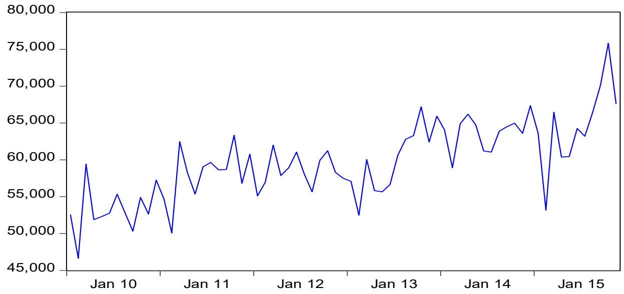

Fig. 1 Total Export of Malaysia (RM Million), January 2010 - November 2015 [13]

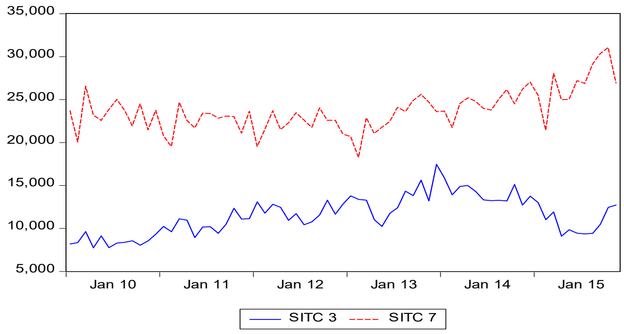

Fig. 2 Exports of SITC 3 and SITC 7 of Malaysia (RM Million), January 2010 – November 2015 [13]

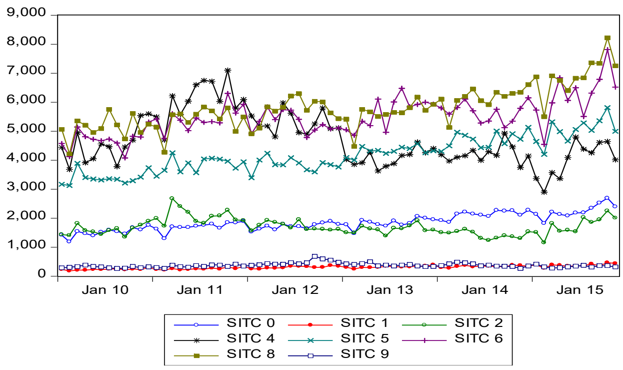

Fig. 3 Exports of SITC 0, SITC 1, SITC 2, SITC 4, SITC 5, SITC 6, SITC 8 and SITC 9 of Malaysia (RM Million), January 2010 - November 2015 [13]

The main exports of SITC of Malaysia were SITC 7 and SITC 3. In 2015, exports of SITC 7 and SITC 3 were RM326,073.8 million and RM128,408.0 million or about 41.8% and about 16.5%, respectively. In other words, exports of SITC 7 and SITC 3 were about 58.3% of total export of Malaysia. Exports of other SITC were general small, that is, about or less than 10% over the period from 2010 to 2015 [13]. The main components of export of SITC 7 are thermionic valves and tubes, photocells and parts thereof, automatic data processing machines and units thereof, and telecommunications equipment. The main components of export of SITC 3 are natural gas, whether or not liquefied, petroleum products, refined and petroleum oils, crude and crude oils obtained from bituminous minerals [13]. Fig. 1 displays total export of Malaysia, which fluctuated at an increasing rate. Figs. 2 and 3 show exports of SITC 3 and SITC 7 of Malaysia, which are the main exports and the rest of exports of Malaysia respectively. Generally, exports of Malaysia were fluctuated [13].

III. Data and Methodology

Real total export ($x_{t,t}$) is the sum of export values of SITC from 0 to 9 divided by total export price index (2005 = 100). Real exports of SITC from 0 to 9 ($x_{i,t}$, $i = 0, \ldots, 9$) are export values of SITC from 0 to 9 divided by export price indexes (2005 = 100) of SITC from 0 to 9, respectively. Relative price ($p_{i,t}$, $i = t, 0, \ldots, 9$) is expressed as export price index (2005 = 100) divided by import price index (2005 = 100). Real foreign demand (y_t) is expressed as: $y_t = \sum^{9}_{i=0} \sum^{14}_{i=1} w^j_i IP^i_t$ where j is real exports of SITC from 0 to 9, $w^j_i = x^j_i / \sum^{14}_{n=1} x_i$ is the trade share of the trading partner of Malaysia, i is the United States (US), the United Kingdom, Germany, France, Italy, Spain, the Netherland, China, Japan, Korea, India, Pakistan, Singapore or the Philippines and IP^i_t is industrial production index (2005 = 100) of the i-trading partner of Malaysia, except Pakistan, Singapore and the Philippines are expressed by manufacture production index (2005 = 100) and China is expressed by industrial value-added of China (2005 = 100). These countries imported about 60% of total export of Malaysia in 2014 [17]. Exchange rate volatility is the MSD(3) (v_t). Total export, export values of SITC from 0 to 9, export price indexes, import price indexes and export values of the trading partner of Malaysia were obtained from *Malaysia External Trade Statistics System*, Department of Statistics Malaysia. Industrial value-added of China was obtained from the website of National Bureau of Statistics of China. The real effective exchange rate was obtained from *International Financial Statistics*, International Monetary Fund. All the data were seasonal adjusted using the census X12 multiplicative or additive method, which is a standard method used by the US Bureau of Census to seasonally adjusted the data. All data were transformed into the logarithm. The sample period is from January, 2010 to November, 2015. The sample period is mainly restricted by the availability of the monthly export price indexes in Malaysia, which is available beginning from January, 2010.

The MSD(3) is computed as:

$$MSD(3) = [(1/3) \sum^{3}_{i=1} (\ln e_{t+i-1} - \ln e_{t+i-2})^2]^{1/2} \qquad (1)$$

where ln is logarithm and e_t is the real effective exchange rate. The window of moving average is set to three because monthly data is used and therefore the average of three months is a quarter. This measure is said to be able to capture well of exchange rate volatility [18], [22].

The export models to be estimated are specified as:[1]

[1]The export model estimated with a time trend produces better result than the export model estimated without a trend or constant or with a constant.

Model 1

$$\ln x_t = \beta_{10}\, t + \beta_{11} \ln p_t + \beta_{12} \ln y_t + \beta_{13}\, v_t + u_{1,t} \quad (2)$$

Model 2

$$\ln x_t = \beta_{20}\, t + \beta_{21} \ln p_t + \beta_{22} \ln y_t + \beta_{23}\, v^{+}_t + \beta_{24}\, v^{-}_t + u_{2,t} \quad (3)$$

where t is a time trend, x_t is real export, namely real total export or real exports of SITC from 0 to 9, p_t is relative price, y_t is real foreign demand, v_t is exchange rate volatility computed by the MSD(3), $v^{+}_t = \sum^{t}_{j=1} \Delta v^{+}_j$, Δv^{+}_j, $= \max(\Delta v_t, 0)$ and $v^{-}_t = \sum^{t}_{j=1} \Delta v^{-}_j$, Δv^{-}_j, $= \min(\Delta v_t, 0)$ are partial sum process of positive and negative changes in v_t and $u_{i,t}$ (i = 1, 2) is a disturbance term [9], [19]-[20]. The export model is usually estimated in logarithms, except the measure of exchange rate volatility, which is in its level [2], [15]. Model 2 is model 1, which replaces exchange rate volatility with positive exchange rate volatility and negative exchange rate volatility. Model 2 examines the asymmetric impact of exchange rate volatility on export. Generally, relative price is expected to have negative impact on export. Real foreign demand is expected to have positive impact on export. Exchange rate volatility is expected to have negative impact on export.

The error correction models of the export models are as:

Model 1

$$\Delta \ln x_t = \beta_{30} + \sum^{a}_{i=0} \beta_{31i}\, \Delta \ln p_{t-i} + \sum^{b}_{i=0} \beta_{32i}\, \Delta \ln y_{t-i} + \sum^{c}_{i=0} \beta_{33i}\, \Delta v_{t-i} + \sum^{d}_{i=0} \beta_{34i}\, \Delta \ln x_{t-i} + \beta_{35}\, ec_{t-1} + u_{3,t} \quad (4)$$

Model 2

$$\Delta \ln x_t = \beta_{40} + \sum^{a}_{i=0} \beta_{41i}\, \Delta \ln p_{t-i} + \sum^{b}_{i=0} \beta_{42i}\, \Delta \ln y_{t-i} + \sum^{c}_{i=0} \beta_{43i}\, \Delta v^{+}_{t-i} + \sum^{d}_{i=0} \beta_{44i}\, \Delta v^{-}_{t-i} + \sum^{e}_{i=0} \beta_{45i}\, \Delta \ln x_{t-i} + \beta_{46}\, ec_{t-1} + u_{4,t} \quad (5)$$

where ec_{t-1} is an error correction term and $u_{i,t}$ (i = 3, 4) is a disturbance term.

IV. Results and Discussions

The results of the KPSS unit root test statistic, which are not reported show that the variables in this study are the mixture of I(1) and I(0) variables. The ARDL bounds testing approach and the long-run coefficients of the ARDL approach are given in Table I. The ordinary least squares (OLS) estimator with Newey-West standard error is used when no-autocorrelation of the disturbance term is found to be statistically significant and the OLS estimator with Huber-White standard error is used when homoscedasticity of the disturbance term is found to be statistically significant. The Wald statistics are found to be statistically significant. Therefore, there are long-run relationships between real exports and their determinants. The coefficients of relative price are found to be negative and statistically significant for real total export and real exports of SITC 1, SITC 5, SITC 7 and SITC 8. An increase in relative price will lead to a decrease in real export. The coefficient of real foreign demand is found to be positive and statistically significant for real total export and real exports of SITC 0, SITC 5, SITC 7 and SITC 8. For real export of SITC 1 of model 1, the coefficient of real foreign demand is found to be negative and statistically significant only at the 10% level. An increase in real foreign demand will lead to a decrease in real export. One explanation is that an increase in the foreign output is mainly substitution to export of Malaysia. Generally, the coefficients of exchange rate volatility are found to be positive and statistically significant for real total export and real total exports of SITC 2, SITC 3, SITC 6 and SITC 7. The coefficients of positive exchange rate volatility or negative exchange rate volatility are found mainly to be positive or negative and statistically significant, respectively for real total export and real exports of SITC 1, SITC 2, SITC 6, SITC 7 and SITC 8. For real export of SITC 0, the coefficient of positive exchange rate volatility is only found to be statistically significant.

The results of the error correction models are reported in Table II.[2] The general to specific modelling strategy is used to find the error correction model. The general to specific modelling strategy begins with three lags of each first difference and sequentially excludes less statistically insignificant variables. The OLS estimator with Newey-West standard error is used when no-autocorrelation of the disturbance term is found to be statistically significant and the OLS estimator with Huber-White standard error is used when homoscedasticity of the disturbance term is found to be statistically significant. The coefficients of the one lag of error correction terms are found to be less than one and to have the expected negative signs and statistically significant. This implies the validity of an equilibrium relationship among the variables in the estimated model. The coefficients of relative price and real foreign demand are found mainly to be statistically significant. There are cases of exchange rate volatility are found to have a significant impact on real export, that is, real exports of SITC 2 and SITC 7. Hence, some sectors of exports are more sensitive to exchange rate volatility. There are more cases where the coefficients of positive exchange rate volatility or negative exchange rate volatility are found to be statistically significant, that is, real total export and real exports of SITC 0, SITC 1, SITC 3, SITC 5, SITC 6 and SITC 8.

In the long run, the coefficients of relative price and real foreign demand are found frequently to be negative and positive and statistically significant, respectively. These indicate that relative price and real foreign demand are important determinants for export of Malaysia. This study finds that there is evidence of exchange rate volatility to have significant impact on real total export of Malaysia and some evidence of sub-categories of real total export. The coefficients of positive exchange rate volatility or negative exchange rate volatility are found mainly to be positive or negative and statistically significant on export of Malaysia. In the short run, the

[2] The plots of cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ), which are not reported, generally show no evidence of instability of the error corrections models. The estimations of the models are said to be suitable.

coefficients of relative price and real foreign demand are found frequently to be statistically significant. The coefficient of exchange rate volatility is found to have an insignificant impact on real total export for model 1 but the coefficient of exchange rate volatility is found to have a significant impact for model 2. There are many cases of the coefficients of exchange rate volatility are found to have a significant impact on sub-categories of real total export. The use of partial sum process of positive and negative changes in exchange rate volatility produce more significant impact of exchange rate volatility than the use of the whole exchange rate volatility.

The finding that exchange rate volatility to have significant impact on export is consistent with the findings such as [2], [24], [25]. Some industries are more sensitive to exchange rate volatility. Nonetheless, it would be good the conclusion of this study can be re-examined with the use of different measure of exchange rate volatility. There are some reasons exchange rate volatility has no impact on export [6]-[8], [14], [16]. One explanation is the incomplete transmission between exchange rate volatility and export price because exporting firm absorbs lose temporarily to maintain its market share in foreign country. Thus, there is no significant impact of exchange rate volatility on export. Also, there is no connection between exchange rate volatility and the real economy may be due to local currency pricing, heterogeneous international distribution of commodities and noise traders in the foreign exchange rate markets [14].

There are many ways that the impact of exchange rate volatility can be minimised. In the short run, exporters shall be encouraged to take position in the forward market or the future and options markets. Moreover, exporters can take position in the money market to hedge uncertainty of exchange rate volatility. The knowledge and technique of appropriate hedging methods of exchange rate volatility are important. In the long run, the forward and future markets shall be further developed with more instruments to be introduced and at a lower cost. Exporters of Malaysia shall continue to improve their products through innovation and higher technology and also to differentiate products. The change of the price of a higher quality product or a differentiated product is likely having less influence on its demand. Moreover, exporters of Malaysia shall be diversified their markets to market like in Association of Southeast Asian Nations Economic Community (AEC). Exchange rate volatility is unlikely to be fully eliminated under flexible exchange rate regime. Therefore, it is good the risk of exchange rate volatility can be reduced or minimised. However, exchange rate volatility can be an opportunity to exporters to gain higher profits. Export is an engine of economic growth for Malaysia to achieve its vision to become a high income country.

V. Concluding Remarks

This study finds that export of Malaysia and its determinants are cointegrated. Export and its determinants are found to be cointegrated. In the long run, relative price and real foreign demand are found mostly to be statistically significant. Positive exchange rate volatility and negative exchange rate volatility are found regularly to be statistically significant. In the short run, the coefficients of relative price and real foreign demand are found widely to be statistically significant. There are many cases exchange rate volatility is found to have a significant impact on real export. The impact of exchange rate volatility on export can be negative or positive. In the future, the conclusion of this study can be re-examined with the use of different measure of exchange rate volatility. The industries significantly affected by exchange rate volatility shall be given more assistance such as incentives for their exports. Exports shall be diversified with more focus on exports to AEC. Exports can improve economic growth and help Malaysia to achieve its vision to be a high income country in the near future. Export sector in manufacturing creates more high paying employment opportunities.

APPENDIX

TABLE I
THE RESULTS OF BOUNDS TESTING APPROACH FOR COINTEGRATION AND THE LONG-RUN COEFFICIENTS OF THE ARDL APPROACH

MODEL 1

	$\ln x_{t,t}$	$\ln x_{0,t}$	$\ln x_{1,t}$	$\ln x_{2,t}$		$\ln x_{t,t}$	$\ln x_{0,t}$	$\ln x_{1,t}$	$\ln x_{2,t}$
Wald-Statistic	6.2213***	8.3965***	12.3539***	6.7320***	constant	0.0026 (8.9142)***	0.0043 (10.5562)***	0.0072 (12.7071)***	0.0050 (3.2084)***
	$\ln x_{3,t}$	$\ln x_{4,t}$	$\ln x_{5,t}$	$\ln x_{6,t}$	$\ln p_t$	-0.5225 (-2.4870)**	0.0777 (0.1876)	-0.8543 (-1.6880)*	0.3340 (1.5678)
Wald-Statistic	4.6501**	5.4988***	9.4595***	10.6859***	$\ln y_t$	1.2920 (3.8686)***	1.1790 (2.8780)***	-0.7519 (-1.8250)*	0.6069 (0.6659)
	$\ln x_{7,t}$	$\ln x_{8,t}$	$\ln x_{9,t}$		v_t	0.8383 (2.0135)**	-0.4131 (-0.7025)	0.9424 (1.4197)	4.2870 (3.6264)***
Wald-Statistic	8.3374***	5.5079***	4.7514**						
					Diagnostic Tests				
LM	0.9770	0.6788	4.4127**	1.2312	LM	3.5322**	3.3653	1.3075	1.5471
Reset	1.2969	5.5450**	5.8113**	6.3448***	Reset	3.1120*	0.0861	0.8077	0.0373
Hetero	0.1036	0.1997	0.4170	0.8569	Hetero	0.9168	0.7877	1.0102	1.0026
	$\ln x_{3,t}$	$\ln x_{4,t}$	$\ln x_{5,t}$	$\ln x_{6,t}$		$\ln x_{7,t}$	$\ln x_{8,t}$	$\ln x_{9,t}$	
constant	0.0059 (3.8939)***	0.0003 (0.2005)	0.0057 (10.4651)***	0.0022 (3.2582)***	constant	0.0040 (6.7869)***	0.0041 (3.6893)***	-0.0066 (-1.8292)*	
$\ln p_t$	0.0776 (0.1230)	-0.2855 (-0.8711)	-0.9739 (-4.3992)	0.2365 (0.5726)	$\ln p_t$	-1.8154 (-7.8301)***	-1.3797 (-2.1503)**	1.1049 (1.1578)	
$\ln y_t$	-0.2413 (-0.1981)	1.0989 (0.9133)	1.0976 (2.9458)***	0.9549 (1.5702)	$\ln y_t$	0.8754 (1.7683)	1.5422 (2.0304)**	-1.2006 (-0.5124)	
v_t	3.0295 (1.8464)*	-1.4251 (-0.9294)	0.0625 (0.1331)	2.2811 (2.9861)***	v_t	1.0170 (2.1178)*	0.8604 (1.0334)	-3.5318 (-1.0764)	
					Diagnostic Tests				
			LM	3.4939**	2.1755	1.2887			
			Reset	1.0748	5.3481**	2.6843			
			Hetero	1.3038	1.1870	0.5499			

MODEL 2

	$\ln x_{t,t}$	$\ln x_{0,t}$	$\ln x_{1,t}$	$\ln x_{2,t}$		$\ln x_{t,t}$	$\ln x_{0,t}$	$\ln x_{1,t}$	$\ln x_{2,t}$
Wald-Statistic	5.5098***	9.2410***	3.7273*	6.0655***	constant	-0.0002 (-0.1358)	0.0016 (1.0011)	0.0155 (3.2971)***	-0.0059 (-1.3857)
	$\ln x_{3,t}$	$\ln x_{4,t}$	$\ln x_{5,t}$	$\ln x_{6,t}$	$\ln p_t$	-0.4896 (-2.3092)**	-0.6235 (-1.6087)	2.4625 (1.5901)	0.1833 (0.7868)
Wald-Statistic	3.5749*	3.7298*	7.7130***	6.3729***	$\ln y_t$	1.1844 (3.5916)***	1.0374 (3.0579)***	-0.5941 (-0.8271)	0.3718 (0.3879)
	$\ln x_{7,t}$	$\ln x_{8,t}$	$\ln x_{9,t}$		v_t^+	1.0552 (2.3633)**	1.1963 (1.9909)*	-3.1083 (-1.7178)*	3.8112 (2.9384)***
Wald-Statistic	5.8244***	3.6305*	4.0739*		v_t^-	-1.0561 (-2.3703)**	-0.9130 (-1.5364)	3.5219 (1.9120)*	-3.8688 (-2.9825)***
					Diagnostic Tests				
LM	0.9412	1.1516	0.5472	1.0970	LM	1.2537	0.9750	1.5821	0.0358
Reset	0.7812	4.9130**	1.1523	14.499***	Reset	0.6976	0.1776	0.6276	0.9026
Hetero	0.1231	0.3127	0.6104	0.7680	Hetero	0.4508	0.5641	1.2724	0.8784
	$\ln x_{t,t}$	$\ln x_{0,t}$	$\ln x_{1,t}$	$\ln x_{2,t}$		$\ln x_{7,t}$	$\ln x_{8,t}$	$\ln x_{9,t}$	
constant	0.0117 (0.1568)	-0.0079 (-1.4732)	0.0066 (3.9700)***	-0.0019 (-0.6874)	constant	0.0040 (0.9582)***	-0.0023 (-0.9154)	-0.0163 (-1.0512)	
$\ln p_t$	4.9724 (0.7430)	-0.1196 (-0.3142)	-0.9591 (-4.2329)***	-0.0191 (-0.0381)	$\ln p_t$	-1.6058 (-5.3716)***	-1.2536 (-2.0609)**	2.1487 (1.5659)	
$\ln y_t$	-9.0846 (-0.5710)	1.0312 (0.7462)	1.1035 (2.8887)*	0.9511 (1.3477)	$\ln y_t$	0.9785 (2.6335)**	0.9718 (1.0939)	-2.3409 (-0.7512)	
v_t^+	1.6447 (0.0578)	2.5142 (1.4036)	-0.2946 (-0.5197)	1.6907 (1.7530)*	v_t^+	0.9081 (1.9688)*	2.3435 (3.2167)***	1.7108 (0.4337)	
v_t^-	9.5099 (0.3217)	-3.0051 (-1.6280)	0.3495 (0.6282)	-1.7126 (-1.7799)*	v_t^-	-0.7875 (-1.7744)*	-2.2141 (-2.9424)***	-3.0909 (-0.7192)	
					Diagnostic Tests				
			LM	4.7618***	3.4055**	4.3488**			
			Reset	1.1889	0.4204	1.6727			
			Hetero	1.5785	1.5527	0.2968			

Notes: LM is the Lagrange Multiplier test of disturbance serial correlation. Reset is the test of functional form. Hetero is the test of heteroscedasticity. *** (**, *) denotes significance of the t-statistic at the 1% (5%, 10%) level.

TABLE II
THE RESULTS OF THE ERROR-CORRECTION MODELS

	Model 1					Model 2			
	$\Delta \ln x_{t,t}$	$\Delta \ln x_{0,t}$	$\Delta \ln x_{1,t}$	$\Delta \ln x_{2,t}$		$\Delta \ln x_{t,t}$	$\Delta \ln x_{0,t}$	$\Delta \ln x_{1,t}$	$\Delta \ln x_{2,t}$
constant	-2.5295 (-6.0373)***	-4.0595 (-4.2902)***	3.5476 (3.3384)***	-1.4265 (-6.0628)***	constant	-2.3237 (-7.0553)***	-3.6073 (-3.7463)***	2.7295 (4.8688)***	-0.2283 (-5.4217)***
$\Delta \ln p_t$	-	0.6158 (1.0635)	-1.9171 (-2.0863)**	-0.8894 (-2.9792)***	$\Delta \ln p_t$	-1.2393 (-2.3965)**	-	-1.8447 (-2.1553)**	-0.9584 (-3.1480)***
$\Delta \ln p_{t-2}$	1.0638 (2.0913)**	-	-	-	$\Delta \ln p_{t-1}$	-	-	-2.3902 (-2.5994)**	-
$\Delta \ln y_t$	0.5658 (1.8910)*	-1.1282 (2.6500)**	-	-	$\Delta \ln p_{t-2}$	0.9950 (2.0595)**	-0.0637 (-0.1073)	-	-
$\Delta \ln y_{t-1}$	-	-	1.3512 (2.3891)**	-	$\Delta \ln y_t$	0.6067 (2.1477)**	1.1005 (2.8233)***	-	-
$\Delta \ln y_{t-2}$	-	-	-	-0.7291 (-1.0479)	$\Delta \ln y_{t-1}$	-	-	1.6180 (3.0010)***	-
Δv_t	-	-	-	1.7366 (1.7366)*	$\Delta \ln y_{t-2}$	-	-	-	-0.7989 (-1.0879)
Δv_{t-1}	-0.1737 (-0.3966)	-	-	-	Δv_t^+	0.6528 (1.8304)*	0.2034 (2.6631)**	0.0970 (0.9359)	0.7970 (0.8270)
Δv_{t-2}	-	-	0.6354 (0.7284)	-	Δv_t^-	-0.6668 (-1.8871)*	-	-	-0.9125 (-0.9525)
Δv_{t-3}	-	-0.4876 (-0.6718)	-	-	Δv_{t-1}^-	-	0.0479 (0.5860)	-	-
$\Delta \ln x_{j,t-1}$	-	-0.2184 (-1.8483)*	-0.3682 (-3.0719)***	-	Δv_{t-2}^-	-	-	0.1883 (1.6830)*	-
ec_{t-1}	-0.7990 (-6.0404)***	-0.6743 (-4.2943)***	-0.5715 (-3.3265)***	-0.6743 (-6.0925)***	$\Delta \ln x_{j,t-1}$	-	-0.3403 (-2.2588)**	-0.4670 (-5.2387)***	-
					$\Delta \ln x_{j,t-2}$	-	-0.2037 (-1.7251)*	-	-
					ec_{t-1}	-0.9750 (-7.0578)***	-0.7157 (-3.7546)***	-0.5562 (-4.8436)***	-0.6882 (-5.7986)***

Diagnostic Tests

Adj. R^2	0.3553	0.4528	0.5811	0.4352	Adj. R^2	0.4238	0.5321	0.6479	0.4232
LM	1.2434	1.7433	0.8921	1.9043	LM	0.0545	2.2283	0.9153	1.5975
Reset	1.9968	2.2957	0.2748	5.3795**	Reset	3.6355*	1.6830	0.8239	3.8650*
Hetero	0.3660	0.9607	1.1611	0.8074	Hetero	1.0726	0.5787	1.0017	0.4987

	$\Delta \ln x_{3,t}$	$\Delta \ln x_{4,t}$	$\Delta \ln x_{5,t}$	$\Delta \ln x_{6,t}$		$\Delta \ln x_{3,t}$	$\Delta \ln x_{4,t}$	$\Delta \ln x_{5,t}$	$\Delta \ln x_{6,t}$
constant	1.9127 (3.2175)***	-1.2399 (-2.5350)**	-4.0313 (-7.6205)***	-3.0210 (-7.4166)***	constant	3.1152 (3.2333)***	-1.2519 (-3.0965)***	-4.2651 (-8.0787)***	-2.4731 (-6.3354)***
$\Delta \ln p_t$	-	-1.1735 (-4.4221)***	-1.2817 (-1.9606)*	-	$\Delta \ln p_t$	-0.7756 (-2.6059)**	-1.3080 (-4.9367)***	-	-
$\Delta \ln p_{t-1}$	-0.6753 (-1.9575)*	-	2.0156 (3.2816)***	-	$\Delta \ln p_{t-1}$	-	-0.5641 (-1.9038)*	1.7040 (2.6376)***	-
$\Delta \ln p_{t-2}$	-	0.5721 (2.1201)**	-	-1.7322 (-1.6863)*	$\Delta \ln p_{t-2}$	-	0.5136 (1.8045)*	-	-1.7854 (-1.6548)
$\Delta \ln p_{t-3}$	-	-	1.4463 (2.3019)**	-	$\Delta \ln p_{t-3}$	-	-	1.5062 (2.3092)**	-
$\Delta \ln y_t$	-1.1715 (-1.8037)*	-	1.1386 (3.0917)***	-	$\Delta \ln y_t$	-1.3957 (-1.7924)*	-	1.4219 (3.7074)***	-
$\Delta \ln y_{t-1}$	-	-1.9503 (-2.6516)**	-	-	$\Delta \ln y_{t-1}$	-	-1.6389 (-2.1782)**	-	0.8987 (1.4093)
$\Delta \ln y_{t-2}$	-	-2.3432 (-3.3723)***	-	-0.6718 (-1.0996)	$\Delta \ln y_{t-2}$	-	-1.8105 (-2.4914)**	-	-
Δv_t	-	-1.3505 (-1.5373)	-	-1.0294 (1.1810)	Δv_t^+	-	-	-0.6524 (-1.4828)	1.6081 (2.0306)**
Δv_{t-1}	0.5658 (0.5495)	-	-	-	Δv_{t-1}^+	2.7000 (2.2761)**	-	-	-
Δv_{t-3}	-	-	0.9306 (1.4227)	1.4179 (1.2783)	Δv_{t-2}^+	1.7823 (2.6222)**	0.2148 (1.4938)	-	-
$\Delta \ln x_{j,t-1}$	-0.2502 (-2.2092)**	-0.2915 (-2.8335)***	-	-	Δv_{t-3}^+	-	-	0.1727 (2.2416)**	-
ec_{t-1}	-0.3288 (-3.2074)***	-0.2691 (-2.5453)**	-0.9014 (-7.6245)***	-0.9393 (-7.4325)***	Δv_t^-	-	-0.1289 (-0.9586)	0.7250 (1.6619)	-1.6753 (-2.1301)**
					Δv_{t-1}^-	-2.9007 (-2.4587)**	-	-	-
					Δv_{t-2}^-	-1.7120 (-2.6815)**	-	-	-
					Δv_{t-3}^-	-0.3215 (-1.6238)	-	-	-
					$\Delta \ln x_{j,t-1}$	-0.3257 (-3.5017)***	-0.3648 (-3.4034)***	-	-

	Model 1					Model 2			
					$\Delta \ln x_{j,t-3}$	-0.2374 (-2.3608)**	-	-	-
					ec_{t-1}	-0.0453 (-3.2359)***	-0.3008 (-3.1040)***	-0.9441 (-8.0747)***	-0.7870 (-6.3350)***
Diagnostic Tests									
Adj. R^2	0.3177	0.5305	0.6110	0.4775	Adj. R^2	0.2722	0.5568	0.6010	0.4130
LM	0.0187	1.5311	2.0875	0.6087	LM	2.8007*	0.8365	2.1447	0.1782
Reset	0.2701	0.8327	1.0613	0.2728	Reset	0.1171	0.4595	0.4826	1.7189
Hetero	0.4010	1.3541	0.6149	1.0648	Hetero	0.8339	1.6233	0.4904	0.4107
	$\Delta \ln x_{7,t}$	$\Delta \ln x_{8,t}$	$\Delta \ln x_{9,t}$			$\Delta \ln x_{7,t}$	$\Delta \ln x_{8,t}$	$\Delta \ln x_{9,t}$	
constant	-0.6837 (-3.9896)***	-3.0523 (-2.7595)**	3.5857 (4.4724)***		constant	-1.6884 (-6.6901)***	-2.0907 (-4.7881)***	7.0344 (4.9735)***	
$\Delta \ln p_t$	-1.6447 (-2.1277)**	-1.9095 (-1.7240)*	-		$\Delta \ln p_t$	-1.7340 (-2.0232)**	-2.2509 (-2.6989)***	-	
$\Delta \ln p_{t-2}$	-	-	-0.0599 (-0.5249)		$\Delta \ln p_{t-2}$	-	-	-0.0885 (-0.8214)	
$\Delta \ln p_{t-3}$	-	-0.4371 (-1.6958)*	-		$\Delta \ln p_{t-3}$	-0.9841 (-1.2671)	-	-	
$\Delta \ln y_t$	0.3965 (1.0182)	-	-1.1113 (-1.0917)		$\Delta \ln y_t$	0.8022 (1.9121)*	-	-	
$\Delta \ln y_{t-2}$	-	-	-3.0496 (-3.1886)***		$\Delta \ln y_{t-2}$	-	-	-2.7184 (-3.0155)***	
Δv_t	1.2171 (2.2096)**	0.7861 (1.6703)	-		$\Delta \ln y_{t-3}$	-	-0.3860 (-1.0618)	-	
Δv_{t-3}	-	-	-1.0023 (-0.5761)		Δv_t^+	0.6288 (1.1353)	0.9251 (1.7989)*	-	
$\Delta \ln x_{j,t-1}$	-0.3719 (-3.2415)***	-0.3405 (-4.0196)***	-		Δv_{t-1}^+	-	-	0.2320 (1.0912)	
ec_{t-1}	-0.6254 (-3.9908)***	-0.4262 (-2.7629)***	-0.4191 (-4.4735)***		Δv_t^-	-0.5060 (-0.9189)	-0.7789 (-1.5287)	-	
					Δv_{t-1}^-	-	-	0.3873 (1.6836)*	
					$\Delta \ln x_{j,t-1}$	-	-0.2090 (-1.8644)*	-	
					ec_{t-1}	-0.9332 (-6.6989)***	-0.6803 (-4.8053)***	-0.4369 (-4.9735)***	
Diagnostic Tests									
Adj. R^2	0.4825	0.3887	0.3290		Adj. R^2	0.4063	0.4607	0.3718	
LM	1.7681	2.8969*	0.2019		LM	1.7025	1.3835	0.1511	
Reset	4.7961**	6.7946**	0.4193		Reset	5.2726**	8.3951***	0.5269	
Hetero	1.4914	1.4029	0.4419		Hetero	0.9526	0.6219	0.0787	

Notes: Adj. R^2 is the adjusted R^2. LM is the Lagrange Multiplier test of the disturbance term serial correlation. Reset is the test of functional form. Hetero is the test of heteroscedasticity. Values in parentheses are the t-statistics. *** (**, *) denotes significance at the 1% (5%, 10%) level.

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