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EXCHANGE RATE VOLATILITY, REAL TOTAL EXPORTS AND SUB-CATEGORIES OF REAL TOTAL EXPORTS BY STANDARD INTERNATIONAL TRADE CODE (SITC) OF MALAYSIA

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ABSTRACT
This study examines the impact of exchange rate volatility on Malaysia's real total exports and sub-categories of Malaysia's real total exports by standard international trade code (SITC). Exchange rate volatility is estimated by the stochastic volatility with moving average (SVMA) model. The conventional and partially asymmetric autoregressive distributed lag (ARDL) models are used in the estimation. Exchange rate volatility is found to have significant impact on real total exports and some sub-categories of real total exports in the short run and long run. The impact of exchange rate volatility on exports can be negative or positive and is different for sub-categories of real total exports. The partially asymmetric ARDL model shows that positive exchange rate volatility or negative exchange rate volatility tends to have positive or negative impact on exports. Generally, exchange rate volatility can be harmful to Malaysia's exports.

JEL classification*: F31, F14*
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1. INTRODUCTION
Exchange rate volatility has become an important topic in international finance, especially after the breakdown of the Bretton Woods fixed exchange rate regime in 1973. Generally, the exchange rate is volatile when the country or economy adopts a flexible or manage floating exchange rate regime. Exchange rate volatility is argued to have an adverse impact on exports (Bahmani-Oskooee & Hegerty, 2007; Bahmani-Oskooee et al., 2013, 2014; Choudhry & Hassan, 2015). Exchange rate volatility is a risk to exporters. An increase in exchange rate volatility will have both income and substitution effects. The income effect is when an increase in exchange rate volatility leads to lower revenue from exports and thus, the exporter will increase its exports. The substitution effect is when an increase in exchange rate volatility will lead the

exporter to substitute its export market toward domestic market. For a risk averse exporter, the substitution effect dominates the income effect. Therefore, an increase in exchange rate volatility will lead to a decrease in exports. Conversely, for a very risk adverse exporter, the income effect dominates the substitution effect and hence, an increase in exchange rate volatility will lead to an increase in exports (De Grauwe, 1988). There are also studies that report an insignificant impact of exchange rate volatility on exports. This can be due to incomplete exchange rate pass-through or to exporters hedging themselves in the forward or futures market. Bahmani-Oskooee and Hegerty (2007) and Wong (2014), amongst others, review the literature review on the impact of exchange rate volatility on international trade. There are some studies investigating the impact of exchange rate volatility on exports in Malaysia (Bahmani-Oskooee & Aftad, 2017; Bahmani-Oskooee & Harvey, 2011; Wong & Tang, 2008, 2011). Generally, there is no consensus in the empirical literature of the impact of exchange rate volatility on exports (Aftab, et al. 2016; Baek, 2013; Bahmani-Oskooee & Harvey, 2011; Bahmani-Oskooee & Hegerty, 2007; Bahmani-Oskooee et al., 2013, 2014; Choudhry & Hassan, 2015; Ćorić & Pugh, 2010; De Grauwe, 1988; Fang et al., 2009; Nishimura & Hirayama, 2013; Thorbecke & Kato, 2013; Verheyen, 2012; Wong, 2014; Wong & Tang, 2008, 2011).

This study examines the impact of exchange rate volatility on real total exports and sub-categories of real total exports of Malaysia by standard international trade code (SITC) from 0 to 9. Monthly data for the period of January 2010 through November 2015 was used. The impact of exchange rate volatility on exports can be different for different industries because some industries might be less sensitive to changes in the exchange rate. The use of sub-categories of export data can also avoid aggregation bias in examining the impact of exchange rate volatility on exports. The use of monthly data is expected to be better to capture exchange rate volatility compared to the use of yearly or quarterly data. Exchange rate volatility is estimated by the stochastic volatility with moving average (SVMA) model (Chan and Hsiao, 2014; Chan and Grant, 2016). The SVMA model is selected from a group of the stochastic volatility models. The stochastic volatility models are said to be better in the estimation of volatility compared to the autoregressive conditional heteroscedasticity (ARCH) type models (Chan & Grant, 2016). Moreover, there are limited studies examining the impact of exchange rate volatility on exports using exchange rate volatility estimated by a stochastic volatility model. The export demand model is estimated as a function of relative price, real foreign demand and exchange rate volatility. Real exports are expressed as export value divided by export price and not export value divided by unit value. Therefore, this study provides some evidence of the impact of relative price on Malaysia’s real exports whereas many studies in the literature provide the impact of exchange rate as a proxy of relative price on exports. The autoregressive distributed lag (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 exports to be examined (De Vita & Abbott, 2004). The partially asymmetric ARDL approach enables the investigation of positive and negative impacts of exchange rate volatility on exports. There are not many studies examining positive and negative impacts of exchange rate volatility on exports (Choudhry & Hassan, 2015). Thus, this study provides some evidence of the asymmetric impact of exchange rate volatility on exports. In the literature, studies mostly assume that the impact of exchange rate volatility on exports is symmetric, that is, an increase or a decrease in exchange rate volatility will lead to a decrease or an increase in exports in the same proportion. However, an increase in exchange rate volatility could have different impact than a decrease in exchange rate volatility (Bahmani-Oskooee & Aftab, 2017). Thus, exports could respond to exchange rate volatility in an asymmetric manner. One possible reason for the asymmetry impact of exchange rate volatility is changes in expectations of exporters. An exporter may choose to exports less when risk or exchange rate volatility is higher and likely continue to export less when risk or exchange rate volatility is lower due to lack of confidence in the export market and or in the exchange rate market (Bahmani-Oskooee & Aftad, 2017: 97-98).

The rest of this paper is structured as follows. Section 2 introduces Malaysia's exports by SITC. Section 3 is the data and methodology and section 4 is the empirical results and discussions. Finally, the last section summarizes and provides some concluding remarks.

2. EXPORTS BY STANDARD INTERNATIONAL TRADE CODE (SITC) OF MALAYSIA

Total exports of Malaysia increased over the time but growth rate of total exports was fluctuated from 2010 to 2015. In 2010, total exports was Malaysian ringgit (RM) 638,822.5 million and increased to RM697,861.9 in 2011 or growth rate of total exports was about 9.2 per cent. 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 per cent and 2.5 per cent, respectively. In 2014, total exports were RM765,416.9 million or growth rate of exports were about 6.3 per cent. In 2015, total exports increased to RM779,946.6 million or growth rate of exports were about 1.9 per cent (Table 1).

SITC 0 is 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. 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 per cent and about 16.5 per cent, respectively. In other words, exports of SITC 7 and SITC 3 were about 58.3 per cent of Malaysia's total exports. Exports of other SITC were general small, that is, about or less than 10 per cent over the period from 2010 to 2015. Thus, Malaysia's total exports are concentrated into few categories. The main components of exports 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 exports of SITC 3 are natural gas, whether or not liquefied, petroleum products, refined and petroleum oils, crude and crude oils obtained from bituminous minerals (Table 1).

Table 1: Exports by standard international trade code (SITC) of Malaysia, 2010-2015 (RM Million).

SITC	2010	2011	2012	2013	2014	2015[p]
0	18,168.0 (2.8%)	20,555.2 (2.9%)	20,691.9 (2.9%)	22,100.5 (3.1%)	25,646.7 (3.4%)	27,373.4 (3.5%)
1	2,815.1 (0.4%)	3,136.4 (0.4%)	3,725.9 (0.5%)	3,883.9 (0.5%)	4,079.4 (0.5%)	4,604.2 (0.6%)
2	19,128.8 (3.0%)	25,026.5 (3.6%)	20,609.7 (2.9%)	19,491.6 (2.7%)	17,164.3 (2.2%)	21,237.0 (2.7%)
3	101,958.4 (16.0%)	125,752.3 (18.0%)	143,388.1 (20.4%)	160,347.7 (22.3%)	168,624.1 (22.0%)	128,408.0 (16.5%)
4	54,139.4 (8.5%)	73,118.6 (10.5%)	63,393.7 (9.0%)	49,019.2 (6.8%)	50,490.6 (6.6%)	47,877.8 (6.1%)
5	40,618.3 (6.4%)	46,210.7 (6.6%)	46,101.6 (6.6%)	51,761.4 (7.2%)	56,574.6 (7.4%)	60,683.7 (7.8%)
6	56,391.2 (8.8%)	65,399.6 (9.4%)	63,624.0 (9.1%)	67,700.5 (9.4%)	67,819.0 (8.9%)	75,144.2 (9.6%)
7	280,416.0 (43.9%)	269,762.8 (38.7%)	266,684.8 (38.0%)	273,675.9 (38.0%)	296,735.4 (38.8%)	326,073.8 (41.8%)
8	61,406.7 (9.6%)	64,707.3 (9.3%)	68,704.4 (9.8%)	67,318.7 (9.3%)	73,716.9 (9.6%)	84,513.6 (10.8%)
9	3,780.6 (0.6%)	4,192.6 (0.6%)	5,717.3 (0.8%)	4,693.0 (0.7%)	4,566.0 (0.6%)	4,031.1 (0.5%)
Total	638,822.5 (100%)	697,861.9 (100%)	702,641.2 (100%)	719,992.4 (100%)	765,416.9 (100%)	779,946.6 (100%)

Source: *Malaysia External Trade Statistics*, Department of Statistics Malaysia.
Note: [p] indicates values of provisional and subject to revision. Values in the parentheses are the percentages of the total export.

3. DATA AND METHODOLOGY

Real total exports ($x_{t,t}$) is the sum of export values of SITC from 0 to 9 divided by total exports price index (2005 = 100). Real exports of SITC from 0 to 9 ($x_{i,t}$, i = 0, …, 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, …, 9) is expressed as export price index (2005 = 100) divided by import price index (2005 = 100). Real foreign demand (y_t) is expressed as follows $y_t = \sum_{j=0}^{9} \sum_{i=1}^{14} w_i^j \, IP_t^i$, where j is real exports of SITC from 0 to 9, $w_i^j = x_i^j / \sum_{n=1}^{14} x_i$ 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_t^i 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). Exchange rate volatility is estimated by the SVMA model ($v_{1,t}$). The SVMA model is chosen from a group of the stochastic volatility models, namely the standard stochastic volatility (SV) model, the stochastic volatility with order two process (SV2) model, the stochastic volatility in mean (SVM) model, the stochastic volatility with t error (SVT) model and the stochastic volatility with moving average (SVMA) model based on the marginal likelihood.[1] There are many stochastic volatility models. However, the selection of stochastic volatility estimated from the five stochastic volatility models shall provide an acceptable volatility estimated from the stochastic volatility models. Moreover, Chan and Grant (2016) find that the SVMA model is the best model for estimating stochastic volatility model from all nine series of crude oil (Cushing, Oklahoma West Texas Intermediate and Europe Bren), petroleum product (New York [NY] Harbor Conventional Gasoline Regular, United States [US] Gulf Coast Conventional Gasoline Regular, NY Harbor No. 2 Heating Oil, Los Angeles, California Ultra-Low Sulfur California Air Resources Board Diesel, US Gulf Coast Kerosene-Type Jet Fuel and Mont Belvieu, Texas Propane) and natural gas (Henry Hub Natural Gas) prices. Hence, exchange rate volatility likely good to be estimated by the SVMA model. Monthly data for the period of January 2010 through November 2015 was used. The Moreover, there are limited studies examining the impact of exchange rate volatility on exports using exchange rate volatility estimated by a stochastic volatility model. Exchange rate volatility is estimated from the real effective exchange rate (e_t, 2005 = 100). Total exports, 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.

Financial time series tend to be not normally distributed and exhibited properties such as volatility clustering, heavy-tailed and serial dependence. Models, which assume constant variance are unable to capture time-varying volatility and as a result cannot estimate volatility clustering (Chan and Hsiao, 2014). Volatility clustering is that large changes in observations tend to be followed by large changes whereas small changes are followed by small changes. A heavy-tailed distribution tends to have very large values with many outliers (Ibragimov, Ibragimov and Walden, 2015). Serial dependence is the error for one time period is correlated with the error for a subsequent time period (Greene, 2017). The ARCH type model and the stochastic volatility model

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[1]For future study, it would be good also to consider the stochastic volatility with leverage (SVL) model, which allows a leverage effect. The model is said to be better in capturing volatility. In the SVL model, the innovations in the observation and state equations can be correlated as $y_t = \mu + \epsilon_t^y$, $h_{t+1} = \mu_h + \phi_h(h_{t-1} - \mu_h) + \epsilon_t^h$, where the innovation ϵ_t^y and ϵ_t^h jointly follow a bivariate normal distribution: $\begin{pmatrix} \epsilon_t^y \\ \epsilon_t^h \end{pmatrix} \sim \mathcal{N}\left(0, \begin{pmatrix} exp^{h_t} & \rho exp^{\frac{1}{2}h_t}\omega_h \\ \rho exp^{\frac{1}{2}h_t}\omega_h & \omega_h^2 \end{pmatrix}\right)$. When $\rho < 0$, given a negative shock to y_t at time *t*, volatility at time *t*+1 tends to be larger. When $\rho = 0$, the SVL model becomes the standard SV model (Chan and Grant, 2016).

try to capture volatility clustering, heavy-tailed and serial dependence in time series. The two classes of models, namely the stochastic volatility model and the ARCH type model are non-nested and the implied time varying volatility has different properties. For the ARCH type model, the conditional variance or volatility is a deterministic function of the model parameters and past data. For the stochastic volatility model, volatility is a random variable, that is, volatility is specified as a latent stochastic process. The motivation for the stochasticity in the volatility process is that volatility shall be unpredictable and therefore it shall be determined stochastically (Chan and Grant, 2016). Chan and Grant (2016) report that stochastic volatility models tend to outperform their Generalized AutoRegressive Conditional Heteroskedasticity (GARCH) counterparts, which indicates that stochastic volatility models provide a better alternative to GARCH models. The stochastic volatility models are estimated using the Bayesian techniques. The marginal likelihood is computed using the cross-entropy of Chan and Eisenstat (2015), which is based on the importance sampling approach is that random samples can be obtained from some convenient density with not much additional costs.

The standard stochastic volatility (SV) model is expressed as follows:

Model 1
$$y_t = \mu + \epsilon_t^y,\ \epsilon_t^y \sim N(0, exp^{h_t})$$
$$h_t = \mu_h + \phi_h(h_{t-1} - \mu_h) + \epsilon_t^h,\ \epsilon_t^h \sim N(0, \omega_h^2) \quad (1)$$

where y_t is $\ln e_t$, N denotes normally distibuted and exp denotes exponential. The logarithm volatility, h_t is assumed to follows a stationary autoregressive with order one process with $|\phi_h| < 1$ and unconditional mean, μ_h. The process is initialised with $h_t \sim N(\mu_h, \omega_h^2/(1 - \phi_h^2)$.

The stochastic volatility with h_t follows a stationary autoregressive with order two process (SV2) model is expressed as follows:

Model 2
$$y_t = \mu + \epsilon_t^y,\ \epsilon_t^y \sim N(0, exp^{h_t})$$
$$h_t = \mu_h + \phi_h(h_{t-1} - \mu_h) + \rho_h(h_{t-2} - \mu_h) + \epsilon_t^h,\ \epsilon_t^h \sim N(0, \omega_h^2) \quad (2)$$

where when $\rho_h = 0$, model 2 is reduced to model 1.

The stochastic volatility in mean (SVM) model is expressed as follows:

Model 3
$$y_t = \mu + \lambda exp^{h_t} + \epsilon_t^y,\ \epsilon_t^y \sim N(0, exp^{h_t})$$
$$h_t = \mu_h + \phi_h(h_{t-1} - \mu_h) + \epsilon_t^h,\ \epsilon_t^h \sim N(0, \omega_h^2) \quad (3)$$

where λ captures the extent of volatility feedback and when $\lambda = 0$, the SVM model is reduced to the SV model.

The stochastic volatility with *t* error (SVT) model is expressed as follows:

Model 4
$$y_t = \mu + \epsilon_t^y, \epsilon_t^y \sim t_v(0, exp^{h_t})$$
$$h_t = \mu_h + \phi_h(h_{t-1} - \mu_h) + \epsilon_t^h, \epsilon_t^h \sim N(0, \omega_h^2) \quad (4)$$

The stochastic volatility with moving average (SVMA) model is expressed as follows:

Model 5
$$y_t = \mu + \epsilon_t^y$$
$$\epsilon_t^y = u_t + \psi u_{t-1}, u_t \sim N(0, exp^{h_t})$$
$$h_t = \mu_h + \phi_h(h_{t-1} - \mu_h) + \epsilon_t^h, \epsilon_t^h \sim N(0, \omega_h^2) \quad (5)$$

where u_t and $|\psi| < 1$ (Chan and Hsiao, 2014). The marginal likelihood is used to select the best model.

The export models to be estimated are specified as follows[2]:

Model 6
$$\ln x_t = \beta_{10}\, t + \beta_{11} \ln p_t + \beta_{12} \ln y_t + \beta_{13} v_t + u_{1,t} \quad (6)$$

Model 7
$$\ln x_t = \beta_{20}\, t + \beta_{21} \ln p_t + \beta_{22} \ln y_t + \beta_{23} v_t^+ + \beta_{24} v_t^- + u_{2,t} \quad (7)$$

where ln is the logarithm, t is a time trend, x_t is real exports, namely real total exports 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, which is estimated by the SVMA model, $v_t^+ = \sum_{j=1}^{t} \Delta\, v_j^+$, $\Delta v_t^+ = \max(\Delta v_t, 0)$ and $v_t^- = \sum_{j=1}^{t} \Delta\, v_j^-$, $\Delta v_t^- = \min(\Delta v_t, 0)$ are partial sum process of positive and negative changes in v_t and $u_{i,t}$ (i = 1, 2) is a disturbance term (Schorderet, 2001; Shin, Yu and Greenwood-Nimmo, 2014; Choudhry and Hassan, 2015). The export model is usually estimated in logarithms, except the measurement of exchange rate volatility, which is in its level (Fang, Lai and Miller, 2009; Bahmani-Oskooee and Harvey, 2011). 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 exports. Generally, relative price is expected to have negative impact on exports. Real foreign demand is expected to have positive impact on exports. Exchange rate volatility is expected to have negative impact on exports.

The error correction models of the export models are as follows:

Model 8
$$\Delta \ln x_t = \beta_{30} + \sum_{i=0}^{a} \beta_{31i}\, \Delta \ln p_{t-i} + \sum_{i=0}^{b} \beta_{32i}\, \Delta \ln y_{t-i} + \sum_{i=0}^{c} \beta_{33i}\, \Delta\, v_{t-i} + \sum_{i=1}^{d} \beta_{34i}\, \Delta \ln x_{t-i} + \beta_{35}\, ec_{t-1} + u_{3,t} \quad (8)$$

Model 9
$$\Delta \ln x_t = \beta_{40} + \sum_{i=0}^{a} \beta_{41i}\, \Delta \ln p_{t-i} + \sum_{i=0}^{b} \beta_{42i}\, \Delta \ln y_{t-i} + \sum_{i=0}^{c} \beta_{43i}\, \Delta\, v_{t-i}^+ + \sum_{i=0}^{d} \beta_{44i}\, \Delta\, v_{t-i}^- + \sum_{i=1}^{d} \beta_{45i}\, \Delta \ln x_{t-i} + \beta_{46}\, ec_{t-1} + u_{4,t} \quad (9)$$

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

[2]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.

4. RESULTS AND DISCUSSIONS

The results of the Dickey and Fuller unit root test statistic are reported in Table 2. The lag length used to compute the Dickey and Fuller unit root statistic is based on the Akaike information criterion/the modified Akaike information criterion. The Dickey and Fuller unit root test statistic shows that all the variables are non-stationary in their levels but become stationary after taking the first differences, except exchange rate volatility, namely exchange rate volatility computed by the moving standard deviation with order three [MSD(3)] and exchange rate volatility estimated by the SVMA whereas exchange rate volatility estimated by the SVMA model is closely to be an I(1) series and therefore it can be assumed to be an I(1) series in this study.

Table 2: The results of the Dickey and Fuller unit root test statistic.

$\ln x_{t,t}$	-1.8243(4)	$\ln p_{t,t}$	-1.6629(0)	$\ln y_t$	-2.8710(3)
$\Delta \ln x_{t,t}$	-8.3808***(2)	$\Delta \ln p_{t,t}$	-7.7316***(0)	$\Delta \ln y_t$	-5.0985***(4)
$\ln x_{0,t}$	-2.4192(4)	$\ln p_{0,t}$	-0.5653(2)	v_t	-0.1214(2)
$\Delta \ln x_{0,t}$	-8.3143***(2)	$\Delta \ln p_{0,t}$	-7.3837***(1)	Δv_t	-2.7104(1)
$\ln x_{1,t}$	-1.4935(6)	$\ln p_{1,t}$	0.6757(3)	$v_t{}^{\#}$	-1.7384(20)
$\Delta \ln x_{1,t}$	-17.9671***(0)	$\Delta \ln p_{1,t}$	-3.9328**(2)	$\Delta v_t{}^{\#}$	-3.8652**(19)
$\ln x_{2,t}$	-2.2642(1)	$\ln p_{2,t}$	-3.1148(2)	$v3_t$	-4.7929***(1)
$\Delta \ln x_{2,t}$	-7.0580***(2)	$\Delta \ln p_{2,t}$	-7.6721***(0)	$\Delta v3_t$	-4.8868***(5)
$\ln x_{3,t}$	-2.9137(1)	$\ln p_{3,t}$	-1.7041(5)		
$\Delta \ln x_{3,t}$	-7.3775***(1)	$\Delta \ln p_{3,t}$	-4.0655**(4)		
$\ln x_{4,t}$	-3.0782(2)	$\ln p_{4,t}$	-2.4838(0)		
$\Delta \ln x_{4,t}$	-11.9136***(0)	$\Delta \ln p_{4,t}$	-9.2143***(0)		
$\ln x_{5,t}$	-2.7158(2)	$\ln p_{5,t}$	-2.1025(0)		
$\Delta \ln x_{5,t}$	-5.2880***(5)	$\Delta \ln p_{5,t}$	-7.2134***(0)		
$\ln x_{6,t}$	-2.6070(4)	$\ln p_{6,t}$	-1.8784(1)		
$\Delta \ln x_{6,t}$	-11.8233***(0)	$\Delta \ln p_{6,t}$	-7.1011***(6)		
$\ln x_{7,t}$	-1.3208(4)	$\ln p_{7,t}$	-1.0294(0)		
$\Delta \ln x_{7,t}$	-7.8032***(2)	$\Delta \ln p_{7,t}$	-6.4661***(0)		
$\ln x_{8,t}$	-2.5254(1)	$\ln p_{8,t}$	2.1400(0)		
$\Delta \ln x_{8,t}$	-14.2642***(0)	$\Delta \ln p_{8,t}$	-8.9841***(0)		
$\ln x_{9,t}$	-1.5629(4)	$\ln p_{9,t}$	-1.5629(4)		
$\Delta \ln x_{9,t}$	-10.1291***(0)	$\Delta \ln p_{9,t}$	-10.1291***(0)		

Notes: $x_{t,t}$ is total export at time *t*. $x_{i,t}$ is export of SITC *i* at time *t* (i = 0, … , 9). e_t is exchange rate at time *t*. y_t is foreign demand at time *t*. v_t is exchange rate volatility estimated by the SVMA model at time *t*. $v3_t$ is exchange rate volatility computed by the MSD(3) at time *t*. The Dickey and Fuller unit root statistic is estimated based on the model including an intercept and a time trend. # denotes the lag length used to the Dickey and Fuller unit root statistic is based on t-statistic with maximum lag length used in the selection is 20. Values in the parentheses are the lags used in the estimations. *** (**, *) denotes significance at the 1% (5%, 10%) level.

Nonetheless, when the lag length used to compute the Dickey and Fuller unit root model.[3] Exchange rate volatility computed by the MSD(3) is a stationary series statistic is based on t-statistic with maximum lag length used in the selection is 20, exchange rate volatility estimated by the SVMA model is an I(1) series.

The results of the stochastic volatility models are given in Table 3. The estimations are based on the means of the 21000 draws from the posterior distribution using the Gibbs sampler after a burn-in period of 1000 (Chan & Hsiao, 2014). The Ljung-Box tests of the null hypothesis of no serial correlation in the standardised residuals are all not rejected. The McLeod-Li tests of the null hypothesis of no serial correlation in the squared standardised residuals are also not rejected. On the whole, the stochastic volatility models are said to be good to capture the time-varying volatility of the data. The parameters estimated are found mainly to be statistically significant. The stochastic volatility process is highly persistent for all models. The posterior means of ϕ_h of the stochastic volatility models are in the values of 0.98 to 1.04. The SVMA model is the best model based on the largest value of the marginal likelihood. The plots of exchange rate volatility, which is computed by exchange rate volatility is computed by the MSD(3) and estimated by the SVMA model are given in Figure 1. Exchange rate volatility moves in the same direction. However, exchange rate volatility estimated by the SVMA model is found to be non-stationary compared with exchange rate volatility computed by the MSD(3), which is stationary. This can imply that the SVMA model is better to capture volatility clustering in exchange rate, that is, high exchange rate volatility movements are observed to be followed by high exchange rate volatility movements, which is characterised by a period of relative market turbulence whereas low exchange rate volatility movements are observed to be followed by low exchange rate volatility movements, which is corresponding to a period of a relative tranquil market. In Figure 1, exchange rate volatility was relatively clustering after 2014, which is shown by higher stochastic volatility whereas the MSD(3) is tended to be up and down or stationary. This can imply that the SVMA model is better to capture volatility clustering in exchange rate than the MSD(3). Hence, exchange rate volatility estimated by the SVMA model is used to examine its impact on exports in this study.

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[3]Exchange rate volatility is not directly observable and therefore exchange rate volatility should be measured. There are many measurements for exchange rate volatility and yet there is no consensus on the best proxy for exchange rate volatility. The moving standard deviation is one of common measurement for exchange rate volatility in the literature of the impact of exchange rate volatility on exports (Asteriou, Masatci and Pılbeam, 2016). The moving standard deviation with order three or the MSD(3) is calculated as follows:

$$MSD(3) = [\frac{1}{m}\sum_{i=1}^{m}(\ln e_{t+i-1} - \ln e_{t+i-2})^2]^{\frac{1}{2}}$$

where m is the window of moving average, which is 3 in this study, ln is the logarithm and e_t is the real effective exchange rate. The window of the moving standard deviation is arbitrary in the literature (Cushman, 1983, 1988; Chowdhury, 1993). If a larger window size is chosen, this would introduce the problem of over smoothing and lack of degree of freedom in the estimation. If a smaller window size is chosen, the problem may arise is under smoothing. This study uses monthly data and therefore, it is reasonable if the window of the moving standard deviation to be three is used. Koray and Lastrapes (1989) show that the moving standard deviation captures the temporal variation in the absolute magnitude of changes in exchange rate and therefore, exchange rate risk over time.

Table 3: The parameters posterior means of the stochastic volatility models, January, 2010 - November, 2015.

	SV	SV2	SVM	SVT	SVMA
μ	4.66 (0.00)	4.65 (0.00)	4.66 (0.00)	4.66 (0.00)	4.65 (0.00)
μ_h	-3.72 (2.82)	-6.49 (1.46)	-4.28 (2.86)	-3.67 (2.87)	-4.01 (3.08)
ϕ_h	0.99 (0.02)	1.04 (0.07)	0.98 (0.02)	0.99 (0.02)	0.99 (0.02)
ω_h^2	0.12 (0.06)	0.16 (0.09)	0.10 (0.05)	0.11 (0.06)	0.13 (0.06)
ρ_h	-	-0.13 (0.10)	-	-	-
λ	-	-	-25.02 (7.64)	-	-
ν	-	-	-	57.07 (26.33)	-
ψ	-	-	-	-	0.68 (0.07)
ML	149.9 (0.02)	148.7 (0.06)	157.1 (0.02)	149.6 (0.02)	169.3 (0.09)
Q(20)	78.37 (7.92)	80.40 (9.68)	70.04 (14.40)	78.03 (8.05)	41.89 (7.07)
$Q^2(20)$	23.66 (7.56)	24.20 (10.31)	17.37 (6.98)	23.63 (7.79)	15.10 (5.56)

Notes: ML denotes the marginal likelihood. Q(20) and $Q^2(20)$ denote the Ljung-Box and McLeod-Li statistics of order 20 computed based on the standardised errors and squared standardised errors, respectively. Values in the parentheses are the standard deviations.

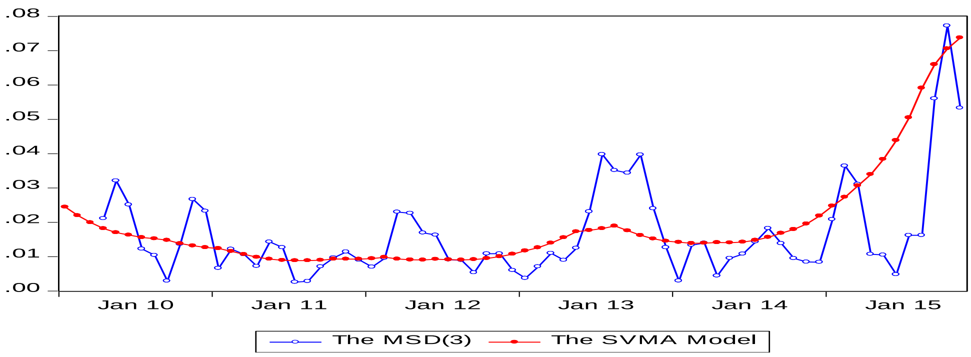

Figure 1: Exchange rate volatility computed by the MSD(3) and estimated by the SVMA model, January, 2010 – November, 2015.

The ARDL bounds testing approach and the long run coefficients of the ARDL approach are given in Appendix A. 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 F 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 mainly to be negative and statistically significant. An increase in relative price will lead to a decrease in real exports. The coefficient of real foreign demand is found many times to be positive and statistically significant. An increase in real foreign demand will lead to an increase in real exports. There are some coefficients of real foreign demand to be negative and statistically significant. One possible explanation is that the growth of real foreign demand is substitution for exports of Malaysia (Bahmani-Oskooee & Aftad, 2017). There are some coefficients of relative price to be positive and statistically significant. One likely explanation is exports of Malaysia relatively to be luxury to other countries. Generally, the coefficients of exchange rate volatility are found to be positive and statistically significant. The impact of exchange rate volatility on real total exports and real exports of SITC 2, SITC 4, SITC 6, SITC 7 and SITC 8 are found to be positive and statistically significant. Conversely, the impact of exchange rate volatility real exports of STIC 1 is found to be negative and statistically significant. The coefficients of positive exchange rate volatility or negative exchange rate volatility are found mainly to be positive or negative and statistically significant.

The summary results of the error correction models are reported in Appendix B[4]. 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 many cases of exchange rate volatility are found to have a significant impact on real exports. However, exchange rate volatility is found generally to have an insignificant impact on real total exports. Hence, some sectors of exports are sensitive to exchange rate volatility whilst some sectors of exports are less sensitive to exchange rate volatility. Moreover, some sectors of exports react negatively to exchange rate volatility whilst some sectors of exports respond positively to exchange rate volatility.

This study finds that the stochastic volatility model is best to be estimated by the SVMA model based on the marginal likelihood. 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 Malaysia's exports. This study finds that there is evidence of exchange rate volatility to have significant impact on Malaysia's real total exports and some evidence of sub-categories of real total exports. The coefficients of positive exchange rate volatility or negative exchange rate volatility are found mainly to be positive or negative and statistically significant on Malaysia's exports.

In the short run, the coefficients of relative price and real foreign demand are found frequently to be statistically significant. The coefficient of exchange rate volatility is found generally to have an insignificant impact on real total exports but

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[4]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.

there are many cases of the coefficients of exchange rate volatility are found to have a significant impact on sub-categories of real total exports. Moreover, some sectors of exports react negatively to exchange rate volatility whilst some sectors of exports respond positively to exchange rate volatility. Moreover, 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 impact of exchange rate volatility on exports can be either negative or positive. Bahmani-Oskooee and Aftab (2017: 94), amongst others, also report the partially asymmetric ARDL model seems to yield more significant short-run results than the ARDL model.

The finding that exchange rate volatility to have significant impact on exports is consistent with the findings such as Wong and Tang (2008, 2011), Bahmani-Oskooee and Harvey (2011) and Bahmani-Oskooee and Aftad (2017). The impact of exchange rate volatility is not the same for different sectors of exports. Some industries are more sensitive to exchange rate volatility. There are some reasons exchange rate volatility has no impact on exports (Bandt & Razafindrabe, 2014: 64; Bernini & Tomasi, 2015; Choudhri & Hakura, 2015; Devereux & Engel, 2002; Gopinath et al., 2010). 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 exports. 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 (Devereux & Engel, 2002).

Exchange rate volatility can have an adverse impact on Malaysia's exports. There are many ways that the impact of exchange rate volatility can be minimised. In the short run, exporters should 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 should be further developed with more instruments to be introduced and at a lower cost. Malaysia's exporters should continue to improve their products through innovation and higher technology. The change of the price of a higher quality product is likely has less influence on its demand. Moreover, Malaysia's exporters should diversify their markets to market like in Association of Southeast Asian Nations Economic Community (AEC). AEC would provide an extensive potential export market to Malaysia's exporters. 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. Exports are an engine of economic growth for Malaysia to achieve its vision to become a high income country. Export sector especially in manufacturing can generate more job opportunities with higher paying.

5. CONCLUDING REMARKS

This study examines the impact of exchange rate volatility on real total exports and sub-categories of real total exports by SITC from 0 to 9. The stochastic volatility model is found good to be estimated by the SVMA model. Exports 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 often found to be statistically significant. In the short run, the coefficients of relative price and real foreign demand are often found to be statistically significant. Exchange rate volatility generally has an insignificant impact on real total exports. However, some cases exchange rate volatility is found to have a significant impact on real exports. The impact of exchange rate volatility on exports can be either negative or positive. The coefficients of positive exchange rate volatility or negative exchange rate volatility are found mostly to be positive or negative and statistically significant on exports. The impact of exchange rate volatility on exports is estimated by the ARDL model whereas the impact of asymmetric impact of exchange rate volatility, namely positive exchange rate volatility and negative exchange rate volatility on exports is estimated by the partially asymmetric ARDL model. Hence, the two different models examine the different impact of exchange rate volatility on exports. Nonetheless, this study finds the use of the partially asymmetric ARDL model produces more significant impact of exchange rate volatility on exports than the use of the whole exchange rate volatility on exports. Therefore, the use of the partially asymmetric ARDL model tends to be better to capture the impact of exchange rate volatility. The better policy implication can be derived from the results of the partially asymmetric ARDL model. The industries significantly affected by exchange rate volatility should be given more assistance such as incentives for their exports. Exports should be diversified with more focus on exports to AEC. Exports can improve economic growth and help Malaysia achieve its vision of becoming a high income country. Exports in the manufacturing sector create more high paying employment opportunities.

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Appendix A: The results of bounds testing approach for cointegration and the long run coefficients of the ARDL approach.

Model 6

	$\ln x_{t,t}$	$\ln x_{0,t}$	$\ln x_{1,t}$	$\ln x_{2,t}$	$\ln x_{3,t}$	$\ln x_{4,t}$
F Statistic	6.2717***	9.5418***	4.2650**	17.8841***	8.1807**	3.9948*
	$\ln x_{5,t}$	$\ln x_{6,t}$	$\ln x_{7,t}$	$\ln x_{8,t}$	$\ln x_{9,t}$	
F Statistic	9.5857***	9.1139***	6.6623***	3.9459*	4.0051*	

	$\ln x_{t,t}$	$\ln x_{0,t}$	$\ln x_{1,t}$	$\ln x_{2,t}$	$\ln x_{3,t}$	$\ln x_{4,t}$
t	0.0020 (4.6960)***	0.0041 (10.2268)***	0.0082 (13.1685)***	0.0016 (2.0727)**	0.0093 (13.1322)***	-0.0014 (-1.0579)
$\ln p_t$	-0.4155 (-1.5992)	-0.6118 (-1.3004)	3.3064 (2.2206)**	0.2246 (2.0706)**	-0.5414 (-2.3652)**	0.3472 (0.9441)
$\ln y_t$	1.1619 (3.5851)***	1.1024 (2.9571)***	-1.4473 (-1.7895)*	0.4043 (0.8265)	-0.0183 (-0.0329)	1.2642 (1.1952)
v_t	1.3417 (2.2118)**	1.0891 (1.4568)	-4.4799 (-2.4054)**	6.8311 (8.9496)***	0.1917 (0.1455)	4.1128 (2.3489)**

Diagnostic Tests

LM	0.9121	0.4431	0.6416	1.0905	0.1245	1.3376
Reset	0.0702	7.5811***	1.4834	0.0132	0.0096	0.0970
Hetero	0.2829	0.6079	1.0980	1.1075	0.3119	0.8504

	$\ln x_{5,t}$	$\ln x_{6,t}$	$\ln x_{7,t}$	$\ln x_{8,t}$	$\ln x_{9,t}$
t	0.0055 (8.9859)***	0.0019 (2.3925)**	0.0011 (0.5984)	0.0027 (2.1323)**	-0.0065 (-1.2127)
$\ln p_t$	-0.9544 (-4.5032)***	-0.0063 (-0.0143)	0.0180 (0.0180)	-0.9862 (-1.5462)	1.1506 (0.9944)
$\ln y_t$	1.0956 (3.0511)***	1.1196 (1.7663)*	5.0269 (2.1873)**	1.4147 (1.9031)*	-1.6309 (-0.8105)
v_t	0.4147 (0.7665)	1.8699 (1.9958)*	3.8869 (2.3817)**	2.4438 (2.7109)***	-1.8835 (-0.4351)

Diagnostic Tests

LM	1.2492	0.2871	0.6990	1.9171	1.2013
Reset	2.1902	0.1024	3.1736*	0.1071	3.3209*
Hetero	1.1103	1.3339	0.9170	1.4705	0.6898

Model 7

	$\ln x_{t,t}$	$\ln x_{0,t}$	$\ln x_{1,t}$	$\ln x_{2,t}$	$\ln x_{3,t}$	$\ln x_{4,t}$
F Statistic	4.7410**	4.6488**	3.6315*	12.8078***	6.4168***	3.7015*
	$\ln x_{5,t}$	$\ln x_{6,t}$	$\ln x_{7,t}$	$\ln x_{8,t}$	$\ln x_{9,t}$	
F Statistic	8.4602***	6.8768***	4.2231**	6.9700***	3.7298*	

	$\ln x_{t,t}$	$\ln x_{0,t}$	$\ln x_{1,t}$	$\ln x_{2,t}$	$\ln x_{3,t}$	$\ln x_{4,t}$
t	0.0022 (4.4980)***	0.0037 (5.4934)***	0.0086 (11.6728)***	0.000003 (0.0036)	0.0074 (6.9395)***	-0.0019 (-1.4867)
$\ln p_t$	-0.5956 (-2.4229)**	-2.9819 (-2.4915)**	3.5808 (2.4362)**	0.0692 (0.5834)	0.1376 (0.3917)	0.1777 (0.5234)
$\ln y_t$	1.0459 (3.1216)***	0.5011 (0.9005)	-0.8654 (-1.5261)	0.2260 (0.4270)	-3.6493 (-2.7925)***	-0.1789 (-0.1558)
v_t^+	0.9516 (1.6780)*	5.0206 (2.6013)**	-4.9875 (-2.7459)***	6.7013 (8.1533)***	5.2314 (1.5926)	3.6368 (2.5828)**
v_t^-	-0.8510 (-0.9948)	-7.2759 (-2.4497)**	3.7601 (2.0379)**	-3.0346 (-2.1744)**	-9.4867 (-3.0593)	-3.7351 (-1.5594)

Appendix A (*continued*).

Diagnostic Tests

LM	0.6285	0.1544	0.2109	0.3182	1.0173	0.0808
Reset	2.1260	1.1653	2.1303	0.9652	0.9741	2.0129
Hetero	0.3383	0.5524	1.2977	0.6862	1.0164	0.9387

	$\ln x_{5,t}$	$\ln x_{6,t}$	$\ln x_{7,t}$	$\ln x_{8,t}$	$\ln x_{9,t}$
t	0.0055 (8.6276)***	0.0020 (2.3495)**	0.0012 (0.8727)	0.0023 (2.7742)***	-0.0122 (-2.1327)**
$\ln p_t$	-0.9754 (-4.5904)***	-0.1488 (-0.3342)	-1.0864 (-2.0923)**	-1.1162 (-2.7269)***	2.5731 (2.2401)**
$\ln y_t$	1.1369 (3.0433)**	0.9847 (1.5192)	1.2247 (1.7858)*	0.5535 (1.3983)	-5.9038 (-2.4866)**
v_t^+	0.2643 (0.4606)	1.7022 (1.7420)*	2.2549 (2.1551)**	2.5285 (4.2721)***	1.8433 (0.4630)
v_t^-	0.5301 (0.5858)	-1.4656 (-0.8613)	-0.7729 (-0.5439)	-2.0219 (-2.1163)**	-3.7495 (-0.7682)

Diagnostic Tests

LM	2.1979	0.0998	5.9741	1.2063	0.2340
Reset	2.4249	0.3300	10.8553***	0.6138	1.3200
Hetero	1.3030	1.5317	1.0706	2.9368	0.6710

Notes: t is a time trend, $x_{t,t}$ is real total export. $x_{i,t}$ is real export of SITC i (i = 0, … , 9). p_t is relative price of real total export or real export of SITC i (i = 0, … , 9). y_t is real foreign demand. v_t is exchange rate volatility estimated by the SVMA model. LM is the Lagrange Multiplier test of disturbance serial correlation. Reset is the test of functional form. Hetero is the test of heteroscedasticity. The OLS estimator with Newey-West standard error is used when the Lagrange Multiplier test of disturbance serial correlation is found to be significant. The OLS estimator with Huber-White standard error is used when the test of heteroscedasticity is found to be significant. *** (**, *) denotes significance of the t-statistic at the 1% (5%, 10%) level.

Appendix B: The results of the error-correction models.

Mode1 8

	$\Delta \ln x_{t,t}$	$\Delta \ln x_{0,t}$	$\Delta \ln x_{1,t}$	$\Delta \ln x_{2,t}$	$\Delta \ln x_{3,t}$	$\Delta \ln x_{4,t}$
constant	-1.2916 (-3.5957)***	-3.3430 (-4.3345)***	7.7295 (4.3166)***	-0.5347 (-9.2379)***	3.7119 (6.5847)***	-2.0381 (-4.0625)***
$\Delta \ln p_t$	-1.1772 (-2.3121)**	0.7799 (0.9587)	-1.2345 (-1.2884)	-1.0327 (-4.4531)***	-0.9058 (-2.8034)**	-1.0353 (-3.9774)***
$\Delta \ln p_{t-1}$	-	-	-3.1094 (-3.2653)***	-	-	-1.9646 (-2.8008)**
$\Delta \ln p_{t-2}$	1.1450 (2.3714)**	-	-	-	-	-2.5421 (-3.7744)***
$\Delta \ln y_{t-1}$	-	-1.0355 (-2.5386)**	2.3433 (4.1658)***	-	-	-
$\Delta \ln y_{t-2}$	-	-1.3664 (-3.9423)***	1.2826 (2.1873)**	-0.7290 (-1.3445)	0.7378 (1.2317)	-
$\Delta \ln y_{t-3}$	0.4262 (1.5713)	-	-	-	-	-
Δv_t	-	7.8788 (2.2887)**	-20.5582 (-1.8263)*	23.4085 (1.9790)*	-44.1530 (-5.4057)***	25.3832 (2.8986)**
Δv_{t-1}	-	-	22.2075 (1.9158)*	-45.3821 (-2.4182)**	-	-
Δv_{t-2}	1.9193 (0.9423)	-	-	30.0424 (2.4276)**	-	-21.4997 (-2.5385)**
Δv_{t-3}	-	-10.8631 (-2.0780)**	-	-	-	-
$\Delta \ln x_{j,t-1}$	-0.3660 (-2.6489)**	-0.2358 (-2.7924)***	-0.3863 (-3.3669)***	-	-	-0.2766 (-2.8016)***
$\Delta \ln x_{j,t-2}$	-0.2279 (-1.9907)*	-	-	-	-	-
ec_{t-1}	-0.5811 (-3.5992)***	-0.6067 (-4.3556)***	-0.7037 (-4.3118)***	-0.9155 (-9.3444)***	-0.8734 (-6.5800)***	-0.3421 (-4.0697)***

Diagnostic Tests

Adj. R^2	0.4366	0.4991	0.6376	0.6555	0.4247	0.5423
LM	0.1723	4.1824**	0.9855	0.8179	0.5727	1.5942
Reset	0.9008	2.6938	0.4760	0.9215	0.0714	0.7466
Hetero	0.1576	0.7242	1.1701	1.1437	0.7511	0.8631

Appendix B (*continued*).

	$\Delta \ln x_{5,t}$	$\Delta \ln x_{6,t}$	$\Delta \ln x_{7,t}$	$\Delta \ln x_{8,t}$	$\Delta \ln x_{9,t}$
constant	-3.9695 (-7.5130)***	-3.5776 (-6.6508)***	-11.4527 (-5.0082)***	-3.6153 (-3.3733)**	4.8936 (3.9427)***
$\Delta \ln p_t$	-1.7428 (-2.9185)**	-	-1.1718 (-1.7220)*	-1.8766 (-1.7313)*	-
$\Delta \ln p_{t-1}$	1.7959 (2.9333)***	-	-	-	0.0510 (0.4276)
$\Delta \ln p_{t-2}$	-	-1.9233 (-2.0488)**	-	-	-
$\Delta \ln p_{t-3}$	1.3623 (2.2245)**	-	-	-	-
$\Delta \ln y_t$	1.1003 (3.0727)***	-	1.1835 (3.0173)***	-	-
$\Delta \ln y_{t-1}$	-	0.7575 (1.0300)	-	-	-
$\Delta \ln y_{t-2}$	-	-	-	-	-2.5740 (-2.7518)***
$\Delta \ln y_{t-3}$	-	-	-	-0.3014 (-1.0899)	-
Δv_t	2.3410 (1.0219)	-	8.8011 (2.2253)**	-	-
Δv_{t-1}	-	-	-	1.7943 (1.3816)	0.2538 (0.0393)
Δv_{t-3}	-	3.5131 (0.5730)	-6.8130 (-1.5070)	-	-
$\Delta \ln x_{j,t-1}$	-	-	-0.8868 (-7.8157)***	-0.2726 (-2.8133)**	-
$\Delta \ln x_{j,t-2}$	-	-	-0.6228 (-4.3937)***	-	-
$\Delta \ln x_{j,t-3}$	-	-	-0.2927 (-2.6075)**	-	-
ec_{t-1}	-0.8900 (-7.5118)***	-0.8220 (-6.6623)***	-0.3712 (-5.0068)***	-0.5740 (-3.3772)***	-0.4221 (-3.9417)***

Diagnostic Tests

Adj. R^2	0.5967	0.4228	0.5879	0.4426	0.2657
LM	1.6160	0.0985	0.0159	3.1440*	0.9999
Reset	1.2438	0.9454	2.0556	8.4248*	0.5144
Hetero	0.7252	3.3670**	0.8885	1.4071	0.2198

Appendix B (*continued*).

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	$\Delta \ln x_{t,t}$	$\Delta \ln x_{0,t}$	$\Delta \ln x_{1,t}$	$\Delta \ln x_{2,t}$	$\Delta \ln x_{3,t}$	$\Delta \ln x_{4,t}$
constant	-0.9399 (-4.4460)***	-0.6843 (-5.1003)***	5.8544 (5.6234)***	0.7468 (8.4414)***	5.8021 (2.5534)**	2.0257 (16.0791)***
$\Delta \ln p_t$	-0.9717 (-1.9120)*	-	-	-1.2073 (-4.6278)***	-0.7043 (-1.8996)*	-1.3463 (-8.8086)***
$\Delta \ln p_{t-1}$	-	-	-2.7164 (-2.8657)***	-	-	-0.7405 (-3.5937)***
$\Delta \ln p_{t-2}$	1.0732 (2.3413)**	-	-	-0.8652 (-1.4770)	-	-
$\Delta \ln p_{t-3}$	-	0.3226 (0.5950)	-	-	-	-
$\Delta \ln y_t$	-	-	-1.8468 (-3.4124)***	-	-1.7965 (-2.0947)**	1.1413 (2.8513)***
$\Delta \ln y_{t-2}$	-	-0.5811 (-1.7178)*	-	-	1.5280 (2.1196)**	-1.1952 (-2.4447)**
$\Delta \ln y_{t-3}$	0.5020 (1.9216)*	-	-	-	1.6839 (1.8550)*	-
Δv_t^+	-	2.2072 (1.5450)	-4.1028 (-1.3668)	-	-4.2695 (-1.2648)	3.8085 (1.9292)*
Δv_{t-1}^+	-	-	-	-4.1496 (-1.5601)	-	-
Δv_{t-2}^+	2.0179 (1.7295)*	-	-	8.0097 (2.3497)**	-	-
Δv_t^-	-	-	1.2579 (0.9222)	-2.5448 (-1.9864)*	-	-
Δv_{t-1}^-	1.4457 (2.8239)***	3.3936 (4.3199)***	-	-	1.9157 (1.4944)	3.5109 (7.8919)***
Δv_{t-2}^-	-	2.6388 (3.5822)***	-	-3.0372 (-1.7245)*	-	-
Δv_{t-3}^-	-	-	-	-	-	2.3791 (2.0335)**
$\Delta \ln x_{j,t-1}$	-0.2318 (-1.9743)*	-0.6452 (-5.6254)***	-0.2716 (-2.5404)**	-	-0.3679 (-3.2167)***	-0.2876 (-2.5791)**
$\Delta \ln x_{j,t-2}$	-	-0.5829 (-4.7827)***	-	-	-	-
$\Delta \ln x_{j,t-3}$	-	-0.3526 (-3.3094)***	-	-	-	-
ec_{t-1}	-0.6838 (-4.4442)***	-0.5126 (-5.1845)***	-0.8657 (-5.6100)***	-0.9180 (-8.5091)***	-0.1920 (-2.5504)**	-0.4531 (-15.8260)***

Diagnostic Tests

Adj. R^2	0.4736	0.6154	0.6102	0.6134	0.3007	0.5525
LM	0.0873	0.2267	0.0118	0.8793	1.0305	2.7643
Reset	1.4856	2.5717	0.7574	0.0253	0.0128	0.5889
Hetero	0.3451	0.6755	1.1392	0.8597	0.5690	0.6322

Appendix B (*continued*).

	$\Delta \ln x_{5,t}$	$\Delta \ln x_{6,t}$	$\Delta \ln x_{7,t}$	$\Delta \ln x_{8,t}$	$\Delta \ln x_{9,t}$
constant	-4.0094 (-7.2747)***	-2.8112 (-6.5078)***	-2.3024 (-4.2166)***	-0.0593 (-5.8987)***	18.4390 (5.1756)***
$\Delta \ln p_t$	-1.6241 (-2.9260)***	-	-1.7351 (-2.2524)**	-2.2326 (-3.1428)***	-
$\Delta \ln p_{t-1}$	1.7873 (3.1305)***	-	-	-	-
$\Delta \ln p_{t-2}$	-	-2.0641 (-1.9130)*	-	-	-
$\Delta \ln p_{t-3}$	1.4578 (2.5070)**	-	-1.2686 (-1.7084)*	-	-0.0624 (-0.5733)
$\Delta \ln y_t$	1.1060 (3.2688)***	-	-	-	-
$\Delta \ln y_{t-1}$	-	0.8152 (1.2804)	-	-	2.5266 (2.5083)**
$\Delta \ln y_{t-2}$	-	-	-	-0.2508 (-0.7467)	-
$\Delta \ln y_{t-3}$	-	-	0.6295 (1.6255)	-	-
Δv_t^+	-	-	-	-	-2.0455 (-0.5203)
Δv_{t-1}^+	-	-	2.1593 (1.3275)	-	-
Δv_{t-2}^+	2.2858 (1.7029)*	-0.3749 (0.1435)	-	3.8398 (2.6222)**	-
Δv_t^-	0.3180 (0.5254)	-1.3338 (-1.0948)	-0.7243 (-0.9447)	-	-
Δv_{t-1}^-	-	-	-	1.9728 (2.9917)***	1.5752 (0.8702)
Δv_{t-3}^-	-1.3896 (-2.2379)**	-	-	-	-
$\Delta \ln x_{j,t-1}$	-	-	-0.3241 (-2.7835)***	-	-
ec_{t-1}	-0.8446 (-7.2755)***	-0.8378 (-6.5161)***	-0.6581 (-4.2160)***	-0.8329 (-7.2758)***	-0.4447 (-5.1774)***

Diagnostic Tests

Adj. R^2	0.6592	0.4048	0.4859	0.5084	0.2694
LM	0.6792	0.7126	0.9757	1.1251	0.4726
Reset	0.4716	0.5337	3.0694*	4.2382**	0.1650
Hetero	0.5491	0.9954	0.4981	1.7949	0.7460

Notes: $x_{t,t}$ is real total export. $x_{i,t}$ is real export of SITC i (i = 0, … , 9). p_t is relative price of real total export or real export of SITC i (i = 0, … , 9). $x_{j,t-k}$ is lag of real total export or real export of SITC i (i = 0, … , 9) (k = 1, 2, 3). y_t is real foreign demand. v_t is exchange rate volatility estimated by the SVMA model. 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. The OLS estimator with Newey-West standard error is used when the Lagrange Multiplier test of disturbance serial correlation is found to be significant. The OLS estimator with Huber-White standard error is used when the test of heteroscedasticity is found to be significant. Values in parentheses are the t-statistics. *** (**, *) denotes significance at the 1% (5%, 10%) level.