

EXCHANGE RATE VOLATILITY AND ITS IMPACT ON COMMODITY TRADE FLOWS BETWEEN SINGAPORE AND MALAYSIA

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Since advent of current float in 1973, the literature on the impact of exchange rate volatility on trade flows has grown so rapidly that most countries have their own literature and Singapore as our country of concern is no exception. Previous studies have investigated the response of aggregate trade flows of Singapore with the rest of the world to exchange rate volatility and have found mostly insignificant link. In this paper we argue that they all suffer from aggregation bias and concentrate on trade flows between Singapore and her major partner, Malaysia. After disaggregating their trade flows by commodity we find that exchange rate volatility has significant short-run effects in 70 out of 156 exporting industries and in 73 out of 155 importing industries. However, short-run effects last into the long run only in 46 exporting and 36 importing industries. We also find that less than 50% of Singapore's industries were affected by the Asian Financial Crisis in 1997.

Keywords: Exchange Rate Volatility, Industry Data, Singapore, Malaysia, Bounds Testing

JEL Classification: F31

1. INTRODUCTION

Introduction of floating exchange rate regime in early seventies has presented exchange rate uncertainty to traders and possibility of negative effects on trade between nations. However, theoretical developments have produced models that predict the effects of exchange rate volatility on trade could also be positive if traders maximize trade today in order to cover part of future loss due to exchange rate uncertainty. Regardless of the outcome, each nation follows its own recourse to meet this challenge. For example, countries may adopt floating exchange rate, pegged rate, managed rate, etc. Exchange rate regimes in both Singapore and Malaysia are fairly similar. Monetary

* Valuable comments of an anonymous reviewer are greatly appreciated. Remaining errors are ours.

Authority of Singapore (central bank) adopts a managed float regime which allows the Singapore dollar to fluctuate within a band. Similarly, Bank Negara Malaysia (Malaysia's central bank) implements comparable policy. Although both exchange rates float within bands, still the real exchange rate between Singapore dollar and Malaysian ringgit could experience volatility outside a given band due to differential inflation rate in Singapore and Malaysia. Figure 1 highlights the degree of volatility of the real exchange rate between Singapore dollar and Malaysian ringgit.

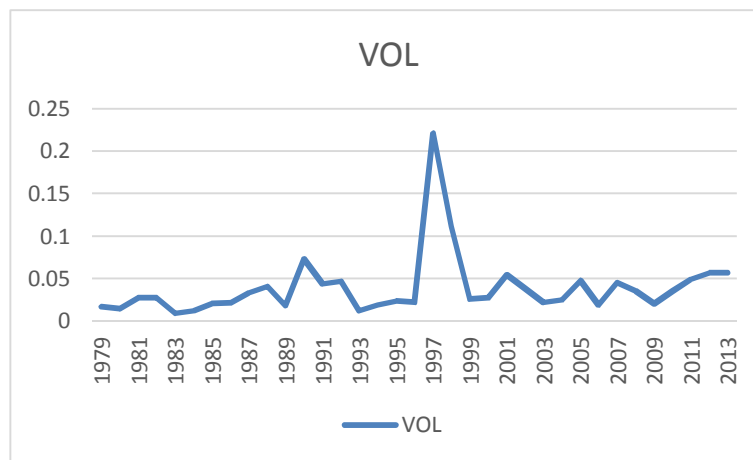


Figure 1. Volatility of Singapore Dollar-Malaysia Ringgit Real Rate: 1979-2013

Has this volatility affected trade volume between Singapore and Malaysia? In trying to answer such questions we usually rely upon predictions from past models and estimates. In trying to learn past studies we come across the most recent review articles by McKenzie (1999) and recently by Bahmani-Oskooee and Hegerty (2007) who provide a detail theoretical and empirical review of the impact of exchange rate volatility on trade flows. From these review articles we gather that a few studies have included Singapore in their list of countries. Bahmani-Oskooee and Payesteh (1993) used standard Ordinary Least Square method to investigate long-run effects of exchange rate volatility on import and export volumes of six countries: Greece, Korea, Pakistan, the Philippines, Singapore and South Africa. In the results for Singapore they find no significant effects. Suspecting that the results could suffer from spurious regression problem, they then relied upon Engle and Granger (1987) cointegration method and showed that indeed the variables are not cointegrated. Since Engle and Granger (1987) method does not allow feedback effects among variables, Bahmani-Oskooee (1996) adopted Johansen's cointegration technique which allows feedback effects among variables of a given model. In the case of Singapore, although he finds cointegration among the variables of both import and export demand models, measure of exchange

rate volatility carries an insignificant coefficient in the import demand model but significantly positive coefficient in one vector and negative coefficients in two vectors. The negative effects is also confirmed by Poon, *et al.* (2005) who used, again, the Johansen's method but only export volume of Singapore in addition to exports of Indonesia, Japan, South Korea, and Thailand.

The mixed findings by the above studies do suffer from aggregation bias in that they have used trade flows of Singapore with the rest of the world. To reduce the bias another set of studies assess the impact of bilateral exchange rate volatility on bilateral trade flows between two countries. Unfortunately, no study has included Singapore as a trading partner.¹ In this paper we try to assess the impact of exchange rate volatility on the trade flows between Singapore and her major trading partner Malaysia. However, following the recent trend we disaggregate the bilateral trade flows between the two countries by commodity and investigate the short-run and long-run effects of real exchange rate volatility on 22 industries in Singapore that import from Malaysia and 26 industries that export to Malaysia.² These industries in each group conduct more than 84% of the trade. To that end, we outline the models and methods in Section 2. The results are presented in Section 3 with a summary in Section 4. Definition of variables and sources of the data appear in the Appendix.

2. THE MODELS AND THE METHOD³

In the literature related to this study where export and import demand models are formulated, it is a common practice to include a scale variable such as a measure of economic activity and a relative price term in addition to a measure of exchange rate volatility. As such we adopt the models used by Bahmani-Oskooee and Hegerty (2009) and use the following export demand model:

$$X_{it} = \alpha + \beta Y_{it} + \gamma P_{it} + \delta R_{it} + \epsilon_{it} \quad (1)$$

where X_{it} is export volume of commodity i by Singapore to Malaysia which is assumed to depend positively on the level of economic activity in Malaysia, Y_{it} . It is

¹ For list of these studies see Bahmani-Oskooee and Hegerty (2007, Table III). Example of such studies include De Vita and Abbott (2004) who considered trade flows between the U.S. and Canada, Mexico, Germany, Japan and UK.

² Note that we are following Bahmani-Oskooee *et al.* (2013) who did similar analysis for 124 US exporting industries to Brazil and 103 US importing industries from Brazil and Bahmani-Oskooee and Hegerty (2009) who considered experience of large number of industries that trade between the U.S. and Mexico. Like these studies initially we included 155 exporting and 156 importing industries. The results for all these industries are available from the authors upon request.

³ The models and methods in this section closely follow Bahmani-Oskooee and Hegerty (2009).

also assumed to depend on the real exchange rate defined in a manner that a decline reflects a real depreciation of Singapore dollar (see the Appendix). Therefore, if a depreciation of Singapore dollar is to boost her export of commodity to Malaysia, we expect an estimate of to be negative. Finally, denotes a measure of volatility of and it is included to account for the impact of exchange rate uncertainty on the export volume of commodity . Based on the theory an estimate of could be negative or positive.

If we just estimate equation (1), we can only infer the long-run effects of exogenous variables on export volume of commodity . However, short-run effects could be different than long-run effects. In order to assess the short-run effects of each exogenous variable, specially the volatility of the real exchange rate, we turn equation (1) to an error-correction model. Since it is possible that the variable to be stationary or I(0) and other variables to have a unit root, i.e., to be I(1), we adopt Pesaran *et al.*'s (2001) ARDL bounds testing approach as follows:

$$\begin{aligned} \Delta Y_t &= \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 Y_{t-3} + \beta_4 Y_{t-4} + \beta_5 Y_{t-5} \\ &+ \gamma_1 X_{t-1} + \gamma_2 X_{t-2} + \gamma_3 X_{t-3} + \gamma_4 X_{t-4} + \gamma_5 X_{t-5} \\ &+ \delta_1 Z_{t-1} + \delta_2 Z_{t-2} + \delta_3 Z_{t-3} + \delta_4 Z_{t-4} + \delta_5 Z_{t-5} + \epsilon_t \end{aligned} \quad (2)$$

If we are to compare (2) to Engle and Granger (1987) specification we note that lagged error term from (1) that is known as error-correction term is replaced by the linear combination of lagged level variables.⁴ Pesaran *et al.* (2001) propose applying the F test to establish joint significance of lagged level variables as a sign of cointegration. However, they demonstrate that the F test here has new critical values that they tabulate. In producing these new critical values since they account for degree of integration of the variables, there is no need for pre-unit root testing under this approach and variables could be combination of I(1) and I(0) and this is one of the main advantage of this approach. Of course, another advantage is that short-run and long-run effects of exogenous variables are inferred in one step by estimating only (2). Once (2) is estimated, short-run effects are judged by coefficient estimates attached to first-differenced variables and long-run effects are judged by the estimates of – normalized on .⁵

Following the same approach and again using Bahmani-Oskooee and Hegerty (2009) we reapply the following error-correction model associated with import volume of

⁴ After all, by deduction lagged error term from (1) is equal to linear combination of lagged level variables. We can easily see this by solving (1) for and lagging the solution by one period.

⁵ For exact normalization procedure see Bahmani-Oskooee and Fariditavana (2015).

commodity :

$$\begin{aligned}
 & , = + , + + \\
 & + + , + + \\
 & + + , \tag{3}
 \end{aligned}$$

where is import volume of commodity by Singapore from Malaysia. Like export demand model, it is assumed to depend on Singapore’s own income, , the real exchange rate, and its volatility, . Once (3) is estimated, we expect normalized estimate of to be positive implying that as Singapore’s economy grows it imports more. We also expect normalized estimate of to be positive if a real depreciation of Singapore dollar (i.e., an increase in) is to reduce her imports of commodity . Finally, normalized estimate of could be negative or positive. Estimates of models (2) and (3) where the same tests are used in both models are reported in the next section.⁶

3. EMPIRICAL RESULTS

Error-correction models (2) and (3) are estimated for each of the 22 Singapore’s exporting industries to Malaysia and for each of the 26 Singapore’s importing industries from Malaysia. As reflected by each industries trade share in Table 1, these industries in each group engage in more than 84% of the trade. Table 1 not only shows each industries trade share, but also descriptive statistics associated with exports and imports of each industry as well as descriptive statistics of other variables in both models.

As the Appendix shows, annual data over the period 1979-2013 are used to carry out the empirical exercise mostly due to the fact that trade flows at commodity level do come at annual frequency from the sources indicated in the Appendix. In order to gain some insight about the behavior of the real exchange rate volatility, we plot it in Figure 1.

As can be seen from that figure, there is a spark in the volatility measure in 1997-98 and this could be attributed to Asian Financial Crisis of 1997. To account for this a dummy variable is included in each and every model. Following Bahmani-Oskooee and

⁶ For some other applications of this approach see Halicioglu, (2007, 2013), Narayan *et al.* (2007), Tang (2007), Mohammadi *et al.* (2008), Wong and Tang (2008), De Vita and Kyaw (2008), Payne (2008), Dell’Anno and Halicioglu (2010), Chen and Chen (2012), Wong (2013), Hajilee *et al.* (2014), and Tayebi and Yazdani (2014).

Hegerty (2009) we impose a maximum of four lags on each first-differenced variables and utilize Akaike Information Criteria (AIC) and choose an optimum model in each case.

Let us first concentrate on the estimates of exports demand model outlined by equation (2). Due to volume of the estimates, while we report short-run coefficient estimates of exchange rate volatility, long-run estimates are reported for all exogenous variables. While Table 2 reports coefficient estimates, Table 3 reports diagnostics associated with those estimates.

From the short-run estimates we gather that in almost half of the industries there is at least one short-run estimate that is significant at least at the 10% level. The list includes the two largest exporting industries, i.e., industry 332 (Petroleum products with 36.66% export share) and 729 (Other electrical machinery with almost 18% export share). In order to identify industries in which short-run effects last into the long run, we consider long-run estimates in Table 2. As can be seen, the volatility measure carries a significant coefficient in eight industries coded 332, 599, 698, 729, 732, 861, 897, and 931. Again, the two largest industries, i.e., 332 and 729 are in the list. While the coefficient estimate is negative in five industries, it is positive in three, in line with our theoretical expectation. Note that while the largest industry 332 (Petroleum products with 36.66% export share) is affected positively, the second largest industry (Other electrical machinery coded 729 with almost 18% export share) is affected negatively. Furthermore, the list includes durables (e.g., industry coded 729) and nondurables (e.g., industry coded 599).

As for the long-run effects of the other two variables, Malaysian income carries a significant coefficient in 13 industries. While the income effect is significantly positive in 12 industries, it is negative in industry coded 729 (the second largest industry). This must be an industry that exports less as Malaysia grows, mostly due to an increase in production of substitute goods in Malaysia (Bahmani-Oskooee 1986). The long-run effects of the real exchange rate itself is rather mixed. variable carries an unexpected positive and significant coefficient in industries coded 512, 599, 698, 729, 861, 864, 891, 892, 893, and 897. However, it carries significantly expected negative coefficient in four industries coded 332, 711, 734, and 931.⁷ However, for these long-run estimates to be valid, we need to establish cointegration. The results of the F test along with other diagnostics for 22 industries are reported in Table 3.

Given its critical value of 4.10 at the 10% significance level, the F statistic is significant in eight industries.⁸ These are mostly industries in which at least one of the exogenous variables carried a significant long-run coefficient. In some industries like

⁷ Note that the dummy that was included to account for the Financial Crisis of 1997 was significant in industries coded 112, 599, 711, and 718.

⁸ Note that this critical value is when there are three exogenous variables in the model ($k = 3$) and we have almost 35 observations. This comes from Narayan (2005, p. 1988) who tabulated the critical values for small samples like ours. Pesaran *et al.*'s (2001) critical values are for large sample.

Table 1. Descriptive Statistics

SITC	Industry	Trade Share	Mean	Max.	Min.	St. Dev.	Skew	Kurt	J.B.
Singapore Exporting Industries									
112	Alcoholic beverages	0.87%	75,378.31	434,467.33	2,797.60	112,436.81	1.94	3.13	21.98
332	Petroleum products	36.66%	3,647,231.77	18,488,774.19	327,495.62	5,046,763.49	2.20	3.95	29.52
512	Organic chemicals	2.15%	333,755.28	1,075,165.71	35,365.52	306,702.83	0.97	-0.26	21.08
581	Plastic materials, regenerated	3.07%	565,623.44	1,530,643.13	37,030.64	452,856.08	0.76	-0.45	20.77
599	Chemical materials and products, n.e.s.	1.00%	189,934.39	500,511.73	26,806.37	119,994.23	0.65	-0.09	16.34
698	Manufactures of metal, n.e.s.	0.71%	151,270.05	463,669.75	20,529.14	116,507.79	0.76	-0.09	17.27
711	Power generating machinery	0.96%	166,108.90	683,687.40	29,104.37	173,647.00	1.49	1.33	17.03
714	Office machines	4.18%	1,213,929.45	3,271,602.86	9,801.24	1,040,575.18	0.15	-1.36	27.90
718	Machines for special industries	2.81%	409,606.14	1,403,054.38	70,864.62	361,315.17	1.28	0.64	17.65
719	Machinery and appliances non electrical	3.62%	906,147.81	1,856,346.68	107,597.45	560,822.31	0.10	-1.34	27.52
722	Electric power machinery and switch	3.04%	1,108,341.63	2,172,545.19	30,574.20	790,444.76	-0.26	-1.73	33.00
724	Telecommunications apparatus	2.63%	861,619.72	2,100,325.51	76,004.15	616,150.98	0.14	-1.24	26.32
729	Other electrical machinery	17.98%	5,101,909.07	12,278,911.96	186,355.52	4,355,980.68	0.17	-1.60	30.96
732	Road motor vehicles	0.84%	169,783.46	417,660.11	30,726.81	105,470.31	0.67	-0.70	22.56
734	Aircraft	0.68%	51,760.01	340,734.31	4,497.96	79,388.94	2.19	4.51	31.28
861	Scientific, medical, optical, means.	1.99%	341,307.71	991,572.14	13,428.68	283,176.83	0.65	-0.29	18.20
864	Watches and clocks	0.80%	148,562.38	507,348.41	6,381.85	140,671.27	1.22	0.83	15.60
891	Musical instruments, sound recorder	0.52%	388,286.80	1,205,579.52	10,483.63	332,832.22	0.86	0.16	16.05
892	Printed matter	0.70%	89,690.68	348,731.26	20,036.86	76,438.89	1.65	3.17	15.93
893	Articles of artificial plastic mate	0.63%	142,015.24	312,594.95	4,639.43	101,549.53	-0.01	-1.55	30.23
897	Jewellery and gold/silver smiths watches	0.50%	43,545.39	291,974.77	750.44	70,641.53	2.31	5.26	38.69
931	Special transactions not classified	1.32%	208,691.92	671,274.97	29,750.18	213,526.36	1.25	0.18	20.73

112 where the F statistic is insignificant, we use an alternative test. In this alternative test we use long-run normalized estimates and equation (1) and generate the error term and label it as ECM. After replacing the linear combination of lagged level variables in (2) by ECM, we estimate the new specification at the same optimum lags. A significantly negative coefficient obtained for ECM signifies adjustment toward long-run and the size of the coefficient reflects the adjustment speed. As Table 3 reveals in almost all industries adjustment is toward long run, though with different speed. For example, in industry coded 112, 67% of adjustment takes place in one year since data are annual. However, in industry coded 599, almost 90% of the adjustment takes place within six months. How stable are short-run and long-run coefficient estimates? Pesaran *et al.* (2001) recommend applying CUSUM and CUSUMSQ tests to the residuals of each optimum model. Identifying stable coefficients by “S” and unstable ones by “US”, the results in Table 3 reveal that most estimates are stable.⁹ Two other statistics are also reported. One is the Lagrange Multiplier (LM) statistic to test for serial correlation and the other is Ramsey’s RESET specification test. They are both distributed as χ^2 with one degree of freedom and given its critical value of 3.84, both are insignificant in most models supporting autocorrelation free residuals and correctly specified optimum models. Finally, adjusted R^2 is reported to judge the goodness of fit in each model.

Next we turn to estimates of Singapore’s import demand model outlined by equation (3). Again, while Table 4 reports coefficient estimates, Table 5 reports diagnostic statistics. From the short-run estimates we gather that exchange rate volatility has short-run significant effects on the imports of industries coded 1, 331, 332, 533, 581, 714, 718, 719, 722, 723, 732, 821, 841, 861, and 897. In these cases, there is at least one estimate that significant at least at the 10% level. The largest industry, i.e., 332 is in the list. The long-run estimates, however, reveal that only in nine industries the short-run effects translate into the long run. While in industries 1, 332, 718, 719, 841, and 861, the long-run effects of volatility is positive, in industries 331, 821, and 897 the effect is negative. Again, durables (e.g., 897) and nondurables (e.g., 331) are among the list.

As for long-run effects of the other two variables, the Singapore’s income carries its expected positive and significant coefficient in 11 industries coded 1, 332, 422, 512, 533, 663, 718, 719, 732, 733, and 861. It also carries a significantly negative coefficient in industry 821 (Furniture), implying that as Singapore grows, it produces more of this good at home and therefore, imports less. As for the real exchange rate, it carries a significantly and expectedly positive coefficient in industries coded 722, 821, 893, and 897 and negative coefficient in 1, 332, and 718.¹⁰ Once again in order to validate these long-run estimates, we shift to Table 5 and the results of the F test along with other diagnostic statistics.

⁹ For a graphical presentation of these tests See Pesaran *et al.* (2001) or Bahmani-Oskooee and Fariditavana (2015).

¹⁰ Again to account for Asian Financial Crisis of 1997, a dummy was included and it carried a significant coefficient in industries coded 001, 331, 422, 533, 663, 718, 719, 722, 723, 732, 821, 841, and 861.

The calculated F statistic to establish joint significance of lagged level variables or cointegration is above its critical value of 4.10 in 13 industries. Again, in some cases where there is at least one long-run significant estimate but the F statistic is insignificant (e.g., 332) we rely upon ECM test. Other diagnostics indicate that most of the optimum import demand models do not suffer from autocorrelation, they are correctly specified, and coefficient estimates are stable.

4. SUMMARY AND CONCLUSION

Introduction of the floating exchange rates in 1973 has introduced a new element into the international financial markets, i.e., exchange rate volatility. Academicians have approached the issue theoretically as well as empirically and mostly have concentrated on the impact of exchange rate volatility on trade flows. They have demonstrated that depending on the degree of risk tolerance by market participants, exchange rate volatility could boost or hurt trade. Empirical findings have been rather mixed. The literature has grown so large that each country has its own literature.

Since this paper is about Singapore, the review of the literature revealed that previous research have assessed the impact of exchange rate volatility on Singapore's trade flows with the rest of the world and have failed to find significant effects. We wonder if such findings suffer from any aggregation bias. To resolve the issue, unlike previous research we concentrate on the trade between Singapore and her major trading partner Malaysia and disaggregate their trade flows by commodity and try to assess the impact of exchange rate volatility on 156 Singapore's exporting industry to Malaysia and 155 Singapore's importing industries from Malaysia. However, we only report the results for each industry that has more than 0.5% market share. The list included 22 exporting industries that all together have more than 84% market share and 26 importing industries which also have 84% market share. Using annual data over the period 1979-2013 and bounds testing approach to error-correction modeling and cointegration we find that while trade flows of most industries are affected by exchange rate uncertainty in the short-run, only in limited number of industries the short-run effects last into the long run. More precisely, exports of eight industries and imports of nine industries are affected significantly in the long run. Additionally, we find that only a few industries are affected by the Asian Financial Crisis in 1997.¹¹

¹¹ Future research should change direction and apply the nonlinear ARDL approach of Shin *et al.* (2014) to see if introducing nonlinear adjustment of exchange rate volatility which requires separating increased volatility from decreased volatility have asymmetric effects. For an application of this new method see Bahmani-Oskooee and Fariditavana (2015). Another future issue is the attention that must be paid to rising China's role in global market, especially in Asia. Volatility of yuan-ringgit or yuan-Singapore dollar could have substitution effect on the trade between Malaysia and Singapore. This comes under the heading of "third-country" effect and deserves attention. For an example see Cushman (1986).

APPENDIX

A1. Data Definitions and Sources

All data are annual (1979-2013) and come from the following sources:

- (a) The World Bank.
- (b) The International Financial Statistics of the IMF.

A2. Variables

VXSG: Volume of export of commodity by Singapore to Malaysia. Singapore's export value data for each commodity come from source a. Following Bahmani-Oskooee and Hegerty (2009) we use aggregate export price index of Singapore to deflate the nominal exports of each commodity. The aggregate export price index comes from source (b).

VMSG: Volume of imports of commodity by Singapore from Malaysia. Singapore's import value data for each commodity comes from source a. We use aggregate import price index of Singapore to deflate the nominal imports of each commodity. The aggregate import price index comes from source (b).

YSG: Measure of the Singapore's income. It is proxied by the real GDP. The data come from source (b).

YMY: Malaysia's real GDP. Data come from source (b).

REX: Real bilateral exchange rate between Singapore dollar (SGD) and Malaysian ringgit (RM). It is defined as $(\text{PSGD} / \text{PMY}) / \text{NEX}$, where PSGD is Singapore's CPI, PMY is Malaysia's CPI, and NEX is the nominal bilateral exchange rate defined as the number of RM per SGD. Thus, a decline in REX is a reflection of real depreciation of the SGD. All data for NEX, PMY, and PSGD come from source (b).

VOL: Volatility measure of real bilateral exchange rate (RE). Following Bahmani-Oskooee, Harvey and Hegerty (2014) for each year this is measured as the standard deviation of the 12 monthly real bilateral exchange rate (RE) within that year. All monthly data come from source (b).

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Received February 17, 2016, Revised January 3, 2017, Accepted February 13, 2017.