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U.S.-SINGAPORE COMMODITY TRADE AND THE J-CURVE

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ABSTRACT

Limited number of studies that investigated the short-run (J-Curve) and long-run effects of currency depreciation on the trade balance of Singapore either used aggregate trade data between Singapore and rest of the world or between Singapore and her major trading partners. While they were able to provide some evidence supporting short-run effects (not following the J-curve), they were unable to discover any long-run effects, especially in the trade between Singapore and the U.S. In this paper we add to the literature by disaggregating the Singapore-U.S. trade flows by commodity and consider the trade flows of 64 industries that trade between the two countries. We find short-run significant effects in 48 industries. The short-run effects last into the long run only in 24 industries. Combining the old and new definition of the J-curve, we support the concept in 27 industries.

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1. INTRODUCTION

The relation between exchange rate and trade balance still continues to be of a common interest not only to economist but also to policy makers. At times, it even induces heads of state to engage in political discussions. In general, despite the mixed empirical results, most policy makers believe that depreciation improves a nation's trade balance and empirical studies try to come closer and closer to that idea. While some rely on testing the long-run condition of the Marshall-Lerner, others try to test the short-run effects of depreciation that comes under the heading of the J-curve or S-curve. No wonder why each country now tends to have its own literature.[1]

[1] For a review article on Marshall-Lerner condition see Bahmani-Oskooee *et al*, (2013). and for a review article on J- and S-curves see Bahmani-Oskooee and Hegerty (2010).

Since this paper is about Singapore, a short account of the related literature is in order so that we can distinguish contribution of this paper from previous literature. Singapore is one of the most highly developed market economy in South East Asia, despite its geographical size which is the smallest in South East Asia. It also commands the highest income per capita of $51,162 [2012(IMF)]. In addition, Monetary Authority of Singapore (central bank) adopts a managed float policy for its exchange rate regime. As such, the Singapore dollar is allowed to fluctuate within a policy band. Early list of studies that estimated the Marshall-Lerner condition (ML hereafter) for developed and developing countries includes Houthakker and Stephen (1969), Khan (1974), Werner and Kreinin (1983), Gylfason and Risager (1984), Bahmani-Oskooee (1986), Bahmani-Oskooee and Niroomand (1998) and Caporale and Chui (1999). Unfortunately, none of these studies include Singapore in their sample. Bahmani-Oskooee (1998) and Bahmani-Oskooee and Kara (2005) are, however, two studies that have included Singapore in their studies. While the first study relies upon Johansen's cointegration analysis and Maximum-Likelihood estimation technique, the second study employs Pesaran *et al.* (2001) bounds testing method. Regardless of estimation method, however, both studies fail to find support for the Marshall-Lerner condition. Therefore, since the sum of import and export demand elasticities does not add up to one, currency devaluation or depreciation cannot improve Singapore's trade balance in the long run.[2] Rather than estimating the ML condition which is said to be an indirect approach, the second group includes studies that have tried to establish a direct link between the trade balance and the real exchange rate and use cointegration analysis to establish the long-run relationship and error-correction modeling approach to test the short-run effects or the J-curve phenomenon. Bahmani-Oskooee and Alse (1994) and Lal and Lowinger (2002) are two studies in this group which have included Singapore in their analysis. While they have found some evidence of short-run effects, no significant long-run effects are discovered, which is consistent with the results of the ML condition from the first group. Studies in the first and second group have been criticized for using trade data between one country (e.g., Singapore) and rest of the world due to aggregation bias. To correct the bias, a third group has emerged in which authors have disaggregated trade flows by major trading partners.[3] In the case of Singapore, Wilson (2001) tested the J-curve for Singapore, Malaysia and Korea using cointegration and error-correction modeling approach. The U.S. and Japan were selected each country's major trading partners. In the results for Singapore, he found neither short-run nor long run significant effects. This was the case for Singapore-U.S. model as well as Singapore-Japan model. In an effort to test the J-Curve between Singapore and her other trading partners, Bahmani-Oskooee and Harvey (2012) used quarterly bilateral data (1973–2009) and bounds testing method to

[2] Another body of the literature aims at estimating import and export demand functions to address other trade issues. Examples include King (1993). Alse and Bahmani-Oskooee (1995). Charos *et al,* (1996). Truett and Truett (2000). Du and Zhu (2001). Agbola and Damoense (2005), Love and Chandra (2005), Narayan and Narayan (2005).and Narayan *et al,* (2007).

[3] This tradition began with Rose and Yellen (1989). who levied such a charge against studies pertaining to the U.S. trade balance.

cointegration and error-correction modeling to estimate a bilateral trade model between Singapore and each of her 13 trading partners. They found support for the J-Curve in the case of Canada, the Philippines, Saudi Arabia and United States but not long-run significant effects, especially in the model between Singapore and the U.S.

Our claim in this paper is that the above bilateral studies suffer from another aggregation bias in that they use total trade of all industries that trade between Singapore and each of its trading partners. To this end, we consider the trade between Singapore and its major partner, the U.S. and disaggregate the trade flows between the two countries by industry and consider the experience of 64 industries that trade between the two countries. To do this, in Section II we outline our model and explain the methodology. In Section III we present the results. A summary is provided in Section IV with data sources and definition of variables in an Appendix.

2. THE MODEL AND THE METHOD

It is now well established that to test the long-run and short-run effects of exchange rate changes on the trade balance we must rely upon cointegration and error-correction modeling analysis. Since these methods are based on reduced form models, following Bahmani-Oskooee and XU (2012) we adopt the following specification at industry level:

$$LnTB_{i,t} = a + b\,LnY_{SG,t} + c\,LnY_{US,t} + d\,Ln\,REX_t + \varepsilon_t \quad (1)$$

where the trade balance of industry i (TB_i) is assumed to depend on level of economic activity in Singapore (Y_{SG}) and in the U.S. (Y_{US}) as well as on the real bilateral exchange rate (REX). Since commodity level data are reported by the U.S., we consider equation (1) from the U.S. perspective and define the TB_i as the ratio of US exports of commodity i to Singapore over its imports of commodity i from Singapore. An estimate of b is expected to be positive if an increase in Singapore's level of economic activity is to lead to an increase in the U.S. exports of commodity i. On the other hand, an estimate of c is expected to be negative if an increase in the U.S. economic activity is to lead to an increase in the U.S. imports of commodity i. Finally, we expect an estimate of d to be positive if a real depreciation of the U.S. dollar, i.e. an increase in REX is to improve the U.S. trade balance of commodity i. As the Appendix shows, by way of construction an increase in the real exchange rate reflects a real depreciation of the U.S. dollar.

Estimates of equation (1) only yields the long-run coefficient estimates. To evaluate short-run effects of depreciation or the J-Curve effect we need to incorporate short-run dynamics to equation (1). Pesaran *et al.* (2001) bounds testing approach offers a unique opportunity on this regards. Hence following their approach and Bahmani-Oskooee and XU (2012) we convert (1) to an error-correction model outlined by equation (2):

$$\Delta LnTB_{i,t} = \alpha + \sum_{k=1}^{n} b_k \Delta LnTB_{i,t-k} + \sum_{k=0}^{n} c_k \Delta LnY_{SG,t-k} + \sum_{k=0}^{n} d_k \Delta LnY_{US,t-k} \quad (2)$$

$$+ \sum_{i=0}^{n} e_k \Delta Ln\, REX_{t-k} + \lambda_1 Ln TB_{i,t-1} + \lambda_2 Ln Y_{SG,t-1} + \lambda_3 Ln Y_{US,t-1} +$$

$$\lambda_4 Ln\ REX_{t-1} + \mu_t$$

Equation (2) follows Engle and Granger (1987) representation theorem with a difference that (Pesaran *et al.*, 2001) include linear combination of lagged level variables instead of lagged error term from equation (1).[4] Once (2) is estimated, the short-run effects are inferred by the estimates of first-differenced variables. The long-run effects are judged by the estimates of $\lambda_2 - \lambda_2$ normalized on λ_1. However, for the long-run effects not to be spurious, (Pesaran *et al.*, 2001) propose applying the familiar F test to establish joint significance of lagged level variables as a sign of cointegration. They tabulate new critical values for the F test that account for integrating properties of variables. Hence there is no need for pre unit root testing and variables could be stationary or non-stationary.[5]

3. THE RESULTS

We are now in position to evaluate the bilateral trade flows of 65 industries that trade between US and Singapore using annual data over the period 1974-2011. Selection of this period is mainly due to availability of the data for as many industries as possible. Following Bahmani-Oskooee and XU (2012) and many others in the literature, we impose a maximum of four lags on each first-differenced variable and use Akaike's Information Criterion (AIC) to select the optimum lags for each model. We then report the results in two tables. While Table 1 reports coefficient estimates, Table 2 reports all diagnostic statistics.

Due to volume of the short-run estimates we restrict ourselves to reporting only short-run coefficient estimates of the real exchange rate We first begin with estimate of equation (2) using aggregate bilateral trade flows. These results are reported at the top of both Tables. The short-run coefficient estimates reveal that while the bilateral trade balance responds to exchange rate changes significantly, the short-run pattern is exactly the opposite of the J-curve effect, i.e., one positive coefficient followed by three negative ones. The long-run effect of the exchange rate is significant but negative. These bilateral results are more or less in line with the literature. However, once we move to industry level results, we discover interesting outcomes. From the industry level results we gather that at the 10% level of significance there are 48 industries in which there is at least one

[4] It could easily be seen that the linear combination of lagged level variables and lagged error term are the same if we solve (1) for the error term and lag the solution by one period.

[5] Pesaran et.al (2001) tabulate critical F-test for larger samples while Narayan (2005).does it for smaller samples such as ours. For other applications of this approach see Bahmani-Oskooee and Hegerty (2007), Halicioglu (2007). Narayan et al. (2007), Tang (2007). Mohammadi *et al*, (2008). Wong and Tang (2008). De Vita and Kyaw (2008), Payne (2008). Bahmani-Oskooee and Gelan, (2009), Chen and Chen (2012).Wong (2013).

significant coefficient, implying that the trade balance of 48 industries are affected by depreciation in the short run. However, only in four industries we observe the traditional definition of the J-

Table-1. Short-Run and Long-Run Coefficient Estimates

			Short Run Estimates				Long Run Estimates			
SITC	Industry	T.Share	Δ ln REX_t	Δ ln REX_{t-1}	Δ ln REX_{t-2}	Δ ln REX_{t-3}	*Constant*	ln Y_{SG}	Ln Y_{US}	Ln *REX*
	Aggregate		0.47(1.01)	-1.09(1.91)	-0.21(0.55)	-1.47(3.79)	164.65(2.80)	-2.85(3.69)	8.89(3.01)	-2.78(3.23)
31	Fish, fresh & simply preserved	0.11%	1.54(0.99)	4.66(2.72)			805.86(1.37)	10.42(1.34)	-40.72(1.37)	-4.62(0.82)
32	Fish, in airtight containers, n.e.s	0.01%	10.58(2.99)	5.76(1.44)	9.39(3.22)	3.73(1.13)	-52.57(0.69)	-1.46(1.38)	3.32(0.86)	4.38(4.31)
48	Cereal preps & preps of flour	0.11%	0.34(0.62)				189.59(2.74)	1.27(1.16)	-8.55(2.38)	0.89(0.57)
53	Fruit, preserved and fruit preparations	0.03%	7.38(4.02)	6.57(3.08)			96.67(1.01)	1.45(1.11)	-4.94(1.05)	-0.02(0.01)
55	Vegetables, roots & tubers	0.02%	3.47(0.95)	-13.92(3.22)	-9.22(2.96)	-7.69(2.31)	-1109.2(3.20)	-15.70(3.29)	57.29(3.24)	21.03(4.06)
62	Sugar confectionery, sugar preps.	0.01%	-3.38(0.74)	-6.81(1.28)			-751.88(1.41)	-10.86(1.86)	39.14(1.52)	17.11(1.87)
71	Coffee	0.04%	-7.03(1.90)	-17.40(4.18)	-1.66(0.55)	-3.52(1.18)	-7924.2(0.35)	-99.71(0.35)	398.42(0.35)	153.65(0.35)
75	Spices	0.002%	4.98(3.59)				-241.19(3.25)	-3.31(2.60)	12.31(3.11)	4.98(3.59)
99	Food preparations, n.e.s.	0.19%	1.61(2.33)				-47.21(0.79)	-2.34(2.29)	3.88(1.22)	2.63(2.77)
221	Oil seeds, oil nuts and oil kernels	0.003%	23.59(2.62)				-40.29(0.23)	-3.91(1.47)	4.81(0.53)	4.32(1.71)
231	Crude rubber incl. synthetic & recl	0.16%	-3.91(1.57)	13.31(4.30)			-48.01(0.52)	2.70(21.16)	-0.37(0.08)	-4.83(1.59)
292	Crude vegetable materials, n.e.s.	0.02%	-2.17(0.89)				-40.01(0.57)	1.03(0.88)	0.79(0.21)	1.33(0.86)
332	Petroleum products	9.66%	5.79(2.48)				355.61(1.89)	6.73(2.69)	-19.64(2.07)	-7.44(2.83)
422	Other fixed vegetable oils	0.002%	- 19.57(2.55)	-6.98(0.77)	-16.15(2.41)		355.64(1.06)	8.84(1.91)	-21.44(1.25)	-4.89(1.10)
512	Organic chemicals	10.64%	1.68(0.79)				-61.56(0.15)	-3.78(0.46)	5.54(0.25)	7.79(0.86)
541	Medicinal & pharmaceutical products	3.70%	2.04(0.91)				215.89(0.94)	-0.34(0.09)	-8.25(0.68)	4.57(0.86)
551	Essential oils, perfume and flavour	0.07%	0.58(0.43)				13.99(0.15)	3.21(2.02)	-3.13(0.64)	0.98(0.45)
581	Plastic materials	3.64%	0.22(0.08)				86.23(0.81)	-2.39(1.39)	-1.23(0.22)	7.05(3.17)
631	Veneers, plywood boards & other woods	0.004%	4.23(1.78)				149.76(1.47)	3.58(2.15)	-8.89(1.68)	-0.14(0.06)
632	Wood manufactures, n.e.s.	0.02%	-1.66(0.49)	-12.52(3.33)	-6.19(1.93)	-7.52(2.36)	-128.94(1.17)	2.76(1.69)	2.94(0.52)	4.85(2.70)
642	Articles of paper, pulp, paperboard	0.06%	3.90(2.40)				-159.38(1.52)	-5.03(2.84)	10.57(1.91)	7.41(3.44)
651	Textile yarn and thread	0.02%	0.88(0.46)				17.12(0.07)	3.55(0.87)	-3.58(0.28)	2.29(0.44)
653	Text fabrics woven	0.02%	-5.38(0.73)	-13.13(1.95)	7.66(1.41)		-152.58(1.52)	-0.14(0.09)	6.43(1.25)	10.64(5.04)
656	Made up articles, wholly or chiefly	0.02%	-7.41(2.43)	14.98(3.99)	5.46(1.74)	14.51(4.67)	167.96(2.84)	2.69(3.02)	-8.86(2.93)	-5.61(4.39)
657	Floor coverings, tapestries, etc.	0.03%	19.89(4.30)	11.93(2.23)			-2452.20(0.69)	-25.44(0.59)	119.09(0.67)	30.32(0.81)
664	Glass	0.10%	7.04(2.79)				-40.80(0.46)	-1.45(0.96)	2.99(0.64)	5.43(3.13)
666	Pottery	0.00%	0.49(0.27)				30.55(0.39)	2.06(1.56)	-2.82(0.68)	0.49(1.28)
667	Pearls and precious and semi-precious	0.02%	15.69(2.70)	9.33(1.59)	4.75(1.22)		1728.30(0.94)	17.86(0.74)	-83.52(0.90)	-19.07(0.91)
682	Copper	0.05%	3.44(1.43)				89.25(0.99)	-0.24(0.16)	-3.22(0.68)	2.63(1.44)
687	Tin	0.04%	10.11(1.23)	-11.74(1.46)	-11.35(1.86)		281.77(0.29)	10.37(0.69)	-19.36(0.39)	20.19(0.75)
689	Miscell.non ferrous base metals	0.09%	5.41(1.70)				3179.10(0.30)	-60.99(0.30)	176.86(0.31)	68.09(0.32)
692	Metal containers for storage and transport	0.03%	0.47(0.12)	-9.12(2.14)	-8.05(2.07)		-259.46(1.52)	-2.08(0.92)	12.25(1.43)	7.71(2.80)
693	Wire products	0.06%	0.32(0.06)	-22.34(3.08)	0.74(0.14)	-12.15(2.34)	38243.3(0.06)	299.03(0.07)	-1780.0(0.06)	- 662.74(0.06)
694	Nails, screws, nuts, bolts, rivets	0.18%	-0.98(0.61)	-1.08(1.11)	-2.58(1.76)		-136.27(1.95)	1.77(1.07)	4.08(1.09)	2.44(1.44)
695	Tools for use in the hand or in machine	0.43%	1.44(0.95)	-1.83(1.04)	-3.03(2.13)	-2.38(1.52)	150.40(0.75)	-3.57(1.29)	9.11(0.89)	7.05(1.61)
697	Household equipment of base metals	0.01%	-1.96(1.04)				488.26(7.59)	9.64(8.40)	-27.16(7.85)	-1.13(1.05)
698	Manufactures of metal, n.e.s.	0.43%	0.52(0.56)				30.10(0.19)	1.24(0.48)	-2.19(0.27)	1.83(0.55)
711	Power generating machinery	1.99%	2.26(1.09)	-4.89(2.13)	-4.18(1.98)		-72.27(1.05)	-2.31(1.85)	4.83(1.37)	-0.19(0.12)
714	Office machines	10.12%	0.90(2.07)				-178.16(1.25)	-5.03(1.98)	11.18(1.46)	4.68(1.52)
717	Textile and leather machinery	0.02%	-4.49(2.49)				183.75(2.28)	4.49(3.32)	-10.91(2.56)	-4.49(2.49)
718	Machines for special industries	2.04%	2.12(0.59)	-0.53(0.12)	1.99(0.61)	-8.51(2.52)	343.12(0.85)	6.32(0.97)	-18.57(0.87)	3.07(0.56)
719	Machinery and appliances non electrical	7.82%	-1.68(1.29)	-2.87(1.78)	-3.20(2.52)	-3.32(2.49)	-107.04(0.88)	0.10(0.05)	4.24(0.68)	5.23(3.03)
722	Electric power machinery and switch	2.25%	-3.37(3.58)	0.49(0.44)	0.51(0.53)	2.79(2.64)	249.40(0.82)	5.63(1.13)	-14.63(0.90)	-11.36(0.98)
723	Equipment for distributing electricity	0.23%	-0.05(0.03)	-1.49(0.75)	-4.97(3.45)	-2.55(1.79)	-76.32(1.06)	-0.54(0.54)	3.56(0.97)	3.42(3.36)
724	Telecommunications apparatus	2.28%	-0.19(0.21)				-68.22(1.67)	0.09(0.14)	2.64(1.24)	5.14(5.94)
725	Domestic electrical equipment	0.07%	7.36(2.99)	-4.25(1.55)	5.46(2.58)		-528.89(2.16)	-9.13(2.74)	28.51(2.29)	5.49(1.66)
729	Other electrical machinery and apparatus	10.17%	0.09(0.27)				-51.91(1.88)	-0.75(1.55)	2.66(1.80)	0.16(0.27)
732	Road motor vehicles	1.02%	1.09(0.80)	3.07(2.43)			-166.13(1.80)	-3.72(3.03)	9.78(2.14)	3.15(1.93)
734	Aircraft	0.88%	3.51(1.03)	-12.69(3.41)	4.61(1.41)	-9.03(2.67)	-157.31(0.71)	-0.02(0.01)	6.41(0.56)	5.59(1.11)
735	Ships and boats	0.13%	8.51(1.71)				328.89(4.10)	4.80(3.87)	-16.98(4.10)	-1.79(1.08)
812	Sanitary, plumbing, heating & light	0.04%	-2.04(0.46)	-10.57(2.16)			-126.62(0.98)	0.44(0.22)	4.75(0.72)	3.71(1.38)
821	Furniture	0.10%	-1.59(1.29)	-5.59(3.87)			361.80(1.09)	1.00(0.36)	15.34(1.36)	8.74(1.67)
831	Travel goods, handbags and similar	0.02%	7.22(3.16)	6.45(2.37)	4.29(1.96)	-4.17(1.82)	102.29(1.12)	-2.16(1.57)	-2.24(0.48)	3.23(1.76)
841	Clothing except fur clothing	0.11%	1.83(1.090	0.22(0.12)	2.64(1.87)		-112.85(0.11)	-64.58(0.12)	96.27(0.120	-16.59(0.09)
861	Scientific, medical, optical, measures.	5.45%	0.99(2.10)				11.60(0.48)	-0.29(0.75)	0.72(0.560	1.11(2.42)
864	Watches and clocks	0.06%	-3.10(2.47)				-50.33(0.56)	1.93(1.25)	0.33(0.07)	-4.32(2.03)
891	Musical instruments, sound recorder	0.32%	-0.51(0.23)	-7.89(2.81)			-885.09(1.19)	-8.45(0.99)	42.27(1.16)	11.22(1.37)
892	Printed matter	0.59%	2.34(3.41)	-0.99(1.38)	-1.68(3.24)	-0.86(1.54)	-24.00(-0.31)	-1.29(1.22)	2.03(0.52)	4.43(3.27)
893	Articles of artificial plastic mate	0.41%	2.52(1.73)	-4.63(2.92)	-1.67(1.19)	-4.43(3.27)	-185.18(1.92)	-2.67(1.85)	9.66(1.93)	8.28(4.16)
894	Perambulators, toys, games and sport goods	0.24%	1.04(0.45)	-1.16(-0.42)	-6.72(3.24)		32.79(0.27)	3.79(1.87)	-4.29(0.74)	7.50(2.64)
896	Works of art, collectors pieces	0.17%	3.99(1.78)				14.77(0.17)	0.35(0.24)	-0.81(0.17)	2.80(1.75)
897	Jewellery and gold/silver smiths watches	0.41%	2.02(0.87)	-1.66(0.65)	-2.54(1.11)	-8.67(3.59)	182.34(3.06)	5.43(5.63)	-11.63(3.76)	2.09(1.56)
899	Manufactured articles, n.e.s.	0.50%	-2.03(1.65)				4.04(0.03)	1.24(0.57)	-1.18(0.17)	-4.76(1.41)
931	Special transactions	13.66%	-2.82(1.89)	7.32(4.08)	-0.86(0.58)	2.59(1.90)	359.56(0.19)	1.89(0.15)	-16.01(0.19)	-28.79(0.24)

Notes: 1. Number inside the parenthesis next to each coefficient is absolute value of the t-ratio.

2. T.Share (Trade share) of each industry is calculated as sum of exports and imports by that industry as a per cent of sum of total US exports and imports to Singapore which includes even industries for which no data were available. These shares are only for 2011. For example, 031- Fish, fresh & simply preserved is 0.11%.

3. A dummy was included in each model to account for the financial crisis in 1997. Industries in which the dummy was significant were : 048, 053, 075, 099, 221, 231, 581, 631, 632, 642, 666, 717, 729, 821, 831, 861, 864, 892, 896, and 899.

4. n.e.s. = not specified elsewhere.

Table-2. Diagnostic Statistic

SITC	*Industry*	*F at opt.lags*	ECM_{t-1}	*LM*	*RESET*	*CUSUM*	*CUSUMSQ*	*Adj* R^2
	Aggregate	5.84	-0.36(4.77)	26.16	0.08	S	S	0.06
31	Fish, fresh & simply preserved	9.13	-0.18(1.47)	3.37	0.85	S	S	0.32
32	Fish, in airtight containers, n.e.s	11.06	-2.09(5.04)	9.80	0.07	S	S	0.64
48	Cereal preps & preps of flour	4.63	-0.39(2.72)	1.15	0.07	S	S	0.13
53	Fruit, preserved and fruit preparations	7.49	-0.49(4.59)	2.99	0.22	S	US	0.22
55	Vegetables, roots & tubers preserved	8.11	-0.67(4.56)	0.05	2.69	S	S	0.54
62	Sugar confectionery, sugar preps.	3.00	-0.37(2.16)	2.37	0.60	S	S	-0.08
71	Coffee	12.95	-0.08(0.35)	8.67	0.51	S	S	0.51
75	Spices	4.59	-0.88(3.99)	0.003	3.79	S	S	0.36
99	Food preparations, n.e.s.	3.59	-0.61(4.23)	0.03	7.72	S	S	0.11
221	Oil seeds, oil nuts and oil kernels	12.42	-1.66(9.78)	0.22	5.38	S	S	0.64
231	Crude rubber incl. synthetic	8.17	-0.81(2.98)	6.15	0.32	S	S	0.32
292	Crude vegetable materials, n.e.s.	4.89	-0.88(3.13)	3.60	4.13	S	S	0.28
332	Petroleum products	14.70	-0.50(3.75)	2.75	0.03	S	S	0.67
422	Other fixed vegetable oils	4.91	-1.13(4.92)	2.49	6.07	S	S	0.69
512	Organic chemicals	3.07	-0.22(1.06)	5.64	2.19	S	US	-0.003
541	Medicinal & pharmaceutical products	1.68	-0.45(2.85)	0.06	8.57	S	US	-0.07
551	Essential oils, perfume and flavour	2.81	-0.59(3.17)	3.22	2.43	S	S	0.05
581	Plastic materials, regenerated.	6.38	-0.71(4.74)	0.64	0.24	S	S	-0.09
631	Veneers, plywood boards & other woods	8.18	-0.51(4.46)	1.17	0.66	S	S	0.26
632	Wood manufactures, n.e.s.	5.13	-1.13(6.01)	1.30	5.08	S	S	0.20
642	Articles of paper, pulp, paperboard	3.19	-0.52(3.55)	1.85	1.34	S	S	-0.09
651	Textile yarn and thread	2.17	-0.38(2.35)	7.19	1.17	S	S	-0.14
653	Text fabrics woven	5.43	-1.43(4.41)	0.06	0.92	S	S	0.39
656	Made up articles, wholly or chiefly	10.45	-1.49(8.03)	13.78	1.18	S	S	0.46
657	Floor coverings, tapestries, etc.	6.17	0.19(0.77)	0.83	0.09	S	S	0.35
664	Glass	3.31	-1.29(4.31)	1.66	3.69	S	S	0.16
666	Pottery	6.75	-0.92(5.29)	0.23	0.61	S	S	0.41
667	Pearls and precious and semi-precious	4.51	-0.28(1.11)	0.35	1.18	S	S	0.30
682	Copper	7.13	-1.31(7.14)	6.06	3.57	S	US	0.32
687	Tin	1.83	-0.19(1.49)	1.99	4.66	S	US	0.05
689	Miscell.non ferrous base metals	4.04	0.04(0.29)	1.18	0.002	S	S	0.39
692	Metal containers for storage and transport	4.54	-0.79(4.55)	3.67	3.08	S	US	0.16
693	Wire products	3.28	0.01(0.06)	3.94	4.94	S	S	-0.06
694	Nails, screws, nuts, bolts, rivets	5.28	-0.53(3.36)	9.75	0.50	S	S	-0.01
695	Tools for use in the hand or in machine	6.70	-0.29(2.64)	5.67	10.27	S	S	0.31
697	Household equipment of base metals	6.19	-1.74(5.44)	0.99	0.01	S	S	0.48
698	Manufactures of metal, n.e.s.	1.66	-0.29(2.09)	1.04	1.23	S	S	-0.01
711	Power generating machinery	8.38	-0.63(4.43)	3.35	5.07	S	S	0.45
714	Office machines	3.19	-0.19(2.20)	1.89	0.13	S	US	0.03
717	Textile and leather machinery	11.09	-0.73(6.99)	0.61	0.59	S	S	0.59
718	Machines for special industries	3.19	-0.46(2.03)	1.33	5.33	S	S	0.35
719	Machinery and appliances non electrical	3.22	-0.47(4.09)	1.84	0.01	S	S	0.06
722	Electric power machinery and switch	6.99	-0.29(1.09)	2.04	7.97	S	S	0.61
723	Equipment for distributing electricity	4.01	-0.99(3.91)	0.01	0.79	S	S	0.48
724	Telecommunications apparatus	9.06	-0.59(4.35)	3.48	0.49	US	S	0.20
725	Domestic electrical equipment	5.37	-0.40(3.660	0.43	0.45	S	S	0.43
729	Other electrical machinery and apparatus	2.50	-0.59(3.69)	0.39	0.63	S	S	-0.15
732	Road motor vehicles	20.38	-0.39(5.36)	1.22	0.001	S	S	0.42
734	Aircraft	3.65	-0.39(2.73)	0.50	2.44	S	S	0.33
735	Ships and boats	0.71	-1.69(5.07)	2.16	10.53	S	US	0.53
812	Sanitary, plumbing, heating & light	3.21	-0.93(4.43)	1.40	6.14	S	S	0.05
821	Furniture	4.28	-0.23(2.23)	0.05	1.11	S	S	0.08
831	Travel goods, handbags and similar	6.08	-0.70(5.48)	1.61	2.34	S	S	-0.06
841	Clothing except fur clothing	5.02	0.02(0.12)	4.38	3.14	S	S	0.21
861	Scientific, medical, optical, measures	4.01	-0.89(4.69)	0.46	0.26	S	S	0.002
864	Watches and clocks	4.89	-0.71(3.95)	0.11	2.50	S	S	0.09
891	Musical instruments, sound recorder	2.56	-0.24(1.51)	0.93	4.38	S	S	0.02
892	Printed matter	11.89	-0.34(4.56)	4.18	7.83	S	US	0.42
893	Articles of artificial plastic mate	7.18	-0.65(4.27)	4.16	1.74	S	S	0.07
894	Perambulators ,toys, games and sporting goods	5.47	-0.53(3.10)	2.75	9.08	S	US	0.28
896	Works of art, collectors pieces	4.14	-1.43(5.56)	7.78	0.26	S	S	0.18
897	Jewellery and gold/silver smiths watches	8.51	-1.22(6.63)	0.15	0.38	S	S	0.68
899	Manufactured articles, n.e.s.	3.53	-0.42(2.78)	0.05	2.76	S	US	0.09
931	Special transactions	4.15	-0.07(0.28)	0.13	10.47	S	S	0.44

Notes:

1. LM: Lagrange multiplier test of residual serial correlation. It is distributed as $\chi^2(1)$
2. RESET: Ramsey's test for function form. It is distributed as χ^2 (1)

3. CUSUM: Cumulative Sum of Recursive Residuals
4. CUSUMSQ: Cumulative Sum of Squares of Recursive Residuals
5. Number inside the parenthesis next to a coefficient is absolute value of the t-ratio.

Curve effect, i.e., negative coefficients followed by positive ones. These four industries are coded as 53, 231, 653, and 656. However, if we rely upon more recent and refined definition of the J-Curve by Rose and Yellen (1989) i.e., negative short-run effects combined with favorable long-run effects, then we identify 24 industries in which the real bilateral exchange rate carries a positive and significant coefficient (at the 10% level) in the long run.[6] These industries are coded 32, 55, 62, 75, 99, 221, 581, 632, 642, 653, 664, 692, 719, 723, 724, 725, 732, 821, 831, 861, 891, 893, 894, and 896.

Combining the two definitions, we, therefore, find support for the J-Curve in a total of 27 industries or 43% of the cases. While most of these industries are small, as measured by their trade shares, two large industries happen to be among them, i.e., industry 581 (with trade share of 3.64%) and 719 (with a trade share of 7.82%). Two other large industries only benefit from depreciation in the short run and they are 332 (with trade share of 9.66%) and 714 (with trade share of 10.12%) since the real exchange rate carries significant and positive coefficient in the short run only. These findings were masked by previous studies which considered aggregate trade balance between the U.S. and Singapore.

As for the effects of the level of economic activities, Singapore income (Y_{SG}) carries its expected positive and significant coefficient in 10 industries coded 231, 332, 422, 631, 632, 656, 697, 717, 894, and 897. All of these industries happen to be small except 332 (Petroleum products) which has almost 10% of the market share. There are also 10 industries in which Singapore income carries a significantly negative coefficient.

As Singapore grows, it produces more of import-substitute goods, and therefore imports less of goods produced by these industries (Bahmani-Oskooee, 1986). These industries are coded as 55, 62, 75, 99, 642, 711, 714, 725, 732, and 893. Again, they are all small except 711 (Power generating machinery with almost 2% share) and 714 (Office machines with 10% trade share). As for the U.S. economic activity, it carries its expected negative and significant coefficient in seven industries coded 48, 332, 631, 656, 697, 717and 897. These are all small industries except 332 (Petroleum products with almost 10% of trade share).

There are also six cases in which the U.S. income carries a significantly positive coefficient. Again, these could be considered import-substitute goods. As U.S. economy grows, the U.S. economy produces more goods that are close substitutes for these industries, hence imports less of them. These industries that are all small are coded as 55, 75, 642, 725, 732, and 893.

[6] Note that the standard errors of normalized coefficients are calculated using non-linear least square technique and the Delta method. These methods are built into the Microfit statistical package that is used in this paper. For more details see pages 394 and 404 of MFIT4.0 manual by Pesaran and Pesaran (1997).

The above long-run analysis will only be valid and long-run coefficient estimates will not be spurious if we establish cointegration among the variables. To this end we move to Table 2 and consider the results of the F test and other diagnostic statistics. Our calculated F statistic is greater than its upper bound critical value of 4.10 from Narayan (2005) in 42 industries supporting cointegration.

These are mostly industries in which there was at least one long-gun significant coefficient. In cases where there is at least one significant long-run coefficient but F is insignificant (e.g., industry 99), we follow the literature and use the long-run coefficient estimates and equation (1) and calculate the error term as:

$$\hat{\varepsilon}_t = LnTB_{i,t} - \hat{a} - \frac{\hat{\lambda}_2}{\hat{\lambda}_1} LnY_{SG,t} - \frac{\hat{\lambda}_3}{\hat{\lambda}_1} LnY_{US,t} - \frac{\hat{\lambda}_4}{\hat{\lambda}_1} Ln\, REX_t \qquad (3)$$

We then replace the lagged level variables in (2) by the estimate of lagged error term from (3) denoted by ECM_{t-1} and estimate the resulting error-correction model after imposing the same optimum lags.[7] A negative and significant coefficient will not only support convergence toward the long-run equilibrium, but it will also signify that estimated models are equilibrium models. Clearly, ECM_{t-1} carries a significantly negative coefficient in most cases.

The size of the coefficient itself measures the speed with which variables are adjusting. Hence, while a value of -0.36 in industry 31 indicates that 36% of adjustment takes place within one year, -1.66 in industry 221 indicates that 83% of the adjustment takes place in six months since data are annual.

Several other diagnostic statistics are also reported in Table 2. To test for autocorrelation in each model, we rely upon the Lagrange Multiplier (LM) statistic which has a χ^2 distribution with one degree of freedom. Given the critical value of 3.84, only in 13 industries the LM statistic is significant, implying that the residuals in these optimum models suffer from serial correlation. Ramsey's RESET statistic is also reported to identify models that are misspecified.

This statistic is also distributed as χ^2 , again with one degree of freedom. In most models this statistic is insignificant, implying correct specification of optimum models selected by AIC criterion. In models that there are short-run coefficients as well as long-run coefficients, stability of all coefficients is tested by the CUSUM and CUSUMSQ tests applied to the residuals of each optimum error-correction model.

We indicate the stable models by "S" and unstable ones by "US" in Table 2. Clearly, almost all coefficients are stable. While Bahmani-Oskooee *et al.* (2005) provides detailed explanations of these tests, we only report the final results in Table 2 as "S" indicating stable coefficients and "US" as unstable ones. Clearly, almost all estimated coefficients are stable.[8]

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[7] The resulting model is also an error-correction model and for that reason $\hat{\varepsilon}_{t-1}$ is denoted by $ECM_{t-1.}$

[8] For step by step application of these two tests and their graphical presentation see Bahmani-Oskooee et al. (2005) and for their origin see Brown *et al*, (1975).

4. SUMMARY AND CONCLUSION

Traditionally, in assessing the impact of currency depreciation on the trade balance of a country researchers used to estimate the Marshall-Lerner condition. Couple studies that tested this condition for Singapore, failed to find support for the condition, hence for a successful devaluation in the long run. In search of finding a different outcome, a few other studies related Singapore trade balance directly to the real exchange rate in addition to other scale variables.

By then applying cointegration and error-correction modeling techniques these studies distinguished short-run effects of currency depreciation from its long-run effects. While they were able to find some significant short-run effects of depreciation on Singapore's trade balance, they were unable to find any long-run effects, especially in the trade between Singapore and the U.S. as its major trading partner.

Concentrating on the trade between Singapore and the U.S., our claim is that previous studies suffer from aggregation bias in that they used aggregate trade flows between the two countries. In this paper we disaggregate these trade flows by commodity and investigate the short-run and the long-run effects of real exchange rate depreciation on the trade balance of each industry. There are 64 industries that trade between the two countries.

Using Pesaran *et al.* (2001) bounds testing approach to cointegration and error-correction modeling we were able to discover short-run significant effect of depreciation on the trade balance of 48 industries. The short-run effects, however, lasted into the long run favorable effects only in 24 industries. Therefore, while our short-run findings are in line with previous research which used aggregate trade flows, the long-run favorable effects in 24 industries is a unique finding that was masked in the previous research. The J-Curve effect, i.e. short-run deterioration combined with long-run improvement was discovered in 27 industries.

APPENDIX

Data Definition and Sources

Empirical analysis was based on annual data over 1974-2011period which come from the following sources:

1. World Bank
2. International Financial Statistics

Definitions:

TB_i= measure of trade balance for industry *i* defined as the ratio of US exports of commodity *i* to Singapore over its import of commodity *i* from Singapore. Industry level data come from source (1).

Y_{SG} = Singapore's income measured by real GDP. Data come from source (2).

Y_{US} = US income measured by its real GDP. Data come from source (2).

REX= Real bilateral exchange rate between US dollar and Singapore dollar. It is defined as $(P_{SG} \bullet NEX / P_{US})$, where P_{US} is US CPI, P_{SG} is Singapore's CPI, and *NEX* is the nominal bilateral exchange rate defined as the number of US dollar per Singapore dollar. Thus, an increase in *REX* is a reflection of real depreciation of the US dollar.

REFERENCES

Agbola, F.W. and M.Y. Damoense, 2005. Time-series estimation of import demand functions for pulses in India. Journal of Economic Studies, 32(2): 146-157.

Alse, J. and M. Bahmani-Oskooee, 1995. Do devaluations improve or worsen the terms of trade? Journal of Economic Studies, 22(6): 16-25.

Bahmani-Oskooee, M., 1986. Determinants of international trade flows: The case of developing countries. Journal of Development Economics, 20(1): 107-123.

Bahmani-Oskooee, M., 1998. Cointegration approach to estimate the long-run trade elasticities in LDCs. International Economic Journal, 12(3): 89-96.

Bahmani-Oskooee, M. and J. Alse, 1994. Short-run versus long run effects of devaluation: Error-correction modeling and cointegration. Eastern Economic Journal, 20(4): 453-464.

Bahmani-Oskooee, M., C. Economidou and G.G. Goswami, 2005. How sensitive are Britain’s inpayments and outpayments to the value of the British pound. Journal of Economic Studies, 32(6): 455-467.

Bahmani-Oskooee, M. and A. Gelan, 2009. How stable is the demand for money in African countries. Journal of Economic Studies, 36(3): 216-235.

Bahmani-Oskooee, M. and H. Harvey, 2012. The J-curve: Singapore vs her major trading partners. Economic Papers, 31(4): 515-522.

Bahmani-Oskooee, M., H. Harvey and S. Hegerty, 2013. Empirical tests of the marshall-lerner condition: A literature review. Journal of Economic Studies, 40(3): 411-443.

Bahmani-Oskooee, M. and S. Hegerty, 2010. The J- and S-curves: A Survey of the recent literature. Journal of Economic Studies, 37(7): 580-596.

Bahmani-Oskooee, M. and S.W. Hegerty, 2007. Exchange rate volatility and trade flows: A review article. Journal of Economic Studies, 34(3): 211-255.

Bahmani-Oskooee, M. and O. Kara, 2005. Income and price elasticities of trade: Some new estimates. The International Trade Journal, 19(2): 165-178.

Bahmani-Oskooee, M. and F. Niroomand, 1998. Long-run price elasticities and the marshall-lerner condition revisited. Economics Letters, 61(1): 101-109.

Bahmani-Oskooee, M. and J. XU, 2012. Is there evidence of the J-curve in commodity trade between U.S. and Hong Kong? The Manchester School, 80(3): 295-320.

Brown, R.L., J. Durbin and J.M. Evans, 1975. Techniques for testing the constancy of regression relations over time. Journal of Royal Statistical Society, B 37(2): 149-192.

Caporale, G.M. and M.K.F. Chui, 1999. Estimating income and price elasticities of trade in a cointegration framework. Review of International Economics, 7(2): 254-264.

Charos, E.N., O.S. Evangelos and T.R. Allen, 1996. Exports and industrial growth: A new framework and evidence. Journal of Economic Studies, 23(1): 18-31.

Chen, S.-W. and T.-C. Chen, 2012. Untangling the non-linear causal nexus between exchange rates and stock prices: New evidence from the OECD countries. Journl of Economic Studies, 39(2): 231-259.

De Vita, G. and K.S. Kyaw, 2008. Determinants of capital flows to developing countries: A structural VAR analysis. Journal of Economic Studies, 35(4): 304-322.

Du, H. and Z. Zhu, 2001. The effect of exchange-rate risk on exports: Some additional empirical evidence. Journal of Economic Studies, 28(2): 106-121.

Engle, R.F. and C.W.J. Granger, 1987. Cointegration and error correction: Representation, estimation, and testing. Econometrica, 55(2): 251-276.

Gylfason, T. and O. Risager, 1984. Does devaluation improve the current account? European Economic Review, 25(1): 37-64.

Halicioglu, F., 2007. The J-curve dynamics of Turkish bilateral trade: A cointegration approach. Journal of Economic Studies, 34(2): 103-119.

Houthakker, H.S. and M.P. Stephen, 1969. Income and price elasticities in world. Trade. Review of Economics and Statistics, 51(2): 111-125.

Khan, M.S., 1974. Import and export demand in developing countries. IMF Staff Papers, 21(3): 678-693.

King, A., 1993. The functional form of import demand: The case of UK motor vehicle imports, 1980-90. Journal of Economic Studies, 20(3): 36-50.

Lal, A.K. and T.C. Lowinger, 2002. The J-curve: Evidence from East Asia. Journal of Economic Integration, 17(2): 397-415.

Love, J. and R. Chandra, 2005. Testing export-led growth in South Asia. Journal of Economic Studies, 32(2): 132-145.

Mohammadi, H., M. Cak and D. Cak, 2008. Wagner's hypothesis: New evidence from Turkey using the bounds testing approach. Journal of Economic Studies, 35(1): 94-106.

Narayan, P.K., 2005. The saving and investment nexus for China: Evidence from cointegration test. Applied Economics, 37(17): 1979-1990.

Narayan, P.K., S. Narayan, B.C. Prasad and A. Prasad, 2007. Export-led growth hypothesis: Evidence from Papua new Guinea and Fiji. Journal of Economic Studies, 34(4): 341-351.

Narayan, S. and P.K. Narayan, 2005. An empirical analysis of fiji's import demand function. Journal of Economic Studies, 32(2): 158-168.

Payne, J.E., 2008. Inflation and inflation uncertainty: Evidence from the Caribbean region. Journal of Economic Studies, 35(6): 501-511.

Pesaran, M.H. and B. Pesaran, 1997. Working with microfit 4.0, interactive econometric analysis. U.K: Camfit Data Ltd.

Pesaran, M.H., Y. Shin and R.J. Smith, 2001. Bound testing approaches to the analysis of level relationship. Journal of Applied Econometrics, 16(3): 289-326.

Rose, A.K. and J.L. Yellen, 1989. Is there a J-curve? Journal of Monetary Economics, 24(1): 53-68.

Tang, T.C., 2007. Money demand function for Southeast Asian countries: An empirical view from expenditure components. Journal of Economic Studies, 34(6): 476-496.

Truett, L.J. and D.B. Truett, 2000. The demand for imports and economic reform in Spain. Journal of Economic Studies, 27(3): 182-199.

Werner, D. and M.E. Kreinin, 1983. Determinants of international trade flows. Review of Economic and Statistics, 65(1): 96-104.

Wilson, P., 2001. Exchange rates and the trade balance for dynamic Asian economies: Does the J-curve exist for Singapore, Malaysia and Korea?. Open Economic Review, 12(4): 389-413.

Wong, K.N. and T.C. Tang, 2008. The effects of exchange rate variablity on Malaysia’s disaggregated electrical exports. Journal of Economic Studies, 35(2): 154-169.