S-Curve Dynamics of Trade: Evidence from US-Canada Commodity Trade

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ABSTRACT

The J-Curve effect is a concept used to describe the short-run effects of currency depreciation on the trade balance, i.e., an initial deterioration of the trade balance followed by an improvement. A concept close to the J-Curve is the S-Curve introduced by Backus, et al *(1994) who found that the cross-correlation function between current terms of trade and future values of the trade balance is positive, but between current terms of trade and past values of the trade balance it is negative. The S-curve, however, did not receive strong support in the cases of Canada and the US Suspecting that the lack of an S-Curve pattern for each of the two countries could be to the result of using aggregate trade data, we disaggregate the trade data between the two countries by commodity and provide overwhelming support for the S-Curve in 41 out of 60 industries, that account for more than 80 per cent of the bilateral trade between the two countries.*

1. INTRODUCTION

CURRENCY DEVALUATION OR DEPRECIATION is said first to have adverse effects on the trade balance, through adjustment lags. After some time, however, it begins to have favourable effects, following a short-run pattern that is known as the 'J-Curve'. Since its introduction by Magee (1973), a literature has emerged in which different authors try to test the phenomenon for different countries.

As far as Canada is concerned, a few studies have tried to test the J-Curve effect. Some have used trade data between Canada and the rest of the world, and some have used trade data between Canada and her major trading partners. At the aggregate level, Rose (1991) estimated a VAR model for five large countries including Canada. In none of the cases was the exchange rate found to be a significant determinant of the trade balance. Aggregate data were also used by Caporale and Chui (1999) in estimating price elasticities to infer the well-known Marshall-Lerner condition. It was concluded that depreciation has no long-run effects on the trade balance of countries included in the sample, including Canada. Studies using aggregate trade data were criticised by Rose and Yellen (1989) when they tested the J-Curve by using bilateral trade data between the US and her major trading partners that included Canada. Again, no significant relation was found between bilateral exchange rates and bilateral trade balances in the long run or in the short run (the J-curve effect). The lack of a long-run relation between the bilateral exchange rate and the bilateral trade balance between Canada and the US was also confirmed by Marwah and Klein (1996), who considered Canada and her five major trading partners.

There is yet another approach to investigating the short-run response of the trade balance to movements in the exchange rate, i.e., the S-curve concept introduced by Backus *et al.* (1994). Rather than engaging in regression analysis, Backus *et al.* basically look at the cross-correlation between the trade balance and the terms of trade or the real exchange rate. If the two variables are defined in a way that a positive association reflects favourable effects of a real depreciation on the trade balance, they demonstrate that the cross-correlation is positive only between the current value of the real exchange rate and future values of the trade balance. However, the cross-correlation is negative between the current value of the exchange rate and past values of the trade balance. By plotting the cross-correlation coefficients obtained from using the current value of the exchange rate and the lagged as well as the lead values of the trade balance, they demonstrate that the pattern resembles the letter S, hence the S-curve. Using aggregate trade data and the terms of trade from 11 industrialised countries, they were able to support their theory in the results for Australia, France, Germany, Italy, Japan, Switzerland, and the UK, but not in the results for the US and Canada.[2]

Since empirical evidence in favour of the J-Curve is mixed at best, and lacking in most cases, one wonders if there is indeed a short-run relation between the real exchange rate and trade balance — the two key variables in trade theory. While the presence of an S-Curve would confirm a theoretically well known relation between the two key variables, its absence would suggest no implicit dynamics between the two. It is somewhat intriguing that there is no evidence of a J-Curve or an S-Curve for Canada. Could the lack of support for the S-curve in the cases of Canada (and the US) be due to using aggregate trade data of each country with the rest of the world? To answer this, we concentrate on bilateral trade between the two countries and consider the trade flows of 60 industries (3-digit industries) that account for almost 80 per cent of trade between the two countries. The S-curve is supported in 41 cases. To demonstrate our findings, in section II we provide a detailed explanation of our approach as well as the definition and sources of the data. Cross-correlation functions are presented in section III with a summary and conclusion in section IV.

2. Data, Definitions, sources, and methodology

Data

We employ annual data over the period 1973-2004 from 60 three-digit industries that trade between the US and Canada. Table 1 provides the list of 60 industries with their SITC codes. The selection of these 60 industries was based on their relative importance in the trade between the two countries. As evidenced from Table 2, the 60 industries account for more than 80 per cent of trade almost every year over the last three decades.

Table 1: Product codes for industries included in the sample

Product	*Product Name*	*Product*	*Product Name*
001	Live animals	673	Iron and steel bars, rods, angles
011	Meat, fresh, chilled or frozen	674	Universals, iron plates & sheets
031	Fish,fresh & simply preserved	678	Tubes, pipes and fittings of iron
048	Cereal preps & preps of flour	682	Copper
051	Fruit, fresh, and nuts - excl. oil	684	Aluminium
054	Vegetables, roots & tubers	691	Finished structural parts
081	Feed-stuff for animals excl.unmill	694	Nails, screws, nuts, bolts, rivets
099	Food preparations,nes	695	Tools for hand or machine use
243	Wood,shaped or simply worked	698	Manufactures of metal, nes
251	Pulp & waste paper	711	Power generating machinery
331	Petroleum, crude and part refined	712	Agricultural machinery
332	Petroleum products	714	Office machines
341	Gas,natural and manufactured	718	Machines for special industries
351	Electric energy	719	Machinery & appliances-non elec
512	Organic chemicals	722	Electric power machinery
513	Inorg.chemicals, oxides,halog	723	Equipment for distributing elec.
533	Pigments, paints, varnishes	724	Telecommunications apparatus
541	Medicinal & pharm. products	725	Domestic electrical equipment
553	Perfumery, cosmetics, dentifrices,	729	Other electrical machinery
561	Fertilizers manufactured	731	Railway vehicles
581	Plastic materials,regen. cellulose	732	Road motor vehicles
599	Chemical materials and prods. nes	733	Other road vehicles
629	Articles of rubber,nes	734	Aircraft
631	Veneers, plywood boards & other	821	Furniture
632	Wood manufactures, nes	841	Clothing except fur clothing
641	Paper and paperboard	861	Scientific, medical, optical,
642	Articles of paper, pulp, paperbd	891	Musical instruments, sound rec.
651	Textile yarn and thread	892	Printed matter
663	Mineral manufactures, nes	893	Articles of artificial plastic mate
664	Glass	894	Perambulators, toys, games

Definitions and sources

Backus *et al.* (1994) defined the trade balance to be the difference between exports and imports, or net exports, as a percentage of GDP. We use the same concept, but at the commodity level. Since data at the commodity level are reported by the US in terms of the American dollar, we deflate net exports by US GDP. As for the terms of trade, Backus *et al.* (1994) used aggregate import and export price indices to form their measure of the terms of trade, because the trade data were at the aggregate level. However, export and import prices are not available at the commodity level to construct the terms of trade associated with each industry. Thus, as a close substitute we use *the real bilateral exchange rate* between the US and Canada. Therefore, we define the bilateral terms of trade between the US and Canada to be P_C / (E*P_{US}), where P_C is the CPI in Canada, P_{US} is the CPI in the US and E is the nominal exchange rate, defined as the number of Canadian dollars per US dollar. In this setup, if a real depreciation of the US dollar is to improve the net exports of an industry, the correlation is expected to be positive. Again, following Backus *et al.* (1994) both constructed variables are detrended using the Hodrick-Prescott Filter. As for sources of the data, US GDP, the bilateral exchange rate E and CPI data all come from the International Financial Statistics of the IMF (CD-ROM). Export and import data at the commodity level come from the World Bank.

Table 2: Trade Shares of Industries Included in the Sample, 1973-2004

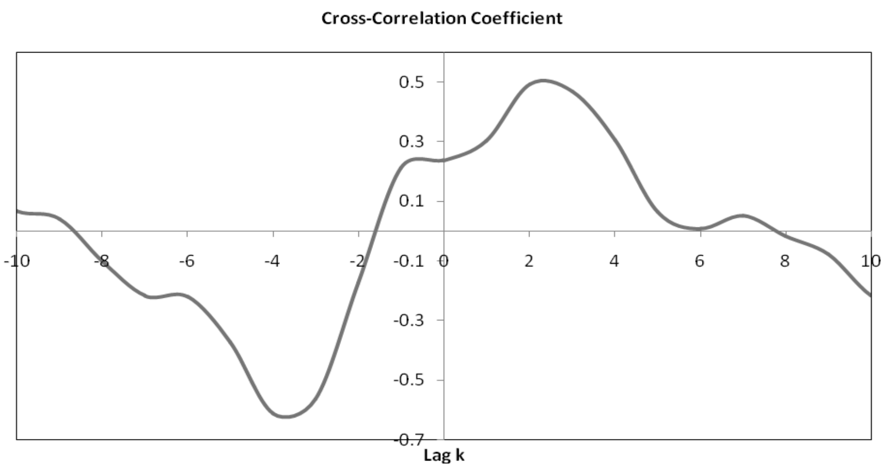
Year	*Trade Share (%)*	*Year*	Trade Share (%)
1973	82.4	1989	75.3
1974	81.9	1990	85.1
1975	81.8	1991	85.5
1976	82.0	1992	85.2
1977	82.5	1993	85.8
1978	82.9	1994	85.9
1979	82.1	1995	86.0
1980	81.1	1996	85.7
1981	81.6	1997	86.1
1982	83.6	1998	86.0
1983	84.6	1999	86.6
1984	84.3	2000	86.8
1985	84.8	2001	85.8
1986	84.5	2002	85.5
1987	79.7	2003	86.3
1988	78.1	2004	86.5

3. The cross-correlation functions

We are now in a position to compute the cross-correlations between the real bilateral exchange rate and the trade balance for the aggregate bilateral trade balance as well as for the trade balance of each industry at various lags (lags and leads). They are then plotted against their corresponding lags or leads. If the underlying cross-correlation functions are asymmetric, i.e., the coefficients are positive for leads (or positive lags) but negative for negative lags, then there is evidence of the S-curve in the corresponding industry. If the contemporaneous correlation is negative, then there is also evidence of the Harbeger-Larsen-Metzler (HLM) effect.[4]

Let us consider first the S-curve for the bilateral trade balance between the US and Canada, for all 60 industries together. The evidence from Figure 1 clearly supports the S pattern, though there is also evidence of HLM effect. Therefore, it appears that bilateral trade data provide support for the S-Curve, whereas the curve was absent when Backus *et al.* (1994) used aggregate data between each country and the rest of the world.

Figure 1: Cross-correlation between REX and trade balance for all 60 industries together



In a study of exchange rate pass-through in US manufacturing industries and its cross-sectional variation, Yang (1997) demonstrates that pass-through effects of currency depreciation on prices vary across industries. Gagnon and Knetter (1995) point to the importance of markup adjustment driven by exchange rate changes as a source of preventing the pass-through effect. To identify industries in which the pass-through effect is complete versus those in which it is incomplete, we construct a cross-correlation function for each industry. Industries in which the pass-through effect is complete should support the S-pattern. We were able to identify 41 industries that supported the S-curve and 19 industries that did not. As a first exercise we thought to produce the S-curve fore 41 industries together to see how it differs from the one in Figure 1. Similarly, we produced the S-curve for the remaining 19 industries. Figures 2 and 3 present these curves.

Figure 2 reveals there is very strong support for the S-curve with no HLM effect when only 41 industries are included in the construction of the S-curve. As expected, Figure 3 provides no support for the S-curve. To learn more about the patterns, we report the cross-correlation functions for industries that exhibit the S-curve pattern. While Table 3 reports the list of these industries (41 in total), Figure 4 produces the cross-correlation function for each of the 41 industries.

Figure 2: Cross-Correlation between REX and trade balance for the 41 industries exhibiting support for the S-curve.

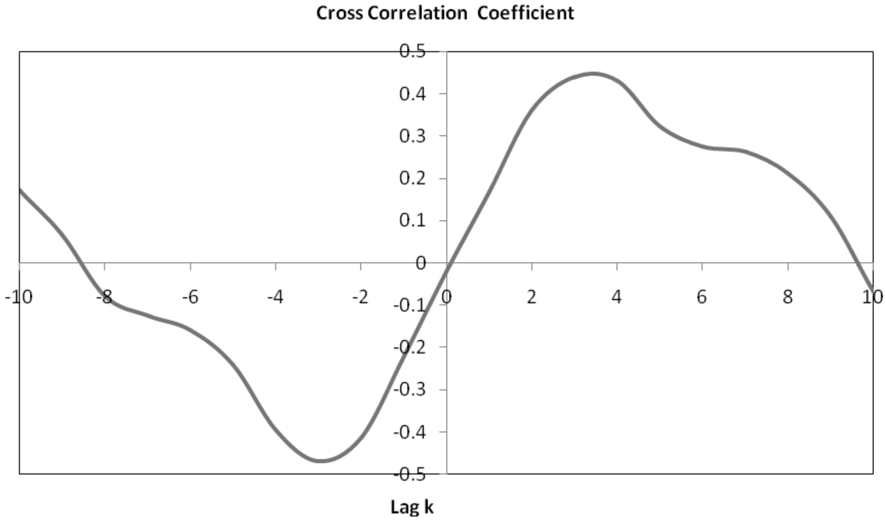


Figure 3: Cross-Correlation between REX and trade balance for the 19 industries not exhibiting support for the S-curve

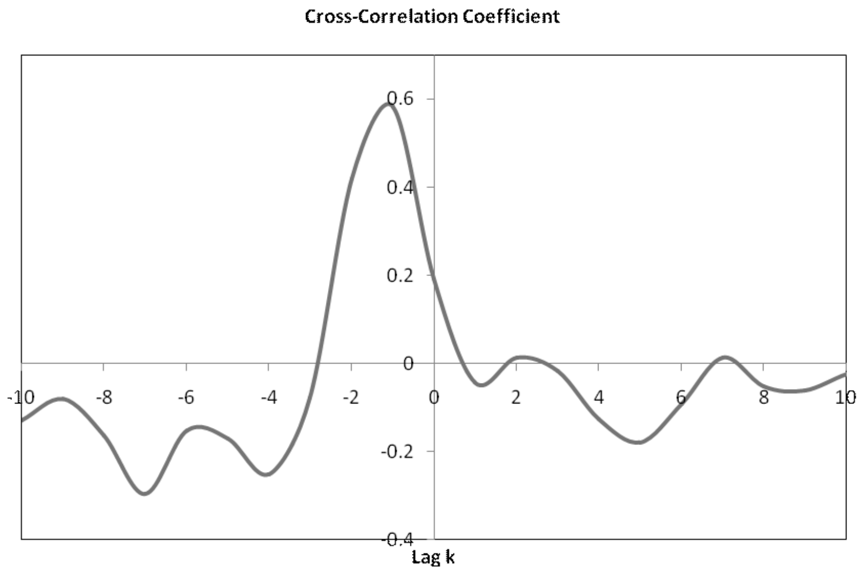
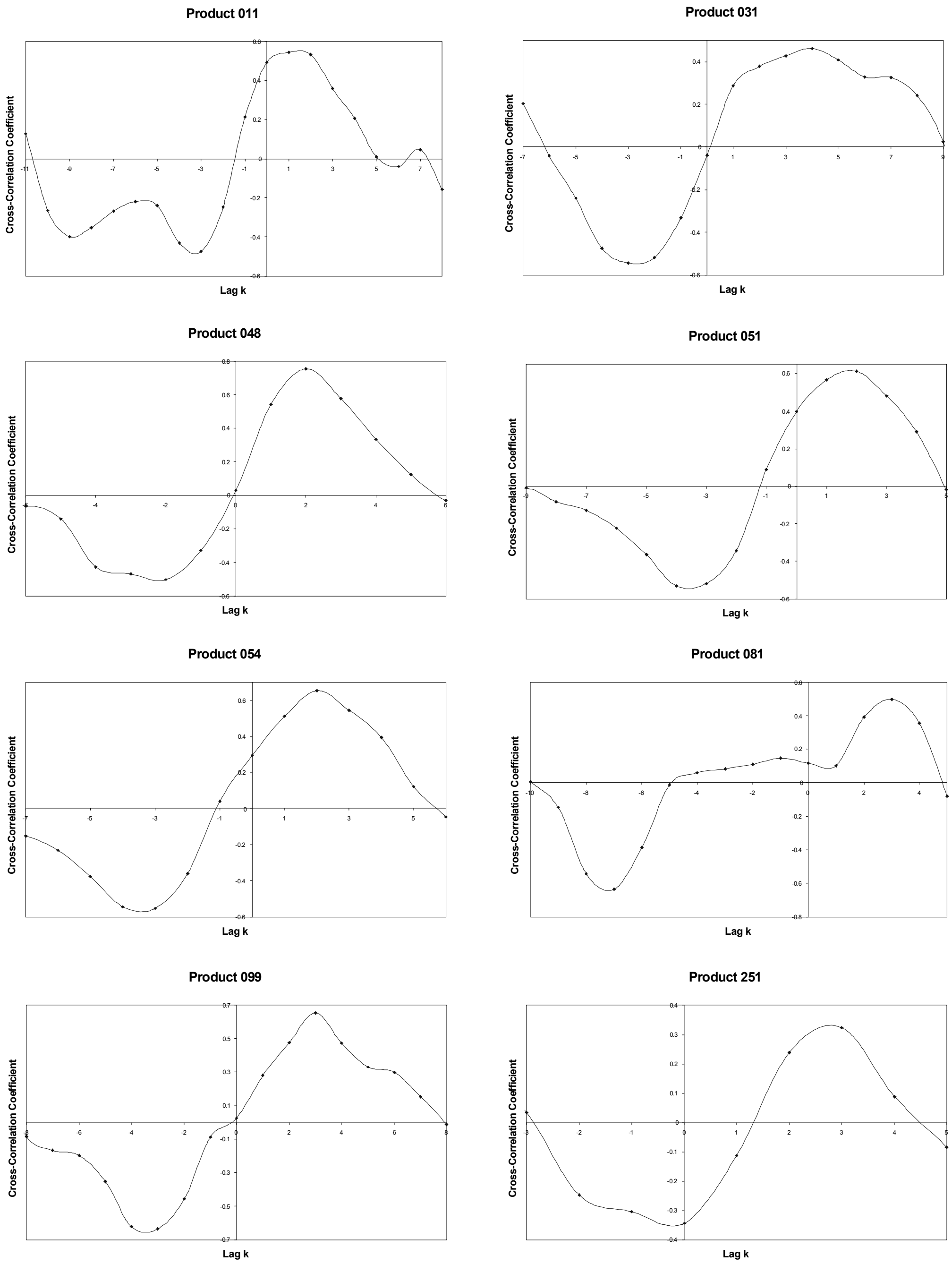


Table 3: Industries exhibiting support for the S-Curve

Product	*Product Name*	*Product*	*Product Name*
11	Meat, fresh, chilled or frozen	691	Finished structural parts
31	Fish,fresh & simply preserved	695	Hand and machine tools
48	Cereal preps & preps of flour	698	Manufactures of metal, nes
51	Fruit, fresh, and nuts - excl. oil	711	Power generating machinery
54	Vegetables, roots & tubers	712	Agricultural machinery
81	Feed.-stuff for animals	718	Machines for special industries
99	Food preparations,nes	719	Non-elec machinery & appliances
251	Pulp & waste paper	722	Electric power machinery
513	Inorg.chemicals, oxides, halog	723	Equipment for elec. distribution
533	Pigments, paints, varnishes	724	Telecomms apparatus
541	Medicinal & pharma products	725	Domestic electrical equipment
553	Perfumery, cosmetics, dentifrices	729	Other electrical machinery
581	Plastic materials, regen.cellulose	733	Road vehicles other than motor
599	Chem. materials and prods,nes	734	Aircraft
632	Wood manufactures,nes	821	Furniture
641	Paper and paperboard	841	Clothing except fur clothing
651	Textile yarn and thread	861	Scientific, medical, optical
664	Glass	891	Musical instruments, soundrec
678	Iron tubes, pipes and fittings	892	Printed matter
682	Copper	893	Articles of artificial plastic
684	Aluminium		

As can be seen from Figure 4, there is clear evidence of the S-curve in these industries. The remaining 19 industries in which the S-curve is not supported are indeed those industries in which the pass-through is incomplete.[5] Note that included in the list are durable as well as non-durable commodities. In a regression analysis of currency depreciation on the trade balance, Burda and Gerlach (1992), who used aggregate durable and nondurable industries' data, showed that durables are relatively more sensitive to movements in the exchange rate. Our results show that when durables and nondurables are disaggregated further by commodity, some commodities in both groups are sensitive to movements in the exchange rate. Another commodity attribute to consider is small versus large industries. Here, by looking at the trade shares reported in Table 4 for each industry in both groups, we realise that the emergence of the S-curve is insensitive to industry size. There are both types of industries in each group.

Figure 4: S-curves at the industry level



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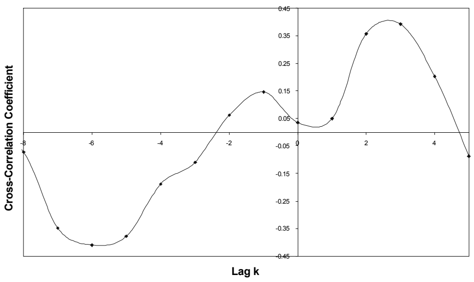

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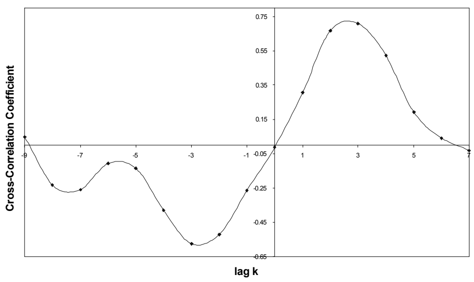

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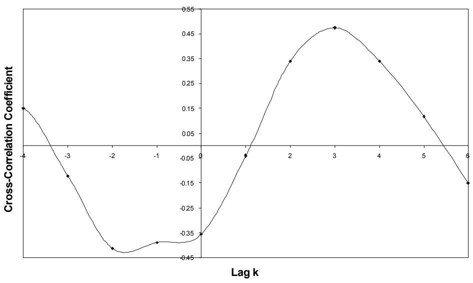

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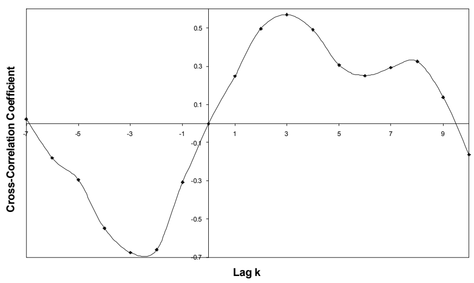

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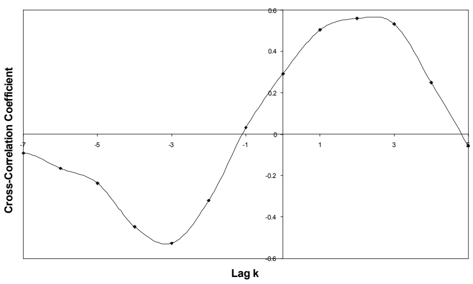

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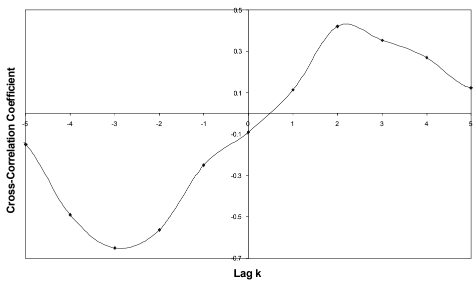

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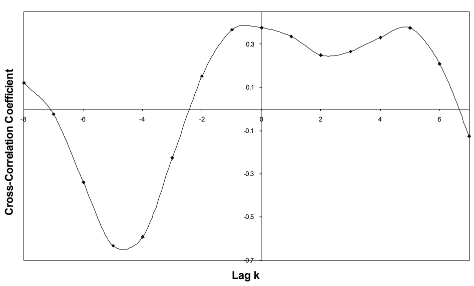

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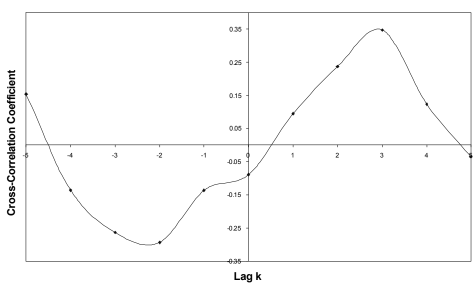

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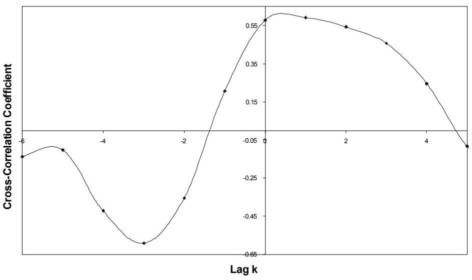

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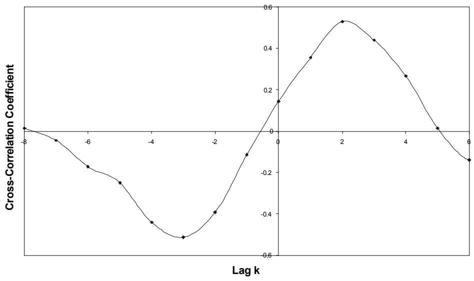

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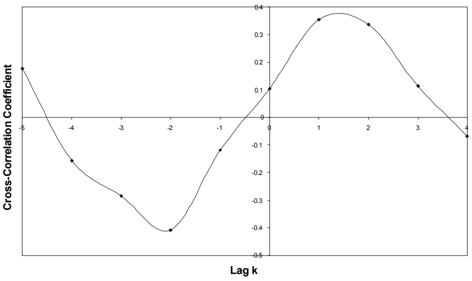

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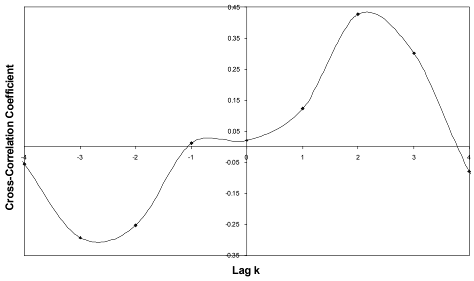

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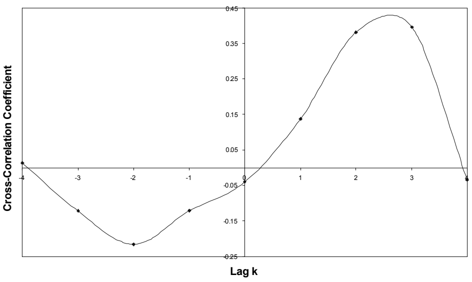

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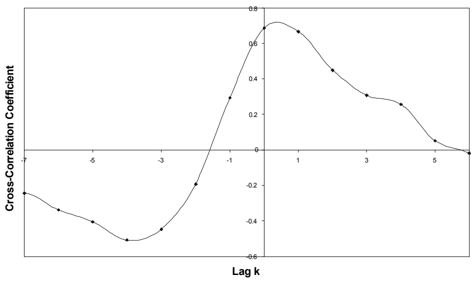

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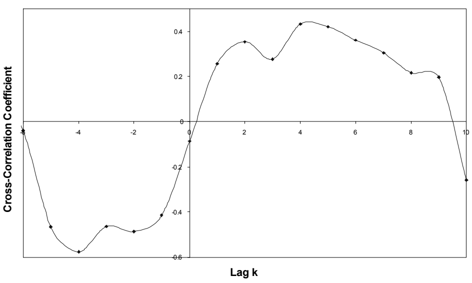

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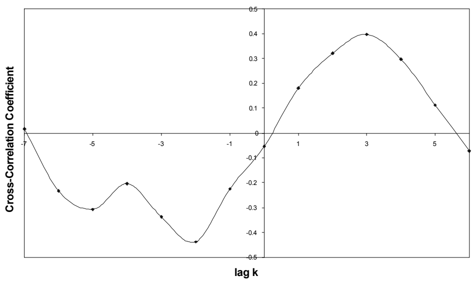

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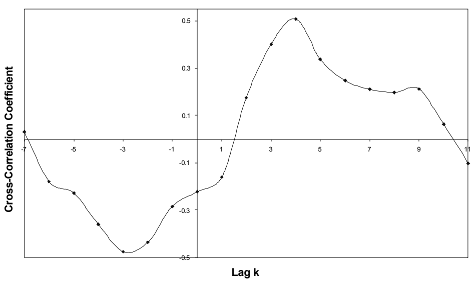

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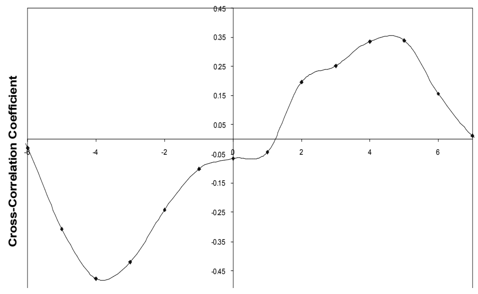

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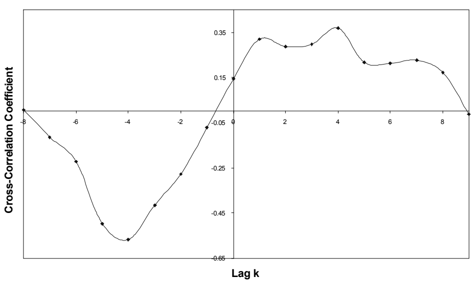

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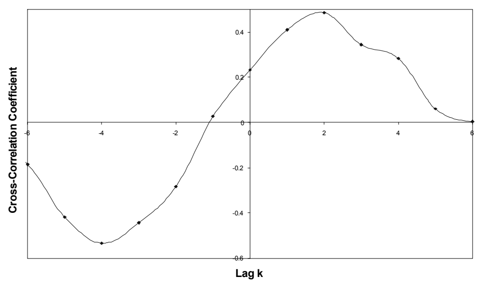

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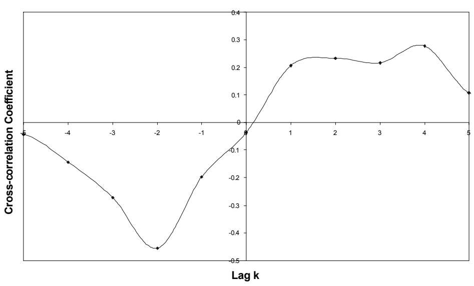

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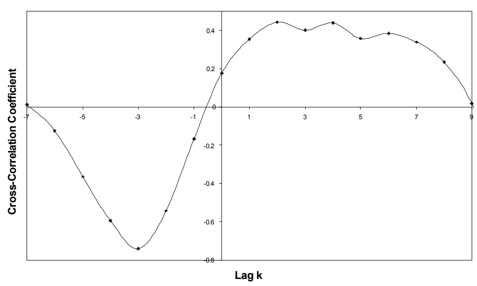

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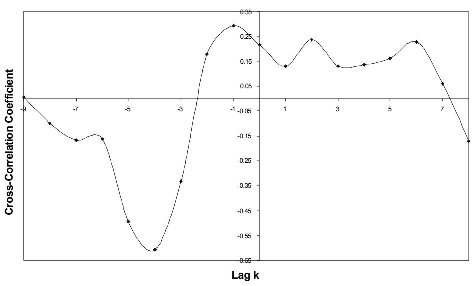

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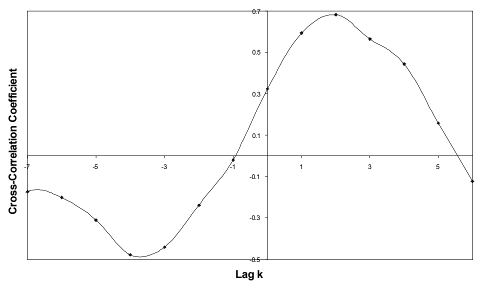

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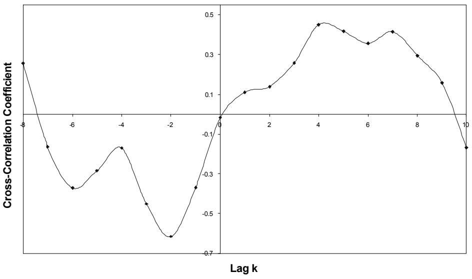

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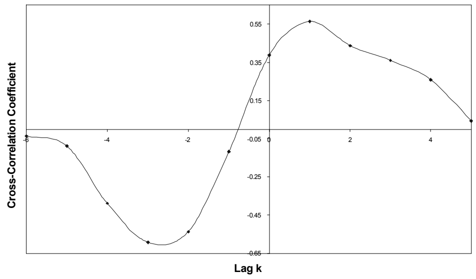

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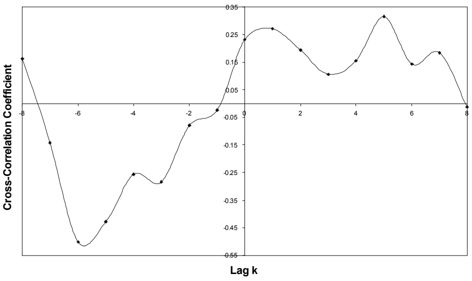

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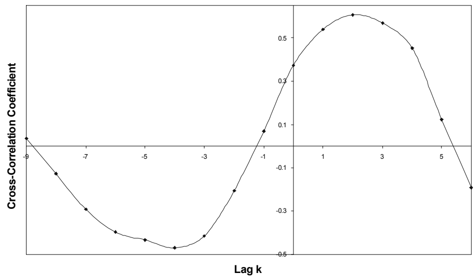

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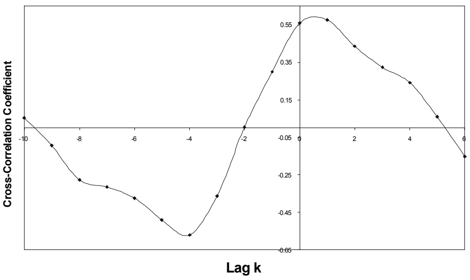

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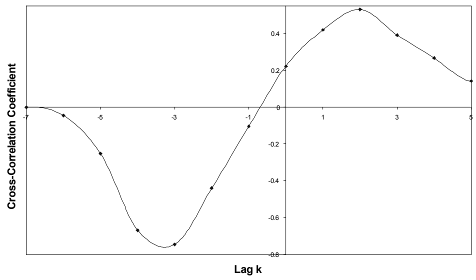

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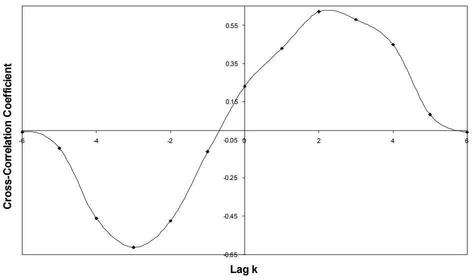

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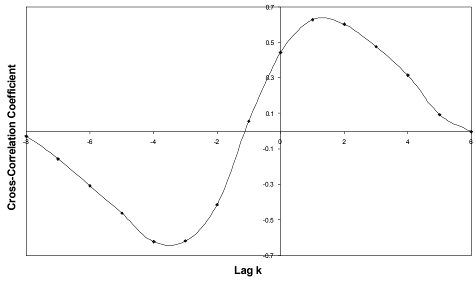

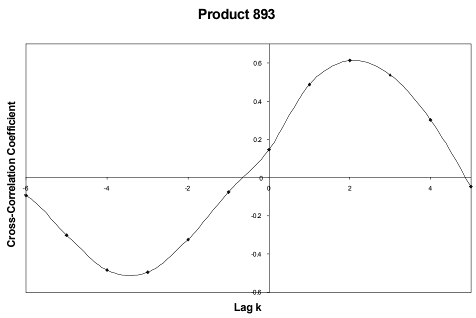

Table 4a. Trade shares of 41 industries exhibiting support for the S-Curve, 2000-2004 (%)

Product	*2000*	*2001*	*2002*	*2003*	*2004*	*Product*	*2000*	*2001*	*2002*	*2003*	*2004*
011	0.51	0.61	0.62	0.54	0.57	691	0.29	0.32	0.35	0.28	0.31
031	0.54	0.59	0.63	0.63	0.55	695	0.30	0.28	0.31	0.31	0.31
048	0.39	0.45	0.52	0.56	0.54	698	1.36	1.15	1.21	1.11	0.98
051	0.29	0.32	0.36	0.39	0.38	711	3.88	3.92	3.85	3.55	3.36
054	0.47	0.53	0.60	0.64	0.61	712	0.45	0.47	0.50	0.53	0.54
081	0.25	0.28	0.30	0.30	0.30	718	0.82	0.81	0.77	0.83	0.91
099	0.27	0.32	0.38	0.39	0.40	719	4.81	4.68	4.81	4.66	4.49
251	0.82	0.66	0.63	0.62	0.63	722	1.83	1.79	1.63	1.45	1.45
513	0.34	0.33	0.31	0.33	0.33	723	0.60	0.57	0.54	0.50	0.50
533	0.39	0.41	0.43	0.44	0.42	724	3.96	2.57	2.19	1.96	1.98
541	0.74	0.87	0.97	1.17	1.12	725	0.33	0.34	0.37	0.38	0.37
553	0.31	0.36	0.39	0.41	0.43	729	3.49	2.64	2.15	2.02	2.11
581	2.35	2.45	2.57	2.68	2.74	733	0.31	0.28	0.33	0.35	0.41
599	0.75	0.81	0.84	0.85	0.84	734	1.65	2.21	1.94	2.03	1.61
632	0.59	0.60	0.64	0.64	0.69	821	1.87	1.79	1.81	1.75	1.76
641	2.72	2.84	2.80	2.66	2.59	841	0.66	0.65	0.65	0.61	0.55
651	0.29	0.27	0.28	0.24	0.23	861	2.02	1.87	1.63	1.55	1.54
664	0.38	0.38	0.40	0.39	0.37	891	0.49	0.51	0.52	0.56	0.53
678	0.42	0.40	0.40	0.40	0.50	892	0.86	0.91	0.97	0.99	0.91
682	0.38	0.37	0.36	0.34	0.44	893	1.02	1.12	1.22	1.23	1.20
684	1.37	1.42	1.43	1.45	1.55						

Table 4b: Trade shares of 19 industries not exhibiting support for the S-curve, 2000-2004 (%)

Product	*2000*	*2001*	*2002*	*2003*	*2004*	*Product*	*2000*	*2001*	*2002*	*2003*	*2004*
001	0.34	0.45	0.44	0.24	0.15	642	0.81	0.89	0.86	0.78	0.74
243	1.84	1.83	1.77	1.54	1.87	663	0.25	0.26	0.27	0.25	0.25
331	3.25	2.78	3.12	3.74	4.43	673	0.34	0.31	0.32	0.31	0.41
332	1.29	1.50	1.48	1.77	1.95	674	0.46	0.43	0.55	0.52	0.62
341	3.00	4.51	3.55	5.39	5.29	694	0.30	0.28	0.29	0.28	0.29
351	0.76	1.03	0.39	0.53	0.47	714	3.19	2.86	2.35	2.24	2.19
512	1.01	1.08	1.04	1.00	1.25	731	0.38	0.32	0.21	0.31	0.30
561	0.38	0.36	0.39	0.39	0.41	732	21.64	20.78	22.75	21.97	21.44
629	0.92	0.95	1.01	0.96	0.95	894	0.44	0.47	0.50	0.52	0.46
631	0.62	0.59	0.63	0.83	0.98						

4. Concluding remarks

Short-run effects of currency depreciation on the trade balance come under the heading of the ‘J-Curve’. All studies that tried to test the J-Curve phenomenon have relied upon a reduced form trade balance model and regression analysis with not much support. Recently, Backus *et al.* (1994) introduced a different approach to investigating the future response of the trade balance to current changes in the real exchange rate. They demonstrated that while the cross-correlation between the current values of the terms of trade and future values of the trade balance is positive, the same correlation between the current values of the terms of trade and past values of the trade balance is negative. Since the plot of cross-correlation functions against the lags and leads resembles the letter S, they label their finding an ‘S-Curve’ and demonstrate its validity for 11 developed countries using aggregate trade data. The evidence of the S-curve in the cases of Canada and the US was very weak.

In this paper we ask whether the weak support for the S-curve in the cases of Canada and the US by Backus *et al.* (1994) is due to using aggregate trade data. To answer this question we first use bilateral trade data between the two countries and provide evidence of the S-Curve. Next, in order to identify industries that their trade flows respond to exchange rate changes, we disaggregate the trade data between Canada and the US by commodity and trace the S-Curve for the trade balance of 60 industries that engaged in imports and exports between the two countries over the period 1962-2004. These industries together handled more than 80 per cent of the bilateral trade between the two countries every year. The S-Curve receives support in 41 industries. Nineteen industries in which the S-curve is not supported could be considered industries in which the pass-through effects of exchange rate changes are not realised, maybe due to adjusting their markup in response to exchange rate changes.

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ENDNOTES

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2. Note that the S-curve is also tested for 30 developing countries by Senhadji (1998), again using aggregate trade data. The cross-correlation between the terms of trade and trade balance was S-shaped in majority of cases - as the lag changes from -3 to +3 years, the underlying correlation first decreases, then increases before declining again; the contemporaneous correlation is negative. We suspect aggregation bias may have played a role in cases where the support was weak or missing, e.g., Chile, Senegal, Tunisia, Yugoslovia.

3. Aggregation can suppress the details observed at disaggregated levels and, hence, cause a loss of information. For example, in their investigation of the J-curve pattern for Japan, Bahmani-Oskooee and Goswami (2003) found no such pattern using aggregate data but were able to recover better support using bilateral trade data. They also found that in the long run, the Yuan's bilateral real exchange rate played a significant role in her bilateral trade with Canada, the UK and the US. The current paper takes the level of disaggregation to the industry level.

4. This is named after the three authors who derived the relation in a Keynesian framework. When a deterioration in the terms of trade causes a drop in income, consumption drops. However, if the marginal propensity to consume is less than one, the drop in consumption will be less than proportionate, causing both savings and net exports to decline. Since the terms of trade is defined such that an increase amounts to a deterioration of the same, a negative contemporaneous correlation between terms of trade and trade balance would be indicative of the HLM effect.

5. These 19 industries in Table 1 are coded as 001, 243, 331, 332, 341, 351, 512, 561, 629, 631, 642, 663, 673, 674, 694, 714, 731, 732 and 894. They are identified in Table 4.

6. For a precise definition and a testing method see Bahmani-Oskooee (1985).

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