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The J-Curve Revisited: An Empirical Analysis for Canada
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Abstract

This paper examines exchange rate and trade data to determine whether J-curve effects have occurred for Canada in recent history. With a unique set of data on import and export volumes, the response of the trade balance and its components to exchange rate changes are determined empirically over 1981:1- 2005:12 through impulse response functions. The responses have taken into account dominant long-run feedback effects, where the long-run parameters have been estimated by the Johansen cointegration technique. The results show that the J-curve phenomenon does not exist for Canada. Robustness checks show that the results do not change when looking at the responses over the pre-NAFTA period and the NAFTA periods.

Keywords: J-Curve; Exchange rate pass-through; Vector Autoregressions; Impulse response function; Cointegration

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Introduction

Understanding the relationship between the exchange rate and the trade account is key to a successful monetary and trade policy, both of which are particularly important for a small open economy such as Canada. The exchange rate – trade account relationship, i.e. the exchange rate channel, is one link in the monetary transmission mechanism. The monetary transmission mechanism is a process that deals with actions taken by the central bank and the associated consequences on macroeconomic variables. In general the transmission mechanism is the complex chain of cause and effect that runs from the Bank of Canada's actions to changes in interest rates and the exchange rate, aggregate demand, the output gap and, eventually, inflation. The goal of Canadian monetary policy is to contribute to rising living standards for all Canadians through low and stable inflation. If the Bank sees inflation rising above its target level, it seeks to slow down the economy through a rise in the overnight rate and consequently longer term interest rates and a rise in the value of the Canadian dollar, leading to a dampening aggregate demand and inflation.

Successfully conducting an inflation targeting policy requires a thorough understanding of the monetary transmission mechanism, including the exchange rate channel. While the general patterns of the monetary transmission process are understood, there is a significant amount of uncertainty with respect to the net effect on each component of aggregate demand and the timing of such effects. Relating to the exchange rate channel, how much do exports respond to a change in the exchange rate, and with what time lags? How quickly and in what magnitude do imports respond to the same change in the exchange rate? The purpose of this paper is to further investigate and understand the exchange rate channel.

While the Canadian dollar experienced depreciations relative to the U.S. dollar over most of the 1990s and over the early part of this decade, the value of the Canadian dollar has increased dramatically over the past 3 years. The substantial movement of the value of the dollar has in Canada revived interest on the effects of such movements on the trade account.

The literature has long debated the question of the response of the trade balance following a domestic currency appreciation or depreciation. The textbook view is one of an improvement in the trade account following a domestic currency depreciation: imports become relatively more expensive leading to a reduction in the purchase of imports, while foreigners will purchase more domestic exports as they are relatively cheaper. This view, however, overlooks two crucial points: the degree to which exporters pass through exchange rate movements into local currency prices of their exports, known as the degree of exchange rate pass through (henceforth ERPT), and the degree to which trade volumes respond to the exchange rate. If, for example, trade volumes are sluggish to respond in the short run following a currency depreciation, short-run lags in the response of trade volumes combined with complete ERPT will initially worsen the trade account. This phenomenon is known in the literature as the J-curve theory, where the response of the trade balance traces out a J-curve tilted to the right.

Evidence on the existence of a J-curve is mixed. Kantao and Klein (1996) estimate trade elasticities between Canada and the U.S. using quarterly data over the period 1977:1-1992:1 and find a deterioration of the trade account over the period of the currency depreciation. Rose and Yellen (1989) investigate the response of U.S. trade using quarterly data over 1960:1-1985:4 through estimating a partial reduced form equation for the merchandise trade account and conclude there is no evidence of a stable J-curve. Rose (1990) finds similar results for the trade balances of a number of developing countries. Moffett (1989) estimates pass-through and quantity response coefficients for the U.S. using quarterly data over the period 1967-1987:4 and simulates a trade balance adjustment, finding that the response does not resemble a J-curve. For further work on the J-curve see the literature review presented by Bahmani-Oskooee and Ratha (2004).

This paper presents updated work on this issue. Unique monthly trade volume data is used over the period 1981:1-2005:12, where the monthly data better captures the dynamic features of the exchange rate mechanism. A useful technique in capturing the response of the trade balance, as suggested by Demirden and Pastine (1995), is to employ VARs and impulse response functions which explicitly account for feedback effects, a feature lacking in the methods of the above studies. Furthermore cointegrating relationships are incorporated in the VARs, as suggested by Ericsson, *et.al* (1998). The studies by Kantano and Klein (1996) and Moffet (1989) are susceptible to spurious relationships due to the possibility of nonstationary variables. Rose and Yellen (1989) and Rose (1990) avoid this potential problem using differenced data, but at the expense of potentially ignoring valuable long-run information.

The response of the trade balance depends on the degree of response of its components, export and import prices and export and import volumes. This paper attempts to measure the response of Canada's trade balance, along with its components, to a currency depreciation. The results indicate that J-curve does not exist. As a robustness check, in taking into account increases in intra-industry changes from changes in location and production processes of firms following the North American Free Trade Agreement in 1994 (NAFTA), we investigate possible changes in trade effects before and after 1994. Over the sample period 1981:1-1993:12, we find that while there is a slight dampening of the response of the trade account and its components over the NAFTA period relative to the pre-NAFTA period, there is still not a J-curve effect over both periods.

The organization of the paper is as follows. Section 2 discusses the components of the trade balance, their determinants, and the J-curve. Section 3 discusses the data. Section 4 presents the empirical framework. VARs and impulse response functions are employed to measure the response of the trade account and its components to exchange rate changes, where the VARs have taken into account long-run relationships among the determinants of the components. The Johansen-Juselius (1990) cointegration approach is used to measure the long-run cointegrating relations. Section 5 discusses the results and robustness checks. The final section concludes and presents possibilities for further work.

Trade Balance Components and the J-Curve

Trade Balance components and their determinants

Nominal net exports for Canada (*NNX*) expressed in Canadian dollars are represented through the identity

$$NNX \equiv EP \cdot x - IP \cdot m$$

where EP is an index of home export prices denominated in Canadian dollars, x is the quantity of home exports, IP is an index of import prices denominated in Canadian dollars, and m is the quantity of home imports.

In measuring the response of the trade balance we will first estimate the long-run determinants of each variable within the trade balance. We will then incorporate these long-run relationships into the corresponding VARs where impulse responses of each of the components will be derived. We begin with a traditional functional relationship for the trade balance:

$$NNX_t = f(E_t, y_t, yus_t) \qquad \textbf{(1)}$$

where E_t is the nominal Canada - U.S exchange rate, as approximately 90% of Canada's trade is with the U.S. (Statistics Canada, 2005), y_t is Canadian real GDP, and yus_t is U.S. real GDP.

In listing the standard determinants of each component of the trade balance, we estimate cointegration relations for each of the following specifications:

$$EP_t = f(E_t, IPP_t, yus_t, y_t) \qquad \textbf{(2)}$$

$$x_t = f(E_t, yus_t) \qquad \textbf{(3)}$$

$$IP_t = f(E_t, PPIMUS_t, yus_t) \qquad \textbf{(4)}$$

$$m_t = f(E_t, y_t) \qquad \textbf{(5)}$$

The specification for export volume x_t (equation 3) captures the traditional determinants being the exchange rate and foreign income, the latter of which is U.S. income. Imports are determined mainly by the exchange rate and domestic income, E_t, and y_t. Concerning import prices, *IP,* our concern is their response to changes in the value of the currency. The percentage by which import prices rise when the home currency depreciates by one percent is known as the degree of pass-through. If there is a one-to-one response of import prices to exchange rate changes, this is known as "complete" exchange rate pass through. This implies that the exporter does not change the price of the good, denominated in the exporter's currency. Alternatively the literature takes on an industrial organization framework, where exchange-rate changes are viewed as marginal cost shocks to the exporter (Dornbusch (1987), Goldberg and Knetter (1997), Yang (1997), Stennek and Verboven (2001)). In either case measuring the degree of exchange-rate pass through involves estimating import price equations, where a common empirical approach is to estimate the functional relationship

$$IP_t = f(E_t, C^f_t, Z^f_t) \qquad \textbf{(6)}$$

where C^f_t is a measure of the foreign (U.S.) exporter's cost, and Z^f_t includes import demand and supply shifters. The proxy for the U.S. exporter's cost will be the producer price index for manufacturing, (*PPIMUS*) as approximately 90% of Canada's imports over 1981-2005 are manufactured goods (Statistics Canada 2005). Since Canada is a relatively small country, a demand factor is not warranted. A proxy for supply will be U.S. real GDP, (*yus*). The coefficient on E_t captures the degree of ERPT. Given that the variables are in logs, ERPT is complete if the coefficient is equal to 1

Export prices will be modeled in a similar fashion as import prices, where costs of Canadian exporters are proxied by the industrial price index of all goods (*IPP*), given that Canada's exports are predominantly in commodities and manufacturing goods (Statistics Canada 2005). In looking at Canadian export prices denominated in Canadian dollars, complete ERPT implies that export prices remain unchanged; U.S. import prices then change by the same percentage as the exchange rate change.

Empirical models of these expressions will be estimated to capture the long-run cointegrating relationships. Each cointegrating relationship will then be included in the corresponding VAR and impulse responses will be derived for each expression above.

The J-curve

A typical J-Curve scenario runs as follows. A depreciation of the Canadian dollar raises the Canadian price of imports, *IP*. There is only a small immediate impact on the volume of trade flows, *i.e.* x and m change little. This is mainly due to contracts, as changes in supply and sourcing require long-term investment decisions, a non-trivial cost. Hence most import and export orders are placed several months in advance. On the demand side the response is sluggish as consumers are slow in changing their habits. Hence export and import volumes reflect buying decisions that were made on the basis of the old exchange rate. Given that the domestic currency price of exports does not change (from the point of view of the foreign country, there is complete exchange rate pass through on their imports), the value of imports, $IP \cdot m$, rises substantially and the value of exports, $EP \cdot x$, rises only slightly, where the balance of trade deteriorates in the short run. As time passes and new contracts are negotiated, the increased price of imports eventually reduces the quantity of imports, while the volume and value of exports also increase, leading to an improvement in the trade balance. The response of the trade balance resembles a "J" tilted to the right. More formally, this short-run response implies that the Marshall-Lerner condition is not satisfied. The condition states that under the assumption of infinitely elastic supply curves of imports and exports of a country, for a given depreciation of the domestic currency, the domestic trade balance will improve as long as the sum of the price elasticities of import demand and export demand, in absolute terms, is greater than 1. The above reasons for a lagged response in import and export volumes translate into low demand elasticities that sum to a value less than 1.

Concern arises over the assumption of infinitely elastic supply curves. Specifically, would export prices remain constant in spite of the devaluation? It may be the case that from the point of view the U.S., it may not want to pass through exchange rate movements into the local (Canadian) currency prices of their exports for fear of losing market share in the importing country (Canada); the domestic price of imports of the home country thus do not increase by the same percentage as the depreciation of its currency. In this case foreign firms lower their markups, where revenues measured in its own currency from sales in the home country will decline.

From the point of view of the home country (Canada), in light of an inelastic demand for its exports, it is plausible that producers will raise export prices, preventing the importing (foreign) country from facing a lower price of imports (denominated in the foreign country's currency) as a result of its currency appreciation. In this case the domestic exporter raises his markup, raising total domestically-denominated revenue. In either case, import prices do not respond one-to-one to changes in the exchange rate. If either of these two cases occur, it is possible for the trade balance to improve following a depreciation, or at a minimum the J-curve should be weakened or "dampened". Measuring the response of each component of the trade balance will shed light on whether the trade balance takes on a J-Curve response.

Data

The data consists of monthly data over the period 1981:1 – 2005:12. The data used for nominal net exports (*NNX)* is merchandise exports less imports on a balance of payments basis. For export prices (*EP*), the data used is the Paasche current weighted export price index, and for import prices (*IP*) the Paasche current weighted import price index. For the volume of exports (*x*), constant dollar exports was calculated using the Laspeyres fixed weighted export volume index and the corresponding current value export series. Constant dollar imports (*m*) was calculated in a similar fashion. To our knowledge these import and export volumes have not been used in studies on the trade account in Canada. The Canadian industrial price index was used as a proxy for the cost of production in the export sector, (*IPP*), and the U.S. producer price index for manufacturing was used for the cost of production in the U.S. export sector, (*PPIMUS*). Canadian output (*y*) is proxied by real (1992) GDP at factor cost, and U.S. output (*yus*) is proxied by real (1992) industrial production. The nominal exchange rate (*E*) is the amount of Canadian dollars per U.S. dollar. All the variables were converted into logarithmic form. The Canadian non-GDP data were sourced from CANSIM, Statistics Canada. The U.S. producer price data was from CITIBASE. GDP data was from the IMF's International Finance Statistics database.

Empirical Framework

Vector Autoregressions

Vector Autoregressions (henceforth VARs) are employed to investigate the response of the trade balance to nominal exchange rate innovations. The approach begins with a *k*-dimensional unrestricted VAR model of order p :

$$Y_t = A_1 Y_{t-1} + \ldots. + A_k \quad Y_{t-k} + \varepsilon_t \quad , \qquad t = 1, \ldots T \ , \qquad \textbf{(7)}$$

where Y_t is a vector of p variables, ε_t is a p-dimensional vector of disturbances, E $(\varepsilon_t \varepsilon'_t) = V$, and ε_t is uncorrelated with all variables dated t-1 and earlier.

If some of the variables in the VAR are nonstationary then it will be difficult to describe their dynamics. Furthermore this may lead to improper statistical inference (estimation and hypothesis testing) as the VAR may not be stable or stationary. In the context of the trade account and changes in the exchange rate, there is no theoretical explanation for a change in the nominal exchange rate to have a permanent effect on real exports and real imports in the long run. Instead nominal exchange rate changes only have nominal effects in the long run. In this context real imports and real exports are mean reverting. Also the results from using an unrestricted VAR to estimate impulse responses over long horizons without taking into account of cointegrating relations may be inconsistent (Phillips 1998). The Augmented Dicky-Fuller (1981) test for integrated variables was employed. Although not reported here, the results show that the variables *NNX , E , EP, IP , IPP , m, PPIMUS , yus* and *y* behave as a random walk with a drift, while *x* behaves as a random walk. One solution is to ensure stationarity by differencing the data. A concern with this approach is that the differenced data potentially ignore valuable information about a system's long-run dynamics if the level of some of the variables have long-run equilibrium relationships, that is if they are cointegrated. One solution adopted by Ericsson, *et.al* (1998) is to incorporate the long-run cointegrating relations with the differenced data in the VAR. Measuring and accounting for both the short-run and long-run properties of the data is a necessary feature in correctly estimating impulse responses. The cointegrating relations for the components of the trade balance are estimated in the next section. Finally the structural shocks are identified through the use of the recursive or Choleski factorization approach.

Long-run relations and Cointegration

The Johansen- Juselius (1990) technique provides a procedure to examine the question of cointegration in a multivariate setting that allows for the testing and estimation of more than one cointegrating vector in the data. The approach makes use of all the information available in the long- and short-run fluctuations of each variable. The approach begins with an unrestricted vector error correction form correction form

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{k-1} \Delta Y_{t-k+1} + \Pi Y_{t-1} + \Psi D_t + \varepsilon_t , \; t = 1,.,T \quad \textbf{(8)}$$

where $\varepsilon_1, \ldots, \varepsilon_T$ are *niid* (0,Σ) and D_t is a vector of nonstochastic variables, such as deterministic variables. The $\boldsymbol{\Pi}$ matrix conveys the long-run information. This approach makes use of all the information available in the long- and short-run fluctuations of each variable. When 0 < rank ($\boldsymbol{\Pi}$) = r < p, $\boldsymbol{\Pi}$ can be written $\boldsymbol{\Pi} = \boldsymbol{\alpha\beta'}$, where $\boldsymbol{\beta}$ may be interpreted as a $p\times r$ matrix of cointegrating vectors and $\boldsymbol{\alpha}$ as a $p\times r$ matrix of 'error correction parameters'. The remaining $(p - r)$ unit root combinations are common stochastic trends.

Results

Cointegrating Relations

The Schwarz Information Criteria was chosen in determining the optimal lag for the Vector Error Correction models. The left panel Table 1 reports the cointegration trace test statistics and the right panel shows the resulting cointegrating parameters for each normalized variable in the trade balance. In all cases the trace tests support one cointegrating vector. All of the estimated parameters have theoretically consistent signs. For the normalized nominal net exports variable (*NNX*), a rise in the nominal exchange rate (*E*) leads to an increase in nominal net exports in the long run, while a rise in U.S. real GDP (*yus*) increases net exports and a rise in Canadian real GDP (*y)* worsens the trade account.

For the export price equation (*EP*), export prices are sensitive to domestic producer price movements (*IPP)* as cost increases are passed through to export prices. A rise in the exchange rate or a currency depreciation results in export prices falling, although by a relatively small amount. The signs on U.S. output and Canadian output can be interpreted as output demand and supply responses of export prices. The volume of exports (*x*) increases following a currency depreciation, while a rise in output in the U.S. stimulates exports; both are theoretically correct responses.

Concerning the import price equation, the degree of exchange rate pass through on import prices is 0.524 , *i.e.* a one percent depreciation of the home (Canadian) currency leads to a 0.524 % increase in import prices. The less than complete ERPT reflects the unwillingness of U.S. exporters to pass through exchange rate movements into Canadian currency prices of their exports over fear of losing market share. Thus U.S. firms lower their markups, where revenue from sales in Canada measured in U.S. currency declines. This value is consistent with the studies of Goldberg and Knetter (2000), and Moffet (1989) which investigate the degree of exchange rate pass through for U.S. imports. Import prices increase as the cost of production of manufacturing in the U.S. increases. The negative sign on *yus* captures an output supply response of import prices. Canadian output was not included as Canada's small economy would have a negligible effect on U.S. import prices. The volume of imports (*m*) fall in response to a currency depreciation. Finally imports rise when Canadian output rises.

In analyzing the response of net exports and its components to shocks to the exchange rate, the long- run influences should be taken into account. Specifically the estimated cointegrating vectors will be used to construct the equilibrium correction terms. These estimated dominant long-run feedback effects will be included in the corresponding VAR from which the impulse response functions will be derived. The constructed error correction terms are

$$ec1_t = NNX_t - 0.568 - 0.097\, E_t - 0.577\, yus_t + 0.680\, y_t$$

$$ec2_t = EP_t - 1.51 + 0.006\, E_t - 2.84\, IPP_t + 0.311\, yus_t + 1.20\, y_t$$

$$ec3_t = x_t - 0.798 - 0.078\, E_t - 2.04\, yus_t$$

$$ec4_t = IP_t - 4.88 - 0.524\, E_t - 0.002\, PPIMUS_t + 0.092\, yus_t$$

$$ec5_t = m_t + 2.93 + 0.295\, E_t - 2.90\, y_t$$

Impulse Response Analysis

The immediate or short-run response of the trade account to an exchange rate change is best captured through impulse response functions. The VARs contain the differenced variables representing the components of the trade balance, along with the error correction terms calculated above. Figures 1-5 present the impulse responses of the differenced variables in each equation in Table 1, along with their corresponding error-correction terms, from a shock to the nominal exchange rate. The letter *d* denotes a difference variable. For example, Figure 1 presents the response of d*NNX* from a VAR composed of the variables ordered d*yus*, d*E*, d*NNX*, d*y*, and *ec1* to a positive, one standard-deviation orthogonal shock to *dE*, along with the 95% confidence intervals (CI). Figures 1-15 show the response of a particular variable to a shock in the exchange rate (*dE*).

Figure 1 shows the response of the trade balance variable, d*NNX,* from a shock to the exchange rate, d*E.* Within the same period of the depreciation (time 0 on the horizontal axis) there is a small positive change in the trade balance, i.e. an improvement in the level of the trade balance. However this improvement is not statistically significant as the confidence band spans zero, although marginally as the lower bound is just below the zero axis. Nevertheless the change is not negative, thus suggesting that there is no J-curve effect during the period of the exchange rate change. For the remaining periods, the responses are statistically insignificant. Overall the results do not show a J-curve response to Canada's trade balance as the trade account remains relatively unresponsive to a currency depreciation.

Figures 2-5 presents the trade account components' responses to shocks to the exchange rate, where the VARs that produce Figures 2-5 relate to equations 2-5, with each cointaining the corresponding error correction term. The results of each are in general consistent with the unresponsive result of the trade account, in particular the result of not showing a J-curve effect. Beginning with the trade volumes, the volume of exports (d*x*) in Figure 3 show a marginal negative change, where this result is statistically insignificant. One period after the shock shows a marginal positive change in the trade account, but again it is statistically insignificant. For the import volumes (d*m*) in Figure 5, there is very little if any change during the period of the exchange rate change. The remaining periods show very marginal changes, and again are all statistically insignificant.

The responses of export prices (d*EP*) and import prices (d*IP*) in Figures 2 and 4 are relatively similar and are thus consistent with the response of the trade account. For both, after the currency depreciation, they initially show a positive change and by approximately the same amount. Furthermore these initial responses are statistically significant. For both prices, price changes stop after approximately 2 periods after the exchange rate shock. For export prices, the positive change suggests that Canadian exporters raise the Canadian price of goods faced by U.S. importers. Hence Canadian firms do not pass on the Canadian dollar depreciation to their U.S. customers. The result is consistent with the careful study conducted by Schembri (1989). Using data from the Census of Manufacturers on a Canadian export industry, when the Canadian dollar depreciated, US dollar prices fell only by 15% of what they should have. This showed that there was price stickiness or incomplete pass through to export prices, implying Canadian exporters are able to keep their prices and hence profit margins relatively stable, reflecting some degree of monopoly power. This effect is also present in this study. Specifically, a one standard-deviation orthogonal shock to *dE* translates to the response function of the change in the log of the exchange rate to 0.01 on the vertical axis (not reported here). As Figure 2 shows, Canadian dollar export prices change positively (incomplete pass through to U.S.importers) and by a less amount, approximately 0.005. These two effects lead to a drop in U.S. dollar prices, but by proportionately less than the rate of depreciation of the Canadian dollar, resulting in incomplete exchange rate pass through.

Figure 4 shows the response of import prices. The response shows a positive change, where this effect is statistically significant. Furthermore there is incomplete pass through to import prices. Figure 4 shows that the change in import prices is approximately 0.006, whereas as noted the exchange rate changes by 0.01. Given that Canadian import prices do not fully adjust to changes in the exchange rate, this suggests that foreign firms are partly absorbing exchange rate changes in their profits. This response of Canadian import prices is another result that is consistent with the import price results in Schembri (1989).

Overall, both export and import volumes are unresponsive to exchange rate changes. This is perhaps due to the quantities having been determined by contracts that were set in previous periods. Another potential explanation is the time taken for Canadian importers to shift to cheaper products, and the time taken for foreign consumers to realize prices have changed. With both import and export prices both rising by approximately the same proportion, along with unresponsive export and import volumes, these responses together are consistent with the unresponsiveness of the trade account in Figure 1. Thus there is not a J-curve effect in Canada following a currency depreciation.

Robustness check: Pre-NAFTA and NAFTA periods

We investigate whether the results from above are significantly affected with the implementation on January 1994 of the North American Free Trade Agreement . As is well documented this policy resulted in a rationalization and reallocation of production activity in North American, leading to greater intra-industry trade across the Canada-U.S-Mexico border (Head and Ries (1999), Statistics Canada (2002), Dion (2000), Cameron and Cross (2001), Dion et al (2005). Increased intra-industry trade would imply trade flows being determined more by intra-industry or upstream-downstream production factors and timing and less on the exchange rate.

Cointegrating relations are estimated for equations 1-5 but over the two sample periods 1981:1-1993:12 (pre-NAFTA) and 1994:1-2005:12 (NAFTA). The results are presented in Table 2. For the pre-NAFTA estimates most of the estimated coefficients are similar to the full period sample, including the parameters on the exchange rate. However for the NAFTA period the signs on the exchange rate for the trade balance equation (1) and volume of exports (3) have changed. As is done with the full sample analysis, error correction terms are constructed with these parameters and are included in the corresponding VARs. Figures 6-10 present the impulse response functions over the pre-NAFTA period 1981:1-1993:12, and Figures 10-15 show the impulse response functions over the NAFTA period 1994:1-2005:12.

Figure 6 shows an improvement in the trade account in the period of the currency depreciation. This effect however is statistically insignificant, but only marginally so as the lower bound of the confidence interval is just below the zero axis. In the remaining periods the changes are also insignificant. Overall, as in the full sample case, in the pre-NAFTA period there is no J-curve effect.

The response in the components of the trade account are consistent with no J-curve effect. Both impulse responses for export volume changes and import volume changes (Figures 8 and 10) show a slightly greater response than over the whole sample. However again the responses are insignificant, but only marginally so for export volumes. The positive responses of both export and import prices in Figures 7 and 9 are similar to the full sample cases, both again showing incomplete exchange rate pass through and both being statistically significant. Overall with relatively unresponsive trade quantities, along with export and import prices rising in similar proportions, these effects confirm a relatively unresponsive trade account, implying no J-curve effect over the pre-NAFTA period.

Over the NAFTA period, the trade account responds slightly less than in the pre-NAFTA period. Export and import volumes responses are small and more dampened relative to the pre-NAFTA case, where again the responses are statistically insignificant. The response of export and import prices are similar as in the pre-NAFTA case, both being positive and both statistically significant. Again incomplete exchange rate pass through is present in both prices.

Overall while there is some dampening effects on the trade account over the NAFTA period, for the most part the responses are similar on this variable and the components of the trade account over the pre-NAFTA and NAFTA periods. More importantly, concerning the main focus of this paper, the result of no J-curve effect for Canada is robust when taking into account NAFTA.

Robustness checks on levels of variables

To explore the sensitivity of the impulse responses that were conducted using differenced variables, we conducted the impulse responses derived from the VECMs of equations 1-6. Hamilton (1994, pp. 652-653) proposes such a sensitivity test. Specifically we investigate whether the first period impulse response of the nonstationary variable is similar to the response of the differenced variable. For all the variables, the initial (first period) responses were all consistent with the difference variable responses in Figures 1-15 (full and sub samples) of the paper. Most notably, for the initial response of NNX, it was positive, not negative, showing there is not a J-curve effect after a currency depreciation. Thus the impulse response results in Figures 1-15 are robust with respect to the corresponding VECM impulse responses. The results are available upon request.

Concluding Remarks

Using impulse response analysis that incorporates cointegating relations, along with a unique data set of export and import volumes, evidence shows that the J-curve effect does not exist for Canada. Specifically, concerning the trade account, the impulse response showed a positive change in the period of the currency depreciation, not a negative response. The response of the trade account was statistically insignificant. The responses of the components of the trade account where consistent with the trade account effect, where export and import volumes were essentially not affected, and export and import prices showed a significant positive change, both showing incomplete pass through. The pricing responses showed the effect of pricing to market, reflecting a degree of monopoly power of Canadian exporters and firms importing into Canada. Robustness checks showed that while the response of the trade account and trade quantities where marginally dampened over the NAFTA period relative to pre-NAFTA, the result of no J-curve effect in Canada held in both periods.

From a policy perspective, identifying that the trade account is relatively unresponsive to exogenous changes in the exchange rate, this is relevant information in the measurement of the effect of the exchange rate channel on aggregate demand and consequently inflation, i.e. the exchange rate channel. After a currency depreciation, brought on say by monetary policy through an increase in the rate of growth of money, there will be only a marginal effect on aggregate demand through the trade account. There would thus be a weak influence on inflation, given that aggregate demand relative to aggregate supply has not changed significantly.

Further relating to the inflation rate, the results show import prices experiencing incomplete exchange rate pass through, implying a diminished inflationary effect of a currency depreciation as import prices will not rise proportionately.

In light of these results, in conducting monetary policy, to reduce output and consequently inflation, given the relative unresponsiveness of the exchange rate on the trade account, a greater change in the interest rate is necessary to achieve a given change in output.

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Table 1. Johansen Trace Tests and Estimation Results, 1981:1-2005:12

Equation and Normalized Variable:	(trend in data levels and constant in cointegrating relations)								
	(i) Trace Test			(ii) Cointegrating Parameters					
	Rank	statistic	95% critical value	constant	E	IPP	PPIMUS	yus	y
(1) NNX	≤ 0	54.15*	47.21	0.568	0.097	-	-	0.577	-0.680
(lags=2)	≤ 1	18.13	29.68						
(2) EP	≤ 0	89.92*	68.52	1.51	-0.006	2.84	-	0.331	-1.20
(lags=1)	≤ 1	43.70	47.21						
(3) x	≤ 0	166.60*	29.68	0.798	0.078	-	-	2.04	-
(lags=2)	≤ 1	3.91	15.41						
(4) IP	≤ 0	48.02*	47.21	4.88	0.524	-	0.002	-0.092	-
(lags=3)	≤ 1	12.24	29.68						
(5) m	≤ 0	38.74*	29.68	-2.93	-0.295	-	-	-	2.90
(lags=2)	≤ 1	6.04	15.41						

Table 2. Johansen Trace Tests and Estimation Results, pre NAFTA and NAFTA periods

Equation and Normalized Variable:	(trend in data levels and constant in cointegrating relations)								
	(i) Trace Test			(ii) Cointegrating Parameters					
	Rank	statistic	95% critical value	constant	E	IPP	PPIMUS	yus	y
Pre-NAFTA, 1981:1-1993:12									
(1) NNX	≤ 0	58.82*	47.21	2.21	0.258	-	-	0.161	-0.675
	≤ 1	15.30	29.68						
(2) EP	≤ 0	89.84*	68.52	1.55	-0.015	2.26	-	-2.05	0.389
	≤ 1	41.64	47.21						
(3) x	≤ 0	63.72*	59.68	-0.865	0.269	-	-	2.43	-
	≤ 1	4.88	4.27						
(4) IP	≤ 0	62.14*	47.21	5.36	0.552	-	-0.058	-0.145	-
	≤ 1	27.39	29.68						
(5) m	≤ 0	29.81*	29.68	-2.54	-1.15	-	-	-	2.85
	≤ 1	5.66	15.41						
NAFTA, 1994:1-2005:12									
(1) NNX	≤ 0	60.10*	47.21	3.15	-0.486	-	-	0.227	-0.418
	≤ 1	27.84	29.68						
(2) EP	≤ 0	91.71*	68.52	4.34	-0.111	-0.064	-	0.235	-0.064
	≤ 1	46.00	47.21						
(3) x	≤ 0	69.86*	29.68	3.38	-0.266	-	-	1.50	-
	≤ 1	12.90	15.41						
(4) IP	≤ 0	59.23*	47.21	5.42	0.151	-	-0.169	-0.005	-
	≤ 1	19.89	29.68						
(5) m	≤ 0	73.26*	29.68	1.20	-0.123	-	-	-	1.97
	≤ 1	8.54	15.41						

* Rejected at the 5% level of significance

Figure 1. Response of dNNX from impulse of dE from VAR (dyus, dE, dNNX, dy, ec1), 1981:1-2005:1

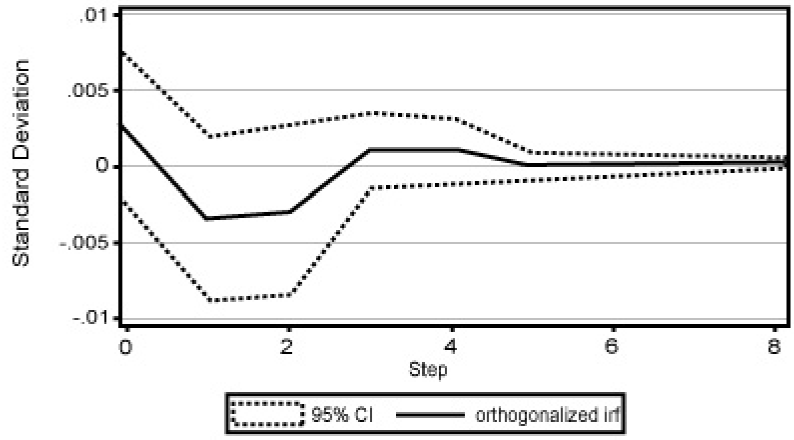

Figure 2. Response of dEP from impulse of dE from VAR (dyus, dE, dIPP, dEP, dy, ec2), 1981:1-2005:12

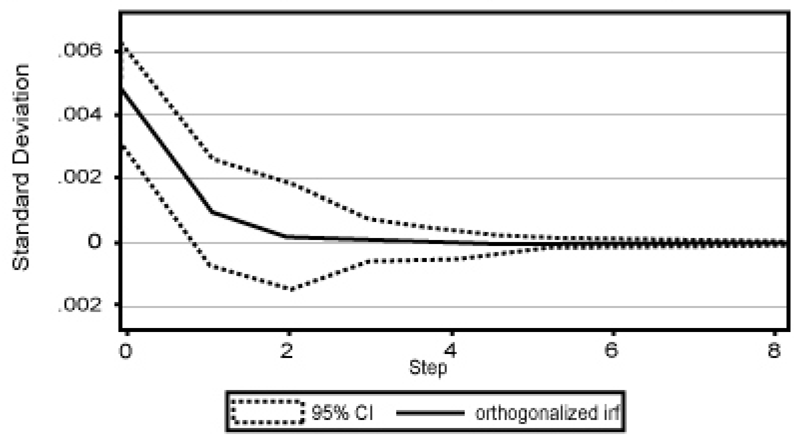

Figure 3. Response of dx from impulse of dE from VAR (dyus, dE, dx, ec3), 1981:1-2005:12

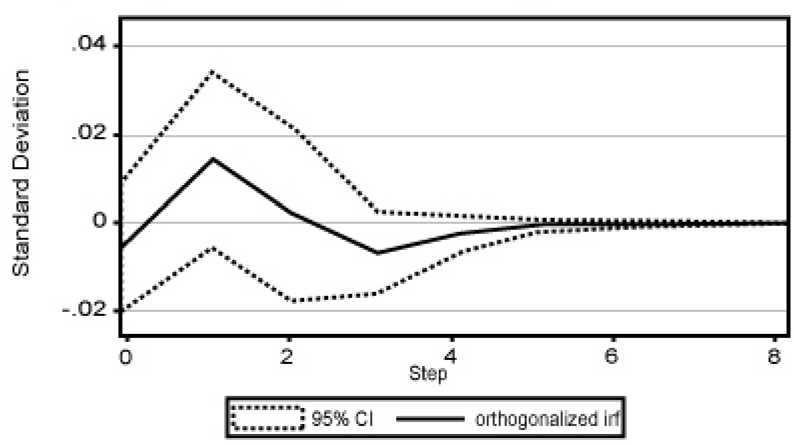

Figure 4. Response of dIP from impulse of dE from VAR (dyus, dPPIMUS, dE, dIP, ec4), 1981:1-2005:12

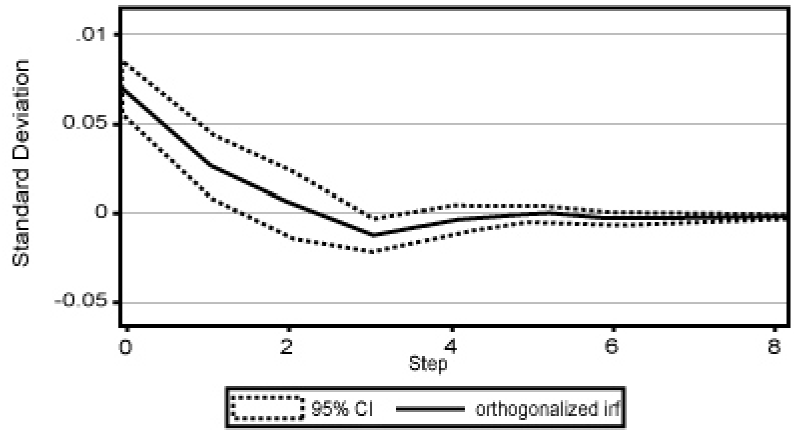

Figure 5. Response of dm from impulse of dE from VAR (dy, dE, dm, ec5), 1981:1-2005:12

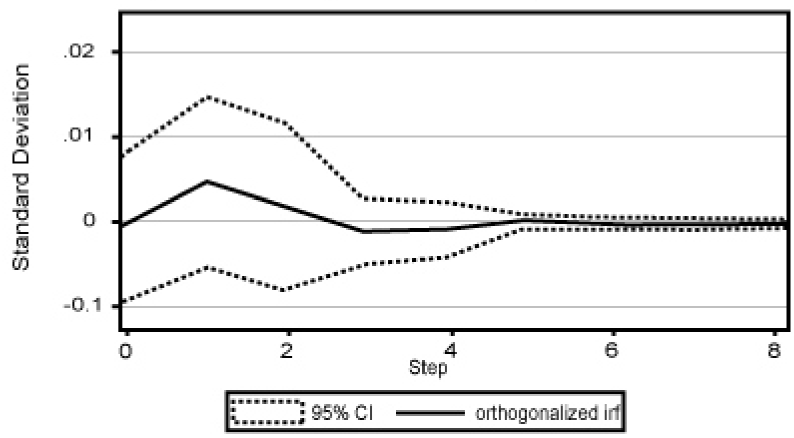

Figure 6. Response of dNNX from impulse of dE from VAR (dyus, dE, dNNX, dy, ec1pre), 1981:1-1193:12

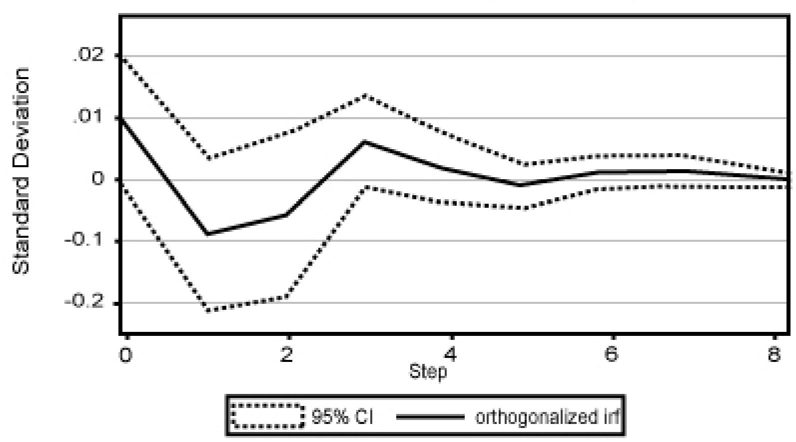

Figure 7. Response of dEP from impulse of dE from VAR (dyus, dE, dIPP, dEP, dy, ec2pre), 1981:1-1993:12

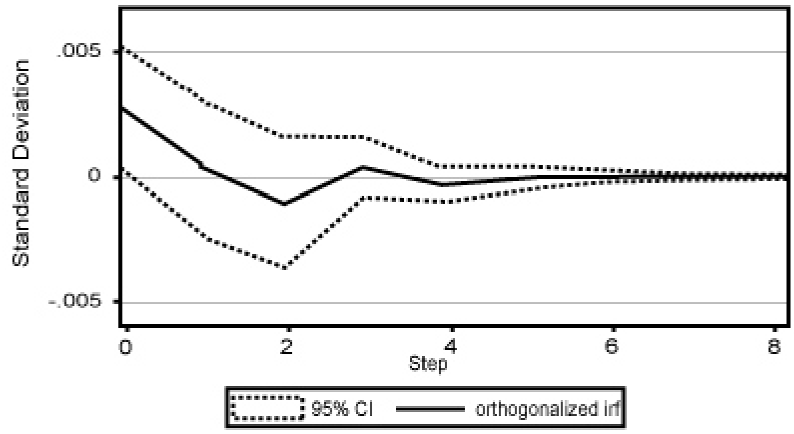

Figure 8. Response of dx from impulse of dE from VAR (dyus, dE dx, ec3pre), 1981:1-1993:12

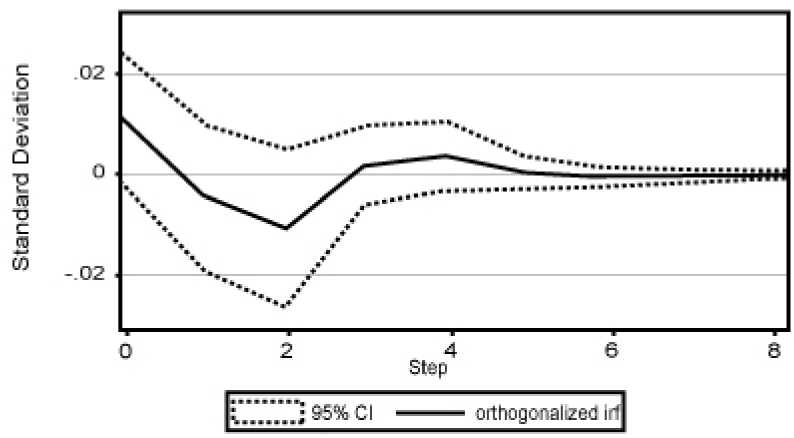

Figure 9. Response of dIP from impulse of dE from VAR (dyus, dPPIMUS, dE, dIP, ec4pre), 1981:1-1993:12

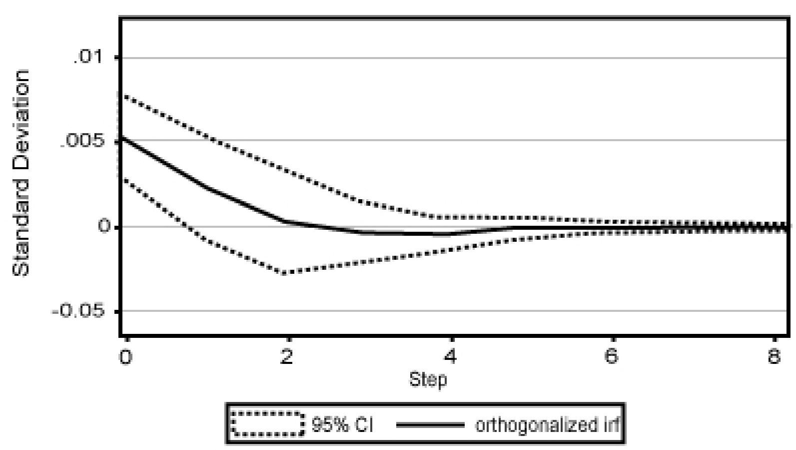

Figure 10. Response of dm from impulse of dE from VAR (dy, dE, dm, ec5pre), 1981:1-1993:12

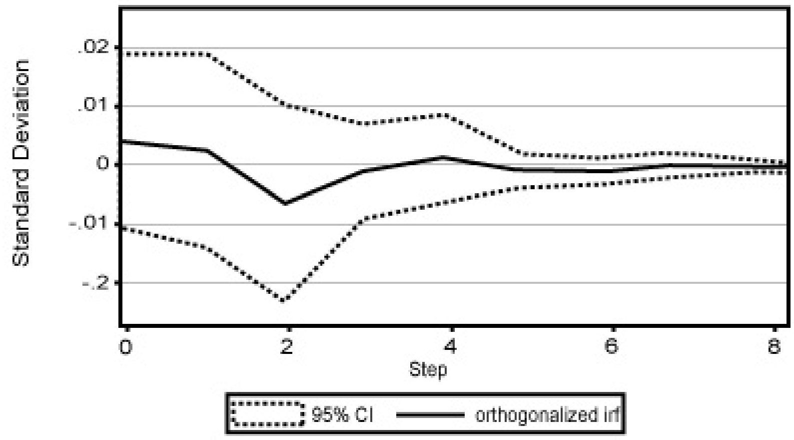

Figure 11. Response of dNNX from impulse of dE from VAR (dyus, dE, dNNx, dy, ec1nafta), 1994:1-2005:12

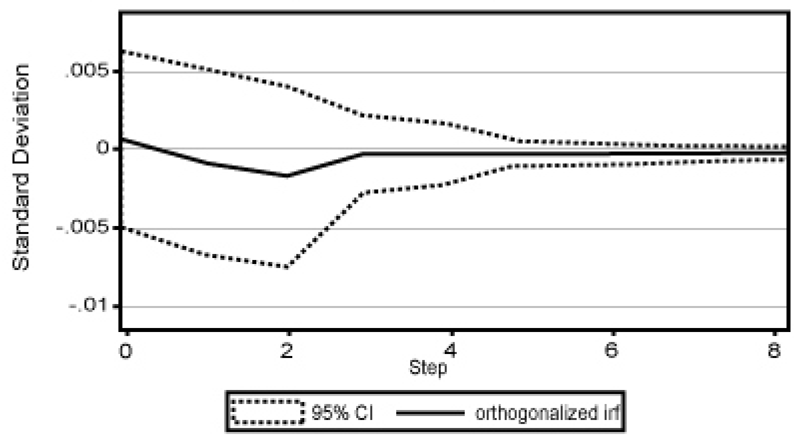

Figure 12. Response of dEP from impulse of dE from VAR (dyus, dE, dIPP, dEP, dy, ec2nafta), 1994:1-2005:12

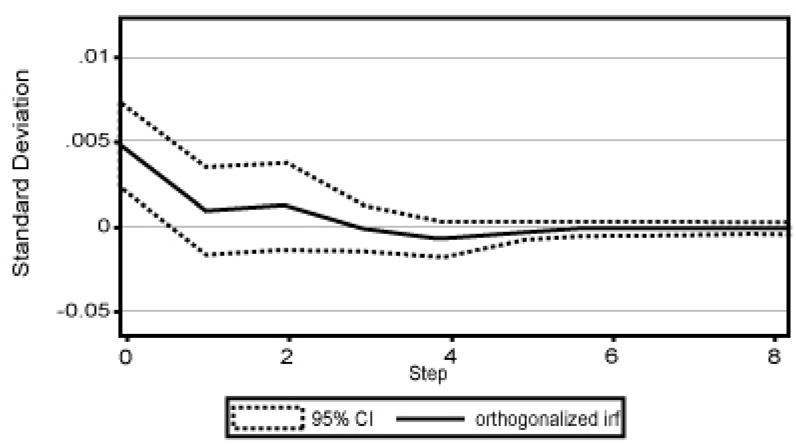

Figure 13. Response of dx from impulse of dE from VAR (dyus, dE, dx, ec3nafta), 1994:1-2005:12

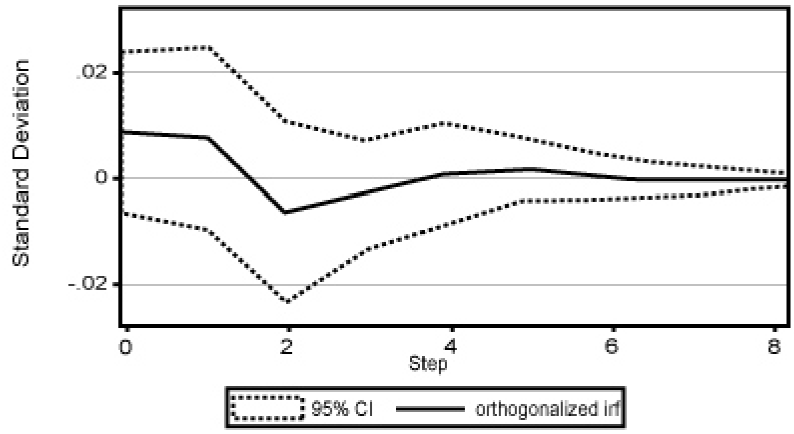

Figure 14. Response of dIP from impulse of dE from VAR (dyus, dPPIMUS, dE, dIP, ec4nafta), 1994:1-2005:12

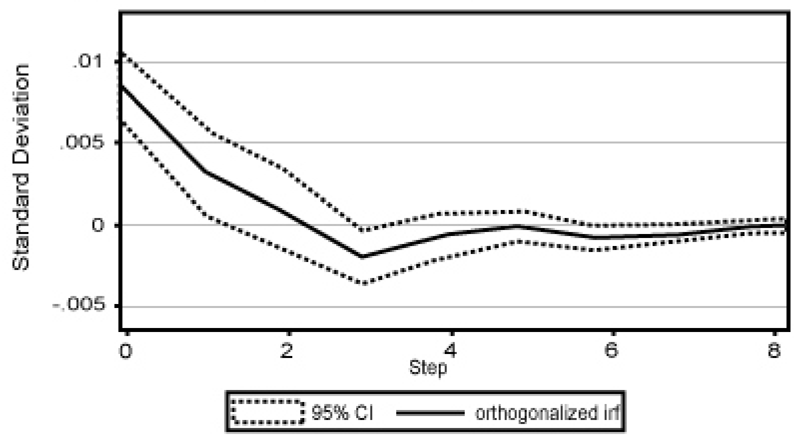

Figure 15. Response of dm from impulse of dE from VAR (dy, dE, dm, ec5), 1993:1-2005:12