# The Effects of a Fluctuating Exchange Rate on the Canadian Automotive Industry: 1981-2006

*Carson Sherwood*


## Abstract

This paper examines the effects that historical movements in the Canadian American exchange rate had on different sectors of the Canadian automotive industry. Accepted econometric techniques were employed and altered to accommodate the particular requirements of the specific research endeavor. This paper provides evidence apropos of how exchange rate movements affect the Canadian automotive industry; the research also proposes a framework suitable for addressing questions regarding manufacturing industries and their sensitivity to exchange rate movements.



## Acknowledgements

I would like to thank Professor Bhatia, Professor Bowlus and Professor van Hasselt for the advice and assistance they provided me in completing this paper. I also appreciate the time and patience that Vince Gray extended towards me in gathering data and Philippe Belley's assistance with STATA.


## 1. Introduction

The Canadian automotive industry has long been a vital sector of the Canadian economy and remains so due to its size, backward and forward linkages as well as its substantial contribution to international trade. The recent appreciation of the Canadian – U.S. exchange rate has prompted an outcry from the Canadian automotive industry concerning its stability and profitability. According to Jim Stanford (Reuters 2008), a researcher for the Canadian Auto Workers, Canada is acutely influenced by the value of the U.S. dollar relative to the Canadian dollar, and he argues that the recent appreciation of the Canadian dollar has devastated the automotive industry. Nick Orlando (Globe and Mail 2007), an executive of Martinrea International, provides a similar interpretation, citing that overall demand for Canadian auto parts will decrease because it will no longer be as profitable for American manufacturers to import Canadian automotive goods.

This paper expands on the debate concerning the sustainability of the Canadian automotive industry given the recent exchange rate appreciation through an investigation of the industry's historical reactions to exchange rate fluctuations. The analysis examines how three different sub-sectors of the auto industry - passenger automobiles, trucks and tractors, and motor vehicle parts - reacted to movements in the exchange rate.

In the case of an exchange rate appreciation,[1] production costs were expected to decrease because imported intermediary goods from the U.S. would become relatively cheaper.[2] This result would support claims that Canadian firms benefit from exchange rate appreciations in at least one area**.** The first set of regressions tested this claim.

The research moves forward to determine whether and how firms' export price fluctuated in relation to movements in the exchange rate. During exchange rate appreciations, it was predicted that Canadian firms would lower their export price to partially offset the relative increase in price for American purchasers. The potential lowering of export prices would theoretically limit revenue losses experienced by Canadian firms.

The response of demand for automotive goods in relation to changes in the exchange rate is examined in the final step of the analysis. The outcomes from the analysis of export price are used to facilitate interpretation of these results. Inference concerning the overall profitability of each sub-sector is then conducted using the results from production costs, export price, and overall export revenue.

The remainder of the paper is structured as follows. Section 2 discusses previous studies relevant to the topic. These studies provide theoretical underpinnings for the current study. Section 3 outlines the econometric model employed. Section 4 describes the data. Section 5 discusses the results and provides economic interpretations of the outcomes. Section 6 serves as a conclusion.

## 2. Relevant Theory and Past Studies

There are several areas of research that must be considered when analyzing cost and price elasticities of the Canadian automotive industry. Specifically, relevant discussions of pricing to market (PTM), just-in-time (JIT) inventory systems, Canadian – U.S. trade agreements and hedging are given.

Pricing to market is an economic effect that has been heavily studied in the past. This phenomenon is defined as the link between the exchange rate and export prices expressed in terms of one's home currency (Mahdavi 2002). The formal definition of pricing to market addresses export prices; a similar effect may occur in relation to a firm's production costs. Given that a firm requires intermediary goods to produce their final product, cost savings may be realized during exchange rate appreciations.

The extent of production savings and pricing to market depend on a variety of factors. The degree of competition in which an industry is operating has a significant effect on the extent to which a firm will participate in PTM (Mahdavi 2002). Typically, a higher degree of competition leads to more PTM. Feinberg (1996), Kardasz and Stollery (2001), and Banik and Biswas (2005) present evidence suggesting that the degree to which

[1]An exchange rate appreciation refers to an increase in the Canadian dollar relative to the American dollar. This holds throughout the paper.

[2]Economic theory suggests that an opposite effect would occur during exchange rate depreciations. This idea holds throughout the paper.

fluctuations in the exchange rate affect costs depends on the elasticity of substitution between inputs. Similarly, the extent to which fluctuations in the exchange rate will manifest in export prices depends on the elasticity of substitution of exported goods. More specifically, Banik and Biswas (2005) provide evidence suggesting that Canadian auto firms' prices, in American dollars, increase by 77% of the change in the exchange rate for small automobiles during an exchange rate appreciation. They found an insignificant pass through when examining medium-sized Canadian automobiles.

Sustained exchange rate appreciations or deprecations may also alter the exchange rate's effects on costs and prices. Feinberg and Kaplan (1992) present evidence concerning this occurrence, noting that sustained fluctuations tend to dampen the effects movements in the exchange rate have on price.

A JIT inventory system has the potential to significantly affect the Canadian automotive industry. A JIT inventory system is characterized by low inventory and warehousing expenditures because materials are ordered based on historical demand. The materials, therefore, are received and used in the manufacturing process shortly thereafter, thus minimizing inventory costs. A decrease in a firm's production costs during an exchange rate appreciation suggests the presence of a JIT inventory system. Assuming such an occurrence, Canadian firms would then save on American-made intermediary goods as well as have incentive to substitute Canadian-made intermediary goods for relatively cheaper American-made intermediary goods during an exchange rate appreciation.

A study conducted by Brox and Fader (1996) finds that Canadian auto parts manufacturers in Southwestern Ontario have experienced significant cost savings via the introduction of JIT proponents. This positive view of JIT is reinforced by Yasin, Small and Wafa (2000) who provide evidence that American manufacturers achieve an increased ability to compete with foreign manufacturers through the adoption of a JIT inventory system.

Another important factor that affects the cost and price elasticity of Canadian automotive goods is the presence of free trade agreements with the United States. In 1965, Canada and the U.S. drafted the Auto Pact, a trade liberalization agreement. This agreement created a duty free market for the major U.S. multinational automobile producers. Despite an agreement for free trade, evidence is presented by Fuss and Waverman (1986) suggesting that the Auto Pact did not enhance Canadian manufacturing productivity. Rather**,** these researchers propose that the Auto Pact delayed major increases in productivity by reducing the ability of international firms to compete in the North American market.

The North American Free Trade Agreement (NAFTA) has been the subject of significant analysis. Holmes and Kumar (1998) attribute the increased degree of specialization among the regions within North America, in regard to the types of vehicles and parts produced, to NAFTA. This led to lower costs of production and an increased ability to compete with international firms. In sum, auto assemblers and part producers have been able to organize more efficiently due to the integration created by NAFTA (Sands and

Weintraub 1998). A free trade agreement would likely lower the costs of production and lead to a larger quantity of exported automotive products.

Hedging is a phenomenon that may play a role in the health of the Canadian automotive industry. Hedging instruments have the ability to offset some of the negative effects that movements in the exchange rate have when engaging in international trade. Eithier (1973) establishes a theoretical result known as the separation theorem. This theorem states that if hedging instruments for exchange rates are costless and readily available, then a firm's production costs and export revenues would not be affected by movements in exchange rates.

Separation theorem is obviously not a reality; however, hedging instruments may still have a significant effect on an exporting firm's cost structure. If an automotive firm were to use hedging products, it is likely that these instruments would partially negate an increase in the cost of intermediary goods in the case of exchange rate depreciations. Furthermore, the instruments may also offset a loss of exporting profits that may occur when the exchange rate appreciates and automotive products become more expensive for American retailers. The significance of hedging instruments on an automotives firm's cost structure or revenues would depend on how firms utilized these products; potentially, both costs and export revenues could be affected if hedging instruments were used in both the production and sale of automotive products.

Empirical studies carried forth by academics do not concur on the effects that hedging has on firms which are engaged in international trade. Cote (1994) presents evidence suggesting that forward covers reduce the effect of exchange rate volatility. Wei (1999) presents contradictory evidence, demonstrating that exchange rate hedges do not reduce volatility in international trade.

## 3. Econometric Model and Estimation Techniques

Three separate steps, using similar estimation techniques, were employed for this research's estimation procedure. The econometric model that was adopted is similar to the model that Kardasz and Stollery (2001) use to estimate exchange rate pass through in Canadian manufacturer prices. The regression model is given by:

$$\Delta LogCANPPI_t = \alpha + \beta_1 \Delta LogER_t + \beta_2 \Delta LogUSAPPI_t + \beta_3 FTA + \beta_4 t + \varepsilon_t \qquad \text{(E.1)}$$

This regression was specified to analyze the effects that movements in the exchange rate have on the production costs of the Canadian automotive industry. The Canadian producer price index, $\Delta LogCANPPI_t$, appears on the left hand side in order to capture the production cost of different automotive sub-sectors. The exchange rate, $\Delta LogER_t$, was the first independent variable included. Its purpose was to quantify the effects that movements in the exchange rate had on the cost of production.

The U.S. automotive producer price index, $\Delta LogUSAPPI_t$,[3] was incorporated to act as the main control variable, capturing the demand and supply shocks in the Canadian economy. Given the close integration of the Canadian and U.S. economies, it is not unreasonable to assume that the U.S. price index will adequately represent these effects (Kardasz and Stollery 2001).

A free trade dummy variable, $FTA$, was added to capture the effects that a free trade agreement may have on the industries' costs and revenues, as noted by previous studies.[4] This dummy identifies 1989 as the year that free trade between Canada and the U.S. began. This date coincides with both countries' governments signing the Canadian United States Free Trade Agreement (CUFTA). CUFTA was chosen over NAFTA[5] because it contains many of the regulations NAFTA imposed on Canada and the U.S.; NAFTA built upon CUFTA by integrating Mexico into the agreement. The inclusion of this variable provides evidence concerning the effectiveness of the Auto Pact in comparison to more modern free trade agreements, such as CUFTA and NAFTA.

A time trend, $t$, was included as a final control variable in order to account for phenomena that have effects on the producer price index, but would not be picked up by the U.S. producer price index**.** An example of such an effect would be productivity; the productivity in the auto industry is not consistent between the U.S. and Canada. Visual analysis of the price indices used indicated that a linear time function is the most appropriate specification to capture time-related effects.[6]

A constant, $\alpha$, was included as this is standard practice. A logarithmic specification of E.1 was taken to allow for the analysis of price elasticities, which is a more informative measure than the absolute changes in the producer price index in response to changes in the exchange rate. First differences were taken for the Canadian producer price index, the exchange rate, and the U.S. producer price index. This was done in order to limit the correlation between these variables, thus, providing more accurate results.[7] Lastly, $\varepsilon_t$ denoted white noise.

[3]Despite the fact that this variable was often found to be insignificant, it was included the final econometric specifications for intuitive reasons. A potential reason for its insignificance is the unavailability of American data that more accurately matched the sub-sectors specified in the Canadian data files that were used.

[4]A one period differenced free trade dummy variable to identify a one time level effect was tested; however, it proved insignificant in all regressions and was not included in the final econometric specifications.

[5]A NAFTA free trade dummy was tried in conjunction with the CUFTA free trade dummy. This did not improve results as there were no cases in which both variables were significant or a case where the NAFTA dummy was significant and the CUFTA variable was not.

[6]Different dummies that attempted to capture events such as a depression were tested. These dummies proved to be insignificant and were excluded from the final econometric specifications.

[7]Augmented Dicky Fuller tests were performed on the natural logarithms of the Canadian producer price indices, the exchange rate, and the U.S. producer price index. I was unable to reject the presence of a unit root in all cases. First differencing these variables is consistent with previous literature.

The second regression was specified to identify how the Canadian export price reacted to movements in the exchange rate. The model is given by:

$$\Delta LogCANEPI_t = \alpha + \beta_1 \Delta LogER_t + \beta_2 \Delta LogUSAPPI_t + \beta_3 FTA + \beta_4 t + \varepsilon_t \quad \text{(E.2)}$$

Noticeably, the only difference is the dependent variable, which is now the Canadian export price index, $\Delta LogCANEPI_t$.[8] The logarithmic specification holds and the variables that were first differenced in E.1 remain constant.

The final regression is given by:

$$\Delta LogExportValue_t = \alpha + \beta_1 \Delta LogER_t + \beta_2 \Delta LogUSAPPI_t + \beta_3 LogUSGDP_t + \beta_4 USUnemp_t + \beta_5 FTA + \beta_6 t + \varepsilon_t \quad \text{(E.3)}$$

This regression intended to identify how the Canadian auto industry's overall revenue reacted to changes in the exchange rate by including the export value, $\Delta LogExportValue$,[9] in Canadian dollars, of automotive goods. Presumably, in periods of strong economic growth, individuals would be more willing to purchase automobiles. For this reason, U.S. GDP per capita,[10] $LogUSGDP_t$, and the U.S. unemployment rate, $USUnemp_t$, were included to account for market demand conditions in the U.S. Export values and the U.S. GDP per capita were also expressed logarithmically. Despite the fact that export value is comprised of both the export price and total quantity exported, insight may be gained into the quantity of goods demanded via an analysis of the previous regression results and standard economic theory of supply and demand. Exact disentanglement of price movement effects from changes in quantity was not possible.

## 4. Data

The data obtained in order to measure the effects that a moving exchange rate has on production costs, export price and export revenue of Canadian automobiles was obtained from a variety of sources.

The Canadian industrial price indices were acquired from the CANSIM database. The commodity categories for this index are based on Principal Commodity Group Aggregates (PCGA). This was the only industry price index available that covered the time span required for the research. The categories utilized included passenger automobiles, excluding passenger vans,[11] trucks and tractors, and motor vehicle parts.

[8]Augmented Dicky Fuller tests were performed on the natural logarithms of the Canadian export price indices. I was unable to reject the presence of a unit root in all cases and thus, first differenced these variables.

[9]Augmented Dicky Fuller tests were performed on the natural logarithms of the export value variables. I was able to reject the presence of a unit root in all cases. Despite this, these variables were first differenced as it seemed intuitively correct to do so.

[10]U.S. GDP and a three year average of U.S GDP were also tested. Neither variation improved results.

[11]Passenger vans were excluded in the unaltered data file. Visual analysis of the data determined vans were excluded from the passenger road vehicles category after 1991. Presumably, vans were incorporated in this category previous to this date. Visual analysis of the price index of vans suggested there was not a significant difference from the price index of passenger automobiles.

This index was used because it measures price changes in commodities sold in Canada at the factory gate; this is the best measure available for the cost of production. The data were reported monthly from 1981 to 2006 and converted to annual values in three different ways: a yearly average, the average of the first quarter and December's value were implemented. These conversion measures are displayed in Figure 1, 2, and 3 respectively. These three measures provided insight into how sensitive the data were to different methods of annualization.[12] In all three instances 1997 was selected as the base year. Given that the yearly average falls between the average of the first quarter and December's value, the regression tables are reported with the yearly average appearing as the dependent variable.

*Figure 1:*

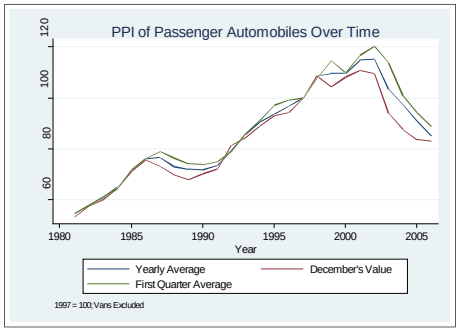



*Figure 2:*

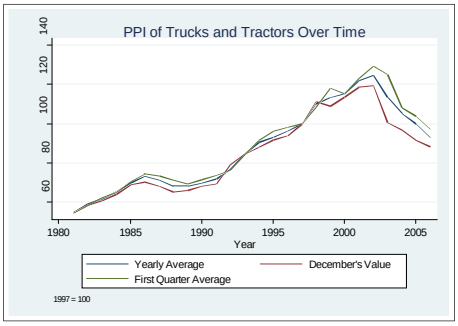
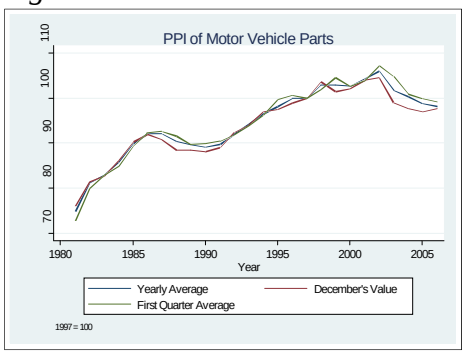


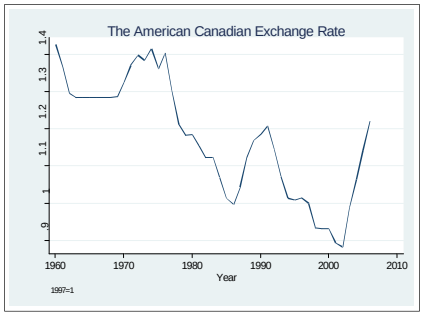

*Figure 3:*




The Canadian – American exchange rate data were acquired from the International Monetary Fund's (IMF) online database. The market rate period average was used in the analysis. The data were reported annually and adjusted so that 1997 was the base year. Figure 4 demonstrates that the exchange rate has a significant number of periods where it appreciates or depreciates. The exchange rate is defined throughout my econometric analysis as the number of American dollars per one Canadian dollar.

[12]Regressions were initially run from the years 1981-2003 due to data concerns. These results did not vary significantly from the results presented in this report.

*Figure 4*:




The U.S. industry price index for the automobile sector was obtained from the Bureau of Labour Statistics (BLS). The data were adjusted so that 1997 was the base year.

Export price data were obtained from the CANSIM database. 1997 was chosen as the base year. The categories are based on standard international trade classification (SITC) revision three codes. The categories that were used for analysis were passenger automobiles, trucks and tractors, and motor vehicle parts. Two different weighting systems were available, the Paasche current weighted and the Laspeyres fixed weighted. The Paasche system reflects changes in both weight and price, while the Laspeyres system is derived from base year shipments, thereby reflecting changes in price alone. The Laspeyres reported data were used to avoid inclusion of a bias from quantity.

Data concerning the value of Canadian automotive exports to America was acquired from the CANSIM database. The value of Canadian exports to America, in 1000s of Canadian dollars, was available on a monthly basis. The data was aggregated into a yearly value by taking the sum through twelve months. It was then adjusted so that 1997 was the base year. Once again, SITC revision three codes were reported.

The values of U.S. GDP, the U.S. GDP deflator, and the U.S. population were acquired from the IMF database. The data were reported annually. The U.S. GDP deflator was adjusted to designate 1997 as the base year. A measure of U.S. per capita GDP was constructed and was then adjusted to account for inflation. This resulted in a measure of GDP that accurately accounted for U.S. demand effects.

U.S. unemployment figures were extracted from the BLS database. The data were reported annually and no adjustments were made to this variable.

The regressions specified in E.1 and E.2 were run using the years 1981 – 2006 and the model specified in E.3 was run from 1981 - 2003. Data availability was the reason the timeframe was limited to these ranges of years.

## 5. Results and Theoretical Discussion

In order to measure the effects of a fluctuating exchange rate on the costs of the Canadian auto industry, the models described in E.1, E.2, and E.3 were estimated for the

passenger automobile sector, the truck and tractor sector, and the automotive parts sector. These individual regressions generated superior insight into how different areas of the industry responded to a fluctuating exchange rate. The results of the three regression models, E.1, E.2, and E.3 are reported in Table 1, Table 2, and Table 3 in the proceeding three subsections and the results of the three aforementioned automotive sub-sectors appear in columns 1, 2, and 3, respectively.

### *5.1 Industry Price Index Analysis*

Estimation of E.1 in the passenger automobile sector produced results suggesting initial period fluctuations in the exchange rate were significant. The results generated suggest that Canadian passenger automobile production costs decrease as the exchange rate appreciates. This result supports the presence of a JIT inventory system in the Canadian passenger automobile industry.[13] Specifically, my results suggest that the cost of production would decrease by 91.7% of a given increase in the exchange rate. This indicates that the Canadian passenger automobile industry has a substantial cost savings mechanism when the exchange rate appreciates.

*Table 1: Regressions of Industry Price Index*

| Variable | $\Delta LogCANPPI$ Passenger Automobiles | $\Delta LogCANPPI$ Trucks and Tractors | $\Delta LogCANPPI$ Automotive Parts |
|---|---|---|---|
| $\Delta LogER_t$ | -0.917*** | -0.912*** | -0.379*** |
| | (0.057) | (0.052) | (0.061) |
| $\Delta USAPPI_t$ | -0.017 | -0.029 | 0.303 |
| | (0.211) | (0.195) | (0.228) |
| $FTA$ | -0.003 | 0.0240** | -0.025** |
| | (0.010) | (0.010) | (0.011) |
| $t$ | -0.002** | -0.002** | 0.001 |
| | (0.001) | (0.001) | (0.001) |
| $\alpha$ | 0.0483*** | 0.0405*** | 0.0129 |
| | (0.011) | (0.010) | (0.012) |
| $R^2$ | 0.958 | 0.963 | 0.765 |
| N | 25 | 25 | 25 |

Notes: *** Indicates significance at the 1% level; ** indicates significance at the 5% level; * indicates significance at the 10% level.

[13]The lagged first differenced exchange rate was initially included in all regressions run for this paper. This variable was never significant and therefore not reported. The insignificance of the lagged exchange rate strengthens my argument of a JIT inventory system because it indicates that the industry reacts only in the initial period to movements in the exchange rate. This characteristic is consistent with a JIT inventory system.

The results from the truck and tractor sector are similar to that of the passenger automobiles sector. Again, the producer price index was found to have an inverse relationship with movements in the exchange rate and the result suggested the presence of a JIT inventory system. The magnitude of this coefficient is similar to that found in the passenger automobile sector; an exchange rate appreciation will result in a decrease in the cost of production of trucks and tractors by 91.2% of the movement in the exchange rate.

The regression of the industry price index of motor vehicle parts manufacturers on the dependent variables suggests that a cost savings effect is present during exchange rate appreciations. My results indicate that parts manufacturers experience a decrease in their costs of production by approximately 37.9% of an appreciation in the exchange rate. This result advocates the presence of a JIT inventory system in the auto vehicle parts sector. This coincides with the research of Brox and Fader (1996) that found that a JIT inventory system had significant cost reducing effects on automobile parts manufacturers in Southwestern Ontario.

The results generated for each sub-sector imply that the industry has the potential to pass on cost savings to U.S. purchasers. This would lessen the impact an appreciation in the exchange rate would have on overall export revenues and profits as exchange rate appreciations would still effectively raise prices for American retailers.

One caveat to note is that the previously mentioned results may be subject to a degree of omitted variable bias. The use of hedging instruments by firms in this industry could have a potential effect on the Canadian producer price index. Hedging instruments could negate the increase in price during exchange rate depreciations.

The use of long-term contracts may also generate bias. Contracts of this nature would effectively lock in prices, thus negating some effects that the exchange rate may have had on the costs of production. These contracts may also include provisions for certain changes if the exchange rate was to fluctuate, thus further reducing any effects the exchange rate may have had on the Canadian producer price index. Both long term contracts and hedging instruments were not modeled econometrically due to lack of data availability.

### *5.2. Export Price Index Analysis*

The analysis of the elasticity of the export price index of passenger automobiles relative to the independent variables produced significant results. The results generated evidence suggesting that during exchange rate appreciations, Canadian passenger vehicle manufacturers lowered their export price to American retailers. Namely, my results indicate that firms in this industry lower their export price by approximately 68.9% of the movement in the exchange rate, thereby sharing the increase in cost American retailers experienced. The increase in cost for American retailers suggests that American firms will lower their demand for Canadian passenger automobiles, substituting for relatively cheaper passenger vehicles produced in foreign nations. The direction of this result is

consistent with the results of Banik and Biswas (2005). The magnitude of my result, however, is not consistent with the aforementioned researchers' study as my result suggests a 31% increase in the effective American price while their result suggested a 77% increase. The difference in magnitude may be a result of different methodologies and the dependent variable definitions, as their result was based on only small-sized Canadian automotives.

*Table 2: Regressions of Export Price Index*

| Variable | $\Delta LogCANEPI$ Passenger Automobiles | $\Delta LogCANEPI$ Trucks and Tractors | $\Delta LogCANEPI$ Automotive Parts |
|---|---|---|---|
| $\Delta LogER_t$ | -0.689*** | -0.607*** | -0.394*** |
| | (0.087) | (0.098) | (0.085) |
| $\Delta USAPPI_t$ | 0.548*** | 0.808** | 0.292 |
| | (0.326) | (0.365) | (0.317) |
| $FTA$ | -0.011 | 0.002 | -0.014 |
| | (0.016) | (0.018) | (0.016) |
| $t$ | -0.000 | 0.001 | 0.000 |
| | (0.001) | (0.001) | (0.001) |
| $\alpha$ | 0.026 | 0.007 | 0.016 |
| | (0.016) | (0.017) | (0.015) |
| $R^2$ | 0.857 | 0.779 | 0.663 |
| N | 25 | 25 | 25 |

The results generated by my study indicate that the findings from the truck and tractor sector are very similar to the automotive vehicle sector. An appreciation of the exchange rate caused the export price of trucks and tractors to decrease by 60.7% of the exchange rate appreciation. This would indicate that Canadian truck and tractor products increased in price by 39.3% if the exchange rate were to appreciate by 100%. The relative increase in cost for American retailers suggests that overall export demand for Canadian made trucks and tractors would decrease.

Evidence generated suggested that the Canadian automotive parts sector also decreased their export price during exchange rate appreciations. In this sub-sector, Canadian manufacturers lowered their price by 37.2% of the movement in the exchange rate. The price after an exchange rate appreciation would remain relatively higher for American purchasers and it is hypothesized that Americans would decrease their demand for Canadian automotive parts.

The nature of the passenger automobiles industry, the truck and tractor industry, and the automotive parts industry would effectively stop the Canadian industry from decreasing

the export price on a one-to-one basis with the exchange rate. The benefit of taking such an action would be that, *ceteris paribus*, overall revenue and demand should remain constant as American importers would have no incentive to substitute between Canadian and foreign automotive goods; the price of Canadian automotive goods in terms of American dollars would remain constant. Firms within this industry experience relatively slow rates of turnover and as a result, the cost of an already produced automotive product may not be the same as one that is currently being produced. Thus, a one-for-one pass through of the exchange rate is not possible; firms need to recoup the costs they faced during production.

### *5.3. Export Value Analysis*

The final section of analysis measures how American demand for Canadian-made auto products reacted during exchange rate fluctuations. In the analysis of the reaction of export prices relative to movements in the exchange rate, it was predicted that quantity demanded during exchange rate appreciations would decrease as the effective U.S. price was predicted to rise. I hypothesized that Canadian automotive goods were elastic, which suggests that during an exchange rate appreciation, export revenues are expected to decrease. This section will test these claims and provide economic insight into how demand reacted.

The evidence generated suggests that the export value of Canadian made automobiles declined as the exchange rate appreciated. This result is consistent with an understanding that Canadian passenger automobiles are an elastic good; under this assumption, Canadian passenger automobiles would be substituted for relatively cheaper foreign passenger automobiles. Despite this feature, I was unable to estimate the profitability[14] of firms operating in the passenger vehicle market**.** It would not be surprising, however, to find that the loss in export value outweighs the cost savings realized by a JIT inventory system.

[14]Data on the profitability of the Canadian automotive industry is not publicly available.

*Table 3: Regressions of Export Value*

| Variable | $\Delta LogExportValue$ Passenger Automobiles | $\Delta LogExportValue$ Trucks and Tractors | $\Delta LogExportValue$ Automotive Parts |
|---|---|---|---|
| $\Delta LogER_t$ | -1.854*** | -0.672* | -0.952 |
| | (0.585) | (0.732) | (0.976) |
| $\Delta LogUSAPPI_t$ | -0.823 | -0.967 | -1.862 |
| | (1.732) | (2.165) | (2.888) |
| $LogUSGDP_t$ | -1.980 | -0.405 | -6.440 |
| | (3.024) | (3.780) | (5.042) |
| $USUnemp_t$ | -0.009 | -0.007 | -0.074 |
| | (0.063) | (0.078) | (0.105) |
| $FTA$ | -0.024 | -0.003 | -0.173 |
| | (0.111) | (0.138) | (0.185) |
| $t$ | 0.0332 | -0.0003 | 0.121 |
| | (0.057) | (0.0712) | (0.095) |
| $\alpha$ | -0.460 | 0.064 | -1.446 |
| | (0.650) | (0.812) | (1.083) |
| $R^2$ | 0.522 | 0.141 | 0.293 |
| N | 23 | 23 | 23 |

Analysis of the truck and tractor industry also suggested that there was an elastic demand for Canadian made trucks and tractors. Once again, a typical analysis of firm structure and profitability suggests that the loss in export revenues would outweigh the cost savings of production incurred when the exchange rate was to appreciate. Specifically, evidence was generated that suggests that export revenue in this sector decreases by 67.2% of an exchange rate appreciation. Again, given recent news of the struggling Canadian automotive sector, I hypothesize that overall profitability of firms in this industry would likely decrease during exchange rate appreciations; the loss in export revenues outweighs the savings induced by a JIT inventory system.

The exchange rate coefficient was determined to be insignificant under an examination of the export revenue of Canadian automotive parts manufacturers. The evidence indicates that export revenues remained constant when the exchange rate fluctuated. The constant export revenues imply that, ceteris paribus, Canadian automotive parts firms' profits would rise during exchange rate appreciations, due to the cost savings that a JIT inventory system would induce. This result contradicts my conjecture that automotive parts are an elastic good; overall export revenues would be expected to decrease during an exchange rate appreciation.

There are several caveats to consider in the analysis of export value. The estimation of the E.3 is not an accurate measure of export demand for the auto industry because export value is a composite of information; it contains only information on quantity and price. Price already aggregates numerous economic effects; the further complication of this variable, through its interaction with quantity, results in a rough proxy for demand.[15] Data on the quantity of automotive goods exported to the U.S. was not available.

A potential reason for the insignificance of the FTA dummy in the export value regressions exists. In the periods preceding 1989, the Canadian automotive industry was far more protectionist; however, in the 1990s, protectionism started to decline and the auto industry experienced a rise in the degree of foreign competition. This argument has similarities with the types of FTA captured in model E.3. The Auto Pact, as noted in previous studies, encouraged protectionism in the automotive industry. As time passed, protectionism as an international trade policy became less popular in lieu of liberal free trade. CUFTA and NAFTA are two FTA agreements that coincide with the era of more free flowing competition. The close alignment between CUFTA and the international increase in competition suggests that the FTA dummy may be capturing these competition effects.[16] This unmeasured degree of competition may also induce bias in the export price regressions.

## 6. Conclusion

The recent media coverage of the health of the Canadian automotive industry motivated my impartial research into how the auto market reacted to movements in the exchange rate. Analysis of the industry was broken into three sub-sectors, passenger vehicles, trucks and tractors, and motor vehicle parts. The costs of production, the exchange rate price, and market export revenue were evaluated for each sub-sector.

Passenger vehicles were found to have a cost savings mechanism during periods of exchange rate appreciation. This is consistent with a JIT inventory system. Export prices decreased during exchange rate appreciations by approximately 91.2% of the exchange rate, a result that is consistent in sign, but not magnitude, of past studies. Overall export revenues decline given an increase in the exchange rate. This indicates that Canadian passenger automobiles are an elastic good. The overall profitability of this sector would depend on whether the cost savings effect dominated the loss in export revenues.

The Canadian truck and tractor industry closely mimicked the analysis of the Canadian passenger vehicle industry. Evidence generated suggested that the industry experienced a

[15]I attempted to derive a measure of quantity by dividing the export value of each automotive sub-sector by its matching export price index. I then took the log of this variable and regressed it on the independent variables specified in E.3. Evidence was generated that suggested that the quantity of passenger automobiles exported to the U.S. was inversely related with the exchange rate. Results proved insignificant for the other sub-sectors. These results were not reported due to the potential inaccuracy of the derived quantity variable.

[16]The possibility of using the Herfindahl-Hirschman Index and/or the concentration ratio of the four largest firms in each submarket to capture competitive effects was deliberated; however, given the time constraints of this work, I was unable to gather and implement these variables.

significant level of production costs savings during exchange rate appreciations. Export prices were found to decline as the exchange rate appreciated; however, overall the price would have increased for American importers relative to the pre-appreciation price. The results suggested that trucks and tractors were an elastic good as overall export revenue was expected to decrease during an exchange rate appreciation. Again, the overall profitability of this sector would depend on whether the cost savings incurred during production outweighed the loss in export revenues.

Automotive parts demonstrated a cost savings effect, suggesting the presence of a JIT inventory system. This finding is consistent with past literature. Export price was found to decrease during exchange rate appreciations. Overall export revenue was found to remain constant suggesting automotive parts were unit elastic. Overall profitability of this industry would be expected to increase during exchange rate appreciations given these findings.

Further analysis of this problem includes, but is not limited to the following suggestions. The inclusion of a variable that measured or acted as a proxy for the degree of hedging that Canadian automotive firms undertake could potentially strengthen the results of the production cost and export revenue regressions run in this report. Similar benefits could be obtained if either a variable or proxy for long-term contracts used by the industry was instituted. The inclusion of a variable that captures the degree of competition in the industry and possibly the market share Canadian auto producers hold in the U.S. market may also strengthen the results in the analysis of export price and export revenue. Lastly, if data were to become available for the quantity of automotive goods and profits made in different automotive sub-sectors, this may provide a better interpretation to the elasticity of automotive products and how overall profitability is affected by movements in the exchange rate.

## References

Banik, Nilanjan, and Basudeb Biswas. 2007. Exchange Rate Pass-through in the U.S. Automobile Market: A Cointegration Approach. *International Review of Economics and Finance* 16 (2): 223-236.

Brox, James, and Christina Fader. 1996. Production Elasticity Differences Between Just-in-time and Non-just-in-time Users in the Automotive Parts Industry. *North American Journal of Economics and Finance* 7 (1): 77-90.

Eithier, Wilfred. 1973. International Trade and the Forward Exchange Market. *American Economic Review* 63 (3): 494-503.

Feinberg, Robert. 1996. A Simultaneous Analysis of Exchange-rate Pass Through into Prices of Imperfectly Substitutable Domestic and Import Goods. *International Review of Economics and Finance* 5 (4): 407-416.

Feinberg, Robert, and Seth Kaplan. 1992. The Response of Domestic Prices to Expected Exchange Rates. *Journal of Business* 65 (2): 267-280.

Fuss, Melvyn, and Leonard Waverman. 1986. The Canada-U.S. Auto Pact of 1965: An Experiment in Selective Trade Liberalization. Working paper no. 1953. National Bureau of Economic Research, Cambridge MA.

Kardasz, Stanley, and Kenneth Stollery. 2005. Exchange Rate Pass-through in Canadian Manufacturing: Its Direct and Indirect Components. *Applied Economics* 37 (15): 1763-1776.

Kumar, Pradeep, and John Holmes. 1998. The Impact of NAFTA on the Auto Industry in Canada. In *The North American Auto Industry Under NAFTA*, ed. Christopher Sands and Sidney Weintraub. 92-183. Washington, D.C.: CSIS Press.

Mahdavi, Saeid. 2002. The Response of the US Export Prices to Changes in the Dollar's Effective Exchange Rate: Further Evidence from Industry Level Data. *Applied Economics* 34 (17): 2115-2125.

Palmer, Randall. (2007). UPDATE 1-Canada Union Sees 300,000 Factory Job Losses. *Reuters*, November 20. http://www.reuters.com/article/bondsNews/idUSN20631438200711 20?pageNumber=1&virtualBrandChannel=0 (April 9, 2008).

*The Globe and Mail*. http://www.theglobeandmail.com/servlet/story/LAC.20071111.RMARTINREA15/TPStory/Business (May 3, 2008).

Wei, Shang-Jin. 1999. Currency Hedging and Goods Trade. *European Economic Review* 43 (7): 1371-1394.

Weintraub, Sidney, and Christopher Sands. 1998. *The North American Auto Industry under NAFTA*. Washington, D.C.: CSIS Press.

Yasin, M.M., M. Small, and M.A. Wafa. 2000. An Empirical Investigation of JIT Effectiveness: An Organizational Perspective. *Omega International Journal of Management Science* 25: 461–471.