

Real Exchange Rate and Real Value Added in Canadian Manufacturing Industries

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Table of Contents

1. Introduction	1
2. Literature Review	6
2.1 Theoretical considerations on the Dutch Disease	7
2.2 Empirical Studies	9
3. Model Specifications and Data	20
4. Data Tests	24
5. Results and Analyses	27
a. Analyses of Trade Exposure	30
6. Conclusions	32

Summary

In an effort to further understand the relationship between exchange rate movements and the performance of Canadian manufacturing industries, this paper explores the relationship between real exchange rate movements and the growth in real value added of various Canadian manufacturing industries. Industries are delineated based on net trade exposure in an effort to understand the ability of trade exposure to exacerbate, or offset, possible detrimental effects of exchange rate appreciation. Significant links between real exchange rate appreciation and value added are found in selected industries, although the health of the overall economy is found to be a far greater determinant of industry growth or contraction.

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1. Introduction

The Canadian dollar experienced a dramatic appreciation relative to the US dollar over the period 2002 to 2007. This period of appreciation witnessed a 32% climb in the value of the Canadian dollar relative to the US dollar. MacDonald (2008) suggests this appreciation has benefited Canada through substantial terms of trade increases leading to strong investment and personal consumption. Conversely, the appreciation of the Canadian dollar has seemingly had concurrent detrimental effects on Canadian manufacturing production and export performance. Aggregate value-added production of Canadian manufacturing industries grew by only 1% from 2002 to 2007 in comparison to aggregate GDP growth of 15%¹. This is in contrast to the previous five years where manufacturing production kept pace with the total economy, growing a cumulative 21% relative to aggregate economic growth of 20%². These apparently adverse effects on manufacturing output, and the link between the growth in manufacturing and the exchange rate, has prompted research into the linkages between the exchange rate and different aspects of the economy.

An appropriate theoretical framework to summarize the effects of increased prices of energy and resource commodities coupled with the appreciating exchange rate would be the Dutch Disease model as used to reference the impact on Dutch manufacturing following the discovery and extraction of natural gas in the North Sea. Corden (1984) provides an excellent overview of the core Dutch Disease model explaining the

¹ Data collected from CANSIM table 379-0027

² Data collected from CANSIM table 379-0027

expected impact of a resource draw away from the lagging sector into the booming sector. Even without an accompanying exchange rate appreciation, the booming sector will experience a rise in the marginal product of labour relative to the lagging sector. This will encourage movements of labour between the two sectors. In the Canadian context, this would imply a movement in labour away from manufacturing into the energy sector. Recent flows of interprovincial migration would suggest this has been the impact in Canada. At the aggregate level, Alberta has been the largest recipient of interprovincial migration over the period 2002 to 2007, with all other provinces except British Columbia facing net reductions in interprovincial migration (Table 2). In many cases, this is a continuation of previous trends but perhaps the most stark change in migration flows relates to Ontario, the center of many of Canada's manufacturing industries, which historically being a net recipient of migration flows experienced a reversal of this trend starting in 2003.

A concurrent exchange rate appreciation as we have seen in Canada can further exasperate the resource shift driven by changes in relative marginal products of labour. As the exchange rate appreciates, Canadian exporters are forced to either raise prices denominated in foreign currency, affecting their ability to compete in foreign markets, or reduce prices as denominated in Canadian dollars, which will reduce their revenues.

Various studies, such as Coulombe (2008) and Dion et al. (2005), help in establishing a Dutch Disease diagnosis of the Canadian situation. These studies focus on labour movements, shifts in capital formation and exchange rate impacts on trade flows, both imports and exports. These studies generally conclude that Canada has experienced

the effects of Dutch Disease. Coulombe (2008), for example, analyses the movements of labour over the period 2002 to 2007 and reveals that labour has significantly decreased in export dependent industries. Dion et al. (2005) are able to link the exchange rate appreciation to decreases in exports of affected industries as well as an increase in the overall volume of imports. In both cases noted, a lag is detected in how exchange rate shifts affect labour movements and trade volumes; that is, an exchange rate appreciation will continue to impact labour movements and trade volumes after the period in which the actual exchange rate shift occurs.

Despite these findings, research is not conclusive that a detrimental Dutch Disease situation has unfolded in Canada. Looking at the growth or decline in aggregate manufacturing in a vacuum can distort the conclusions. MacDonald (2007) clarifies some of the additional factors and links much of the restructuring in the economy away from manufacturing sectors to the emergence of other world economies such as China. In fact, MacDonald further suggests that when looking at aggregate unemployment rates, the misallocation of labour expected as a result of Dutch Disease has not happened. Supporting this argument, MacDonald differentiates between manufacturing of durable and non-durable goods. He observes that the aggregate weakness in manufacturing output is largely related to the production of non-durables, which are more heavily affected by the emergence of increased foreign competition. Over the period 2003 to 2006, the production of durable goods actually grew by 4.8%.

Bayoumi and Muhleisen (2006) of the IMF also evaluate the impact of the rise in energy prices on Canadian output of energy commodities and the expected impact on the non-

energy sectors. Their findings suggest that, although energy driven gains in export revenues may put additional pressure on the Canadian exchange rate, the effects on non energy sectors will not be great. They suggest that the performance of the overall US economy will continue to be a more significant determinant of the performance of Canada's manufacturing sector.

These alternate views suggest some ambiguity on the severity of impact of the appreciating exchange rate. This paper will attempt to further explore these issues and help resolve this ambiguity through modelling directly the effect of exchange rate appreciation on the value added in selected Canadian manufacturing industries. This represents a divergence on the evaluation of Dutch Disease generally, in that it will focus solely on the impact of exchange rate appreciation. The focus on value added may help in establishing a clearer relationship between the exchange rate and Gross Domestic Product estimates. Further, the aforementioned studies have explored the effects on labour and capital accumulation, other areas of interest when exploring the effects of exchange rate appreciation and Dutch Disease.

In an effort to alleviate concerns that, in reality, production shifts may be driven by other independent events such as increases in foreign competition, the model developed will attempt to account for increases in foreign competition, particularly the manufacturing output growth of China. MacDonald's (2007) linkage of performance in specific manufacturing industries to non-exchange rate phenomena suggests that some measures should be incorporated to help in isolating the exchange rate impacts from unrelated economic phenomena.

Further, significant research has indicated that a high percentage of imports into production will act as a natural hedge against the exchange rate appreciation. As the input prices fall with exchange rate appreciation, total production costs similarly fall. Although the greatest beneficiaries of these falling prices are in the retail and wholesale industries according to Ghanem and Cross (2008), manufacturers also stand to gain. Conversely, a high concentration of exports within total output would likely exacerbate the effect of appreciation as they are forced to either reduce prices in Canadian dollars or attempt to compete in foreign markets with an increasing price. Therefore, the analysis will seek to provide a deeper understanding of the impact of import and export shares within production and total output.

This paper will rely on an OLS regression method to provide estimates of these impacts and control for various other factors. As Coulombe (2008) and Dion et al (2005) are able to use OLS models to provide significant results of exchange rate impact on employment and trade respectively, the same approach will be used to model exchange rate impact on value added. Further, this methodology will resemble that used by Zhao (2007) in the evaluation of exchange rate movements on investment, not only in how the model is specified, but in the use of several detailed manufacturing industries in an attempt to understand how impacts may vary across specific industries. Reviewing the differences in trends between different manufacturing sectors, there are significant differences in performance over the past five years although, predominantly, performance has been weaker than in the previous five years (Table 3).

The remainder of this paper is organized as follows. The next section of this paper will

review the relevant theoretical and empirical studies on Dutch Disease. Section 3 provides an overview of the methodology employed in this paper and section 4 provides a summary of data tests employed to ensure the validity of test results. Estimation results are discussed in Section 5, and concluding remarks are presented in Section 6.

2. Literature Review

There are varying opinions on the outcome of exchange rate appreciation as well as the effects of exchange rate volatility. This paper will deal with the effects of exchange rate appreciation or depreciation in an effort to understand the consequences of the rapid exchange rate appreciation over the period 2002 to 2007. Exchange rate variability is also important however, as movements over the time period 2002 to 2007, although predominantly in one direction, have been larger than historical rates and thus signify an increase in volatility.

With regard to exchange rate variability effects, Broll and Eckwert (1999) point out that although considerable research has been devoted to this subject, the vast majority of these studies have been unable to draw a significant relationship between volatility and trade volumes. They further outline a model whereby exchange rate volatility may not have the assumed negative impact on production and trade volumes. They suggest that a firm that can easily react and direct production to domestic rather than foreign markets will be able to use the exchange rate volatility as a potential source of increased revenue. The firm will select output based on domestic prices and then only direct production to exports when the exchange rate turns out to be favourable. Increased

volatility leads to greater potential for large additional revenues due to favourable exchange rate conditions and therefore induces the firm to produce more.

Wang & Barrett (2007) further note the inconclusive results of various studies on exchange rate volatility and the impact on exports. They suggest that some of these ambiguous results may be related to data issues on how exports are aggregated, as volatility may affect different sectors differently. Looking at Taiwan's exports, they find that exchange rate volatility is important in relation to agriculture exports, but not for other sectors such as manufacturing, the focus of this paper.

Given this uncertainty and the inconclusive results of an exchange-rate-volatility-production link, for the purpose of this paper, this particular potential effect will not be considered. Instead, the focus will be on the direction of movement and on the impact of real exchange rate appreciation on affected Canadian manufacturing industries.

2.1 Theoretical considerations on the Dutch Disease

This section presents an overview of the transmission mechanisms involved in a Dutch Disease phenomenon. There are many determinants of the exchange rate including, but not limited to, foreign investment, interest rate differences between countries, and speculation. The most recent currency appreciation in Canada is largely related to the development and growing production value of Canadian resource commodities including oil, gas, nickel etc. The escalating world prices of these commodities have increased Canada's current account surplus, spurred investment in mining and exploration and indirectly caused the currency appreciation. Given the fact that this

recent appreciation is driven by the increase in these commodities, Dutch Disease is the economic phenomenon most closely related to the Canadian situation. Reviewing the traditional results of Dutch Disease will therefore provide insight into understanding the possible impact of the exchange rate appreciation on manufacturing.

In an overview of the core Dutch Disease model, Corden (1984) consolidates the varying literature and conditions which foster or affect the outcomes of a Dutch Disease (DD) situation. The core DD model identifies three independent sectors of the economy – the booming sector, the lagging sector and the non-tradeables sector. The general impact of the booming sector is to draw resources away from the other two sectors. As the marginal product of labour rises in the booming sector, labour is attracted from the other two sectors. This movement of labour out of the lagging sector into the booming sector is known as de-industrialization (Corden, 1984). Another notable effect will be a spending effect on non-tradeables. Assuming some of the additional income earned in the booming sector is spent on non-tradeables, there will be an expected increase in demand and therefore an expected rise in prices in this sector. This will compound the above mentioned de-industrialization with further indirect de-industrialization.

Translating the DD models into expected results in Canada from 2002 to 2007, the expected outcome would be a movement of labour and output out of the lagging sector, which for the purpose of this paper we consider manufacturing, and into the booming sector, the resource (energy) sector. As mentioned, however, these are the results of a more general Dutch Disease model. This paper will deviate from this slightly as the focus will be on the impact of the exchange rate in isolation, not on other possible

outcomes such as increasing wage disparities between industries that may drive resource reallocation.

Although anecdotal evidence that Canada has been suffering from a variation of Dutch Disease is common with the decrease in manufacturing output and a clear booming energy sector to support this theory, there are important distinctions noted by MacDonald (2007). First, versus the discovery of gas in the North Sea, Canada has long been tapping its natural resources of oil, gas and other raw materials. Second, Canada's openness to trade and historical dependence on largely one trading partner and the current shift to imports from emerging economies can complicate the analysis.

2.2 Empirical Studies

Following the collapse of the Bretton Woods system in 1971, many countries have experienced some episodes of rapid appreciation or depreciation of their currency relative to their trading partners. Although these movements may cause possible distortions or short term issues within the economy, Bailliu et al. (2002) do an excellent job of explaining the benefits of the flexible exchange rate regime. It is versus the US currency that the Canadian dollar experienced steep appreciation, and it is also notable that China, another of Canada's important trading partners, has essentially fixed its currency to that of the United States. Given the important policy impacts of the effects on manufacturing, several empirical studies have been undertaken to clarify the exchange rate manufacturing relationship.

Before reviewing the more rigorous analytical studies, it is useful to review a Bank of Canada survey of Canadian businesses on the impacts of the appreciating currency and the various responses (Mair, 2005). The anecdotal evidence of exchange rate effects is extensive and the survey summarizes very well the different considerations. Narrowing the focus to manufacturing, 77% of respondents identified a significant or moderate adverse effect of the exchange rate, the highest reported adverse effects of the industries surveyed. As would be expected, the majority of these firms had significant U.S. sales and competed with foreign products meaning they were largely price takers in U.S. dollars. A natural hedge reported by respondents was having high import intensity in their final output. This helped firms deal with the rising dollar in that these input prices fell with the appreciation. Further, almost one-half of manufacturers reported increasing their import intensity in response to the appreciation of the dollar and lower prices of inputs was given as the main favourable effect of the appreciation. In addition to production inputs becoming cheaper, machinery and equipment, which is heavily imported in Canada, also became cheaper and all manufacturers signalled that they were considering increasing investment given these lower prices. Potential changes in the capital labour ratio in response to changes in exchange rate have been the subject of considerable research and will be discussed in more detail below. About one quarter of adversely effected firms reported a reduction in export volumes following the appreciation. These survey results help clarify the types of relationships we expect to see unfold in the production of manufacturing industries.

There is an important distinction between capital inputs into production, which are

largely imported at the total Canada level, and intermediate inputs, which may also be imported. In both cases, exchange rate appreciation will lead to decreases in price, *ceteris paribus*, but the impact may be very different. Lowered cost in intermediate inputs would translate quickly into reduced production costs denominated in domestic currency. The cost of machinery and equipment would similarly fall, but given that investment in new equipment is less frequent than the purchase of inputs, and a firm, for example, will not replace existing capital simply because the replacement cost is now lower, exchange rate impacts may happen over a longer period of time.

The impact of exchange rates on capital investment has been the topic of extensive research. Analysis of productivity growth often looks to changes or differences in capital-labour ratios. If the exchange appreciation leads to a drop in the prices of machinery and equipment, there would be a reduction in the cost of capital relative to labour. This would lead firms to invest more heavily in machinery and equipment, relative to labour, leading to a shift in the capital-labour ratio. Leung and Yuen (2005) investigated this impact in the Canadian context over the period 1981 to 1997. This period has the benefit of including time when there was appreciation and depreciation in the Canadian relative to the U.S. dollar. Their findings support that shifts in the capital-labour ratio can be expected with changes in the exchange rate. They link a significant 1.7% decline in the capital-labour ratio to every 10% of currency depreciation. They do caution, however, that although this relationship exists, the impact on productivity may not be large given the weight of imported machinery and equipment within total production. This relationship reflects what was reported in the Bank of Canada survey.

More recently, Zhao (2007) explored the effects of exchange rate movements on investment in different Canadian manufacturing industries. Her results imply that exchange rate impact on investment is only significant in four of the industries reviewed, and that whether exchange rate depreciation results in increases or decreases in investment was dependent on the industry. She further suggests that this link may be a result of whether a firm is import or export dependent. Zhao suggests two, opposing mechanisms by which exchange rate may affect investment. A depreciating exchange rate may increase revenues to exporters as they may be able to charge a higher price in Canadian dollars to their foreign markets. Conversely, the depreciating currency may lower the ability to purchase imported machinery and equipment that is now relatively more expensive. Therefore, export dependent firms tend to earn higher profits with exchange rate depreciation that they may then use to increase investment. Similarly, import intensive firms which face higher costs with exchange rate depreciation, are inclined to lower capital investment. Zhao finds both positive and negative reactions to currency appreciation and suggests this focus on export and imports by industry may be a determinant of this reaction. Further, Zhao's results do not lead to a conclusive relationship between the volatility of the exchange rate and investment.

Supporting Zhao's conclusion that it is import versus export dependence that determines the exchange rate impact on capital expenditure is the work of Campa and Goldberg (1993) who studied US investment activity over the period of 1972 to 1986. After analysing investment patterns by industry over time, they are able to conclude that the change in net trade exposure over time leads to a reversal in the effect of exchange

rate appreciation on investment. Their analysis utilises an Index of Effective Exposure which leverages the US 1982 Input Output Tables to derive an index that relates a firm's dependence on imports as inputs into production and share of sales destined for exports. Their analysis and conclusions are also similar to Zhao's in that they find the impact of the volatility of the exchange rate to be quantitatively small on investment.

These relationships between investment and the exchange rate are not the primary focus of this paper but are relevant in that one may expect similar relationships between exchange rate movements and manufacturing value added output. For example, industries that tend to expand investment during times of exchange rate depreciation may also be expected to increase output. It is also notable that trade exposure as a determinant of the impact of exchange rate appreciation was found in research into capital investment. This paper will attempt to verify if a similar relationship exists with value added.

Further supporting the Bank of Canada survey results and helping to establish a Dutch Disease diagnosis of the Canadian situation, Coulombe (2008) has studied the movements of labour over the period 2002 to 2007. The expectation is that exchange rate appreciation will put downward pressure on highly export exposed industries causing employment in these industries to fall. Coulombe (2008) investigates the impact on labour in these industries with a regional look. This type of analysis leverages the relative heterogeneity of industrial composition by province in Canada. Coulombe identifies the significant loss in employment (275 400 from the fourth quarter of 2002 to second quarter of 2007) as a result of exchange rate appreciation, and uses a variety of

models to estimate the speed with which currency appreciation affects labour share in these highly trade exposed industries. He further controls for energy prices, China's import penetration, provincial business cycles, etc. Through all three models, he is able to link loss in employment to currency appreciation. Further, his findings suggest that the adjustment to the most recent episode of exchange rate appreciation is not complete, as the effects on labour of exchange rate shifts happen over several subsequent periods. For example, only 60-70% of the total employment adjustment is complete two years after the currency appreciation.

One attempt to model the impact of appreciation on the performance of Canadian trade provided significant results suggesting that exchange rate appreciation does lead to decreases in export volume and increases in imports. Dion, Laurence and Zheng (2005) note that non-exchange rate factors, which can be Canadian specific, must be considered in analysing export performance. Events like the downturn in aircraft investment following September 11, 2001, poor crop years in 2001 and 2002, and the ban on Canadian beef imports as a result of BSE in 2003 had a negative impact on Canadian exports beyond what may have been driven by the exchange rate. Dion et al. conclude that when considering other simultaneous effects, machinery and equipment and non-automotive consumer goods exports were affected by the appreciation of the exchange rate. Industrial goods production, however, has kept pace with US industrial production. On the import side, import volumes have outpaced total demand for Canadian goods in 2003 and 2004.

However, as aforementioned, looking at the growth or decline in aggregate

manufacturing in a vacuum can distort conclusions. MacDonald (2007) outlines these additional factors providing key macroeconomic statistics that support this opinion. He identifies that the aggregate manufacturing has actually increased, albeit by a minimal 1.3% from 2003 to 2006, and that the growth in durable's manufacturing has been much stronger, 4.8%. It was the non-durable sector that primarily plagued the manufacturing industry, and although the appreciation of the exchange rate reduced profit margins, the booming of the Chinese economy was likely the primary culprit. This theory is further supported by the growth in the US imports of non-durables from China over the period 1990 to 2007 (over 2000% from 1990 to 2007 according to the Bureau of Labor Statistics). Additionally, durable manufacturing has faced increased competition from foreign competitors, especially in auto manufacturing which is not exchange-rate related. He further points out that when looking at aggregate employment rates, the shift in labour out of manufacturing is largely a result of increased foreign competition, exacerbated by the exchange rate.

The Bayoumi and Muhleisen (2006) evaluation of the rise in energy prices also suggests minimal impact on the non energy sectors. They suggest that the increased prices of oil and natural gas, and the resulting increases in Canada's viable and commercially accessible oil reserves, will add about 1% of GDP to Canada's trade surplus over the next 15 years (beginning in 2006). They do not believe that a severely detrimental Dutch Disease situation will unfold as historically many purported Dutch Disease situations actually had minimal ultimate effects and that in many cases what has been called Dutch Disease is related more to long-term trends of de-

industrialization. Notably, Gylfason (2001) has shown that even in the case of the Netherlands, for which Dutch Disease was named, the detrimental effects on manufacturing were actually short lived. Further, Bayoumi and Muhleisen suggest that the performance of the US economy will be a much stronger determinant of Canada's export performance. They conclude that the further development of the tar sands will lead to a positive impact on the Canadian economy with minimal impact on non-energy industries, although there are several risks that could negate many of their results.

Ghanem and Cross (2008) have performed preliminary analysis on the ability of net trade exposure to determine the effect of the recent currency appreciation on Canadian industries. Leveraging the Canadian Input Output tables, they are able to find evidence suggesting that although net exposure to trade plays a significant role in influencing the impact of appreciation, it is not the dominant factor of industry performance. Ghanem and Cross included both direct and indirect exports in their analysis and derived net trade exposure as the share of exports in total output less the share of imports in total inputs. This calculation highlighted Wood and Paper industries as having the highest net trade exposure and thus being a candidate for severe negative exchange rate driven effects. Mirroring the analyses of MacDonald, they find also that the Canadian manufacturing industries which have faced the most significant decreases in production over the recent years have been adversely affected by non-exchange rate related factors.

Further to the above empirical studies, Dissou (2007) developed a multi-sector general equilibrium model in an effort to understand how increased energy prices echo through

the economy, suggesting resulting effects on GDP, employment, consumption, inflation, trade and the real exchange rate. Dissou also provides sector analysis, reviewing the expected results on various Canadian industries. He suggests an additional transmission mechanism not explored in the above papers. The increased price of oil will lead to increased costs to Canadian industries, particularly those that depend heavily on energy within their production inputs. His findings suggest that Dutch Disease type effects, although not truly Dutch Disease, may be a result of increased energy prices. For example, there will be downward pressure on manufacturing industries. Indeed, the increase in petroleum industry exports will not be enough to offset the fall in non-petroleum exports leading to an aggregate drop in real exports both in the short and long term. Interestingly, his model also predicts a drop in real imports. This is despite increased investment stemming from the increased price of oil. This is largely related to the general downward pressure on various industries caused by the increased production costs as a result of higher oil prices. On a sector basis, the results match traditional expected Dutch Disease results. Expected output of most non oil and gas sectors experience negative growth and reduced investment in both the short and long run. Specifically, manufacturing sectors such as pulp and paper will suffer the largest adverse effects.

The negative effects on increased input prices may be offset somewhat if there is a similar fall in price of other inputs. For example, if other imported inputs are now cheaper due to exchange rate appreciation or if substitutes are available for energy commodities in the production process. Relating to agriculture, for example, Lopez

suggests and gives the conditions whereby agriculture industries may be able to lower energy demand if land can be used as a substitute input (Lopez, 1982).

Canada is not alone in having commodity price driven exchange rate appreciations affect the various sectors of the economy. Recently, Australia has experienced a similar resource driven exchange rate appreciation with resulting impacts on the manufacturing sector of the economy. Like Canada, the movements in investment are related to the trade exposure of the particular industry (Swift, 2006). The difference in export versus import concentration within firms lead to striking differences in aggregate responses to exchange rate appreciation from a 1.2% net increase in investment for the most import intensive industry versus a 15% drop in investment for the most export intensive.

In the case of the UK and Norway, Jimenez-Rodriguez and Sanchez (2004) have found that increases in oil prices have had different long term effects. In the case of the UK, a 100% increase in the price of oil over a three year period resulted in a negative overall impact on GDP. Norway, however, at the aggregate GDP level benefited from a similar increase in oil prices. The authors link some of this divergent trend to the effect increased oil prices had on the respective exchange rates. In the case of the UK, the exchange rate appreciated more in response to oil prices and thus had a more detrimental effect on the rest of the economy. With respect to Canada, Jimenez-Rodriguez and Sanchez note that the fall in oil prices over the late 1980's had a detrimental effect on Canada's GDP growth. They link this negative impact to the fact that this was the period where Canada was transitioning to a net oil exporter. This mirrors the effect of that noted by Bayoumi and Muhleisen (2006) which suggests the

recent oil price appreciation benefitted Canada's aggregate economy.

It is notable that when looking at foreign countries' experience with Dutch Disease, the initial structure of their economy relative to Canada's must also be considered. The reaction in terms of possible employment for example may be related to initial trade patterns and policies. Van Wijnbergen (1984) explains the differences in employment responses between Gulf countries, which experienced an overheated labour market, and Latin American countries, which saw a rise in classical unemployment following oil price shocks as a result of pre-existing Latin American trade barriers.

Reviewing the above results, there is evidence that the recent appreciation of the Canadian dollar has had direct effects on Canada's manufacturing industries. There is not, however, consensus on what reduced manufacturing can be attributed to the currency versus other simultaneous events. MacDonald points heavily to these other forces as driving the drop in manufacturing. He is supported by the findings and analysis of Bayoumi and Muhleisen. Coulombe's research reveals a direct impact on employment driven by the exchange rate. In summary, these evaluations of labour movements and capital investment and trade flows point to some direct effects of the Canadian exchange rate. There is evidence however, that trade exposure and coinciding economic phenomena may be playing a more significant role in Canada's manufacturing sectors. In addition to these at times conflicting results, this issue is inherently important as it relates directly to possible government policy intervention, such as the possible use and advantages of energy revenues to subsidize non-energy sectors as discussed by Van Wijnbergen (1984). Bruno & Sachs (1982) further explore

this area through simulating possible government reactions to increased energy revenue and the outcome of distributing additional revenues with different schedules.

3. Model Specifications and Data

The model used for analysis in this paper will rely on a simple OLS regression model. The model regresses the growth rate in value added output of Canadian manufacturing industries³ at the three digit North American Industrial Classification System (NAICS) level against the growth rate in the real exchange rate⁴, the growth rate in the real GDP of Canada⁵ to account for overall economic performance, and the growth rate in non-OECD imports⁶ into Canada to account for increased foreign competition. Further, industries will be stratified into three groups based on trade exposure. The methodology for this stratification is described below. Although the motivation for this paper is largely the effects of the recent exchange rate appreciation on Canadian manufacturers, to understand this relationship, a longer time series is necessary. For this reason, this model will be run on annual data from 1981 to 2007, i.e., 27 observations. As this model will be based on growth rates however, the actual number of observations included will be 26.

³ Statistics Canada, CANSIM database, Table 379-00271, Retrieved September 5 2008

⁴ Author calculated, methodology explained below

⁵ Statistics Canada, CANSIM database, Table 379-00271, Retrieved September 5 2008

⁶ Statistics Canada, CANSIM database, Table 228-0001, Retrieved September 5 2008

There are several methods for computing the exchange rate variable. Lafrance and St-Amant (1999) discuss these methods as well as their benefits and drawbacks. The primary alternatives are either a single weighted index that uses a comparable basket of goods to provide the respective price indexes from relevant countries; normally Consumer Price Indexes, Industrial Price Indexes, GDP deflators or Unit Labour Costs are used in construction of the real exchange rate, or, alternatively, a double weighted index. Perhaps the more robust index is the double-weighted index which accounts for competition between Canadian and foreign producers in third markets versus the more simplified first model of only considering bilateral trade. Given recent increases in international trade between developing economies and the US, competing for what were largely Canadian markets, this may be the most applicable model. They point out, however, that given Canada's overwhelming concentration of trade with the US, constructing a bilateral real exchange rate based on Canadian and US domestic prices will provide similar results. The use of this simple real exchange rate index reflects the methodology of Zhao (2007). The real exchange rate used in this paper is constructed using the respective Industrial Product Price Indexes of Canada and the United States, and is derived as Canadian dollars per US dollar. Therefore, a currency appreciation is represented by a fall in the index.

Industries will be delineated by trade exposure to help clarify the ability of trade exposure to offset or exacerbate the effects of exchange rate appreciation. The conclusions of Zhao (2007) and Campa and Goldberg (1993), who found a link between the reliance on trade and expected reaction in relation to industry investment, suggests

that there should be significant differences between these groups. The calculation method of this trade exposure is not obvious. This paper will rely on the Canadian Input Output tables to provide these estimates. However, as the Input Output tables do not provide the shares of imports in intermediate uses by industry, some assumptions have to be made. This paper assumes that the percentage of imports in the intermediate use of a given commodity in a particular industry is identical to the percentage of imports of that commodity in its total domestic use. For example, if 50% of car parts sold in Canada are imported, this methodology will assume that 50% of car parts used in the car manufacturing industry are imported. Similarly, on the export side, the share of a given commodity that is exported will be applied to industries which produce that commodity, based on the weight of that commodity within total output of that industry. For example, if half the output of a firm is commodity A and the other half is B and Canada exports all of its production of commodity B and 50% of commodity A, then the total export share for this industry would be 0.75. The ratios will be calculated based on 2002 data as this was the year in which exchange rate appreciation began. The industries are grouped according to net trade exposure with Group 1 including industries with less than 15% net trade exposure, Group 2 between 15% and 30% net trade exposure, and Group 3 including firms with greater than 30% net trade exposure. Net trade exposure is calculated by percent of output exported minus percent of inputs imported. This is similar to the methodology used by Ghanem and Cross (2008).

It is notable that the trade exposure by industry evolves over time and is intrinsically linked to the exchange rate. One reaction reported in the Bank of Canada survey is that

firms will often tend to reduce trade exposure during times of appreciation both by increasing use of foreign inputs and reducing export focus. Therefore, using the 2002 levels provides simply a snapshot of trade exposure. Some consistency within the groupings is likely to exist, however, in that industries such as wood manufacturing, which rely on Canadian raw materials as inputs, are likely to maintain higher levels of trade exposure. Further, work by Baldwin and Gu (2008) suggest that imports as a share of total intermediate inputs, at the aggregate level in Canada, changed by only 8.7% over the period 1961 to 2003, which again indicates some consistency can be expected with these ratios.

The growth rate of non-OECD imports are included in an attempt to control for the emergence of increased trade with developing countries. This assumes that competition from China, for example, would occur with or without the appreciation of the Canadian dollar. This assumption is supported by the shifting in manufacturing from the US to foreign producers which were not originally affected by any shifts in exchange rate, as they were originally domestically produced. It is notable that there is a range of estimates on the exact impact of outsourcing in the US and their domestic labour market (Bhagwati et al., 2004). For non-OECD imports, again the Statistics Canada series has been used. It is notable that this may be a weak proxy for the development of, and increased economic relation between, Canada and developing economies. A superior series would attempt to track imports of specific commodities from emerging economies that compete directly with production from Canadian firms. Unfortunately, data limitations remove this possibility.

In summary, the basic model is;

$$\% \Delta Y_t = \% \Delta GDP_t + \% \Delta FP_t + \% \Delta r_t + \varepsilon_t,$$

where $\% \Delta Y$ represents the percentage change in value added. $\% \Delta GDP$ is the percentage change in annual real Canadian Gross Domestic Product. $\% \Delta FP$ represents the percentage change in the proxy for the output of emerging economies and the possible resulting increased competition. Finally, $\% \Delta r$ represents the percentage change in the real exchange rate. This model is similar to that used by Zhao in her investigation of the effects of the appreciation of the real exchange rate on capital investment. Contrary to Zhao's model however, this model omits a variable included by Zhao that accounts for exchange rate variability. This omission is based on the results discussed in the literature review section; those papers were consistently reported to find little or an ambiguous relationship between exchange rate volatility, and investment or industrial performance.

4. Data Tests

The data included in the analysis and the results of each industry were reviewed for standard data problems including multicollinearity, heteroskedasticity, non-stationarity and autocorrelation. The results reveal some data issues and, in some instances, the models had to be re-specified or modified in a way to correct for these problems.

Given the importance of the US economy to Canadian manufacturing, the idea of

including changes in the US GDP in addition to percent changes in Canadian GDP was tested. This model specification, however, is affected by severe multicollinearity between the growth rate of Canadian and US GDP. This is not a surprising result given the interconnections between the two economies. The correlation coefficient between the annual growth rates of Canadian and US GDP over the period 1981 to 2007 is 0.83, higher than the threshold of 0.8 often used to signify severe multicollinearity. To rectify this situation, the models were re-specified and run first using only Canadian GDP and a second time with only US GDP. Both specifications resulted in significant coefficients associated with the GDP variable in the various regressions performed. Preferably, a single series to account for the total economic growth of the combined US and Canadian economies would be used, but given the unavailability of such a series, and the high level of correlation between the two GDP variables for the final model, only the Canadian GDP variable has been included.

A common problem with time series data, autocorrelation, was tested using the Durbin Watson test. Testing at the 5% significance level, two industries were found to contain autocorrelation. For these industries, the Newey West estimator for variance of errors has been used to ensure the validity of hypothesis testing. Following the work done by Davidson and MacKinnon (1993), reported in Green (2003)⁷, three lag periods were used in the construction of the estimates of coefficient variances.

Although more commonly a problem with cross-sectional data, each model was also tested for heteroskedasticity using both the Breush-Pagan-Godfrey (BPG) test for

⁷ p. 267 of Green "Econometric Analysis, 5th Edition"

heteroskedasticity as well as additionally testing for autoregressive conditional heteroskedasticity (ARCH test). Given concern over normality of errors in some models, the modified form of the BPG test, proposed by Koenker, was used⁸. At the 5% significance level, none of the industries failed either the Koenker-BPG test or the test for autoregressive conditional heteroskedasticity.

Non-normal errors were detected using the Jarque-Bera test in four of the industries at the 5% significance level. Fortunately, this does not pose a serious problem for the results as using the normal distribution for hypothesis testing in these models does not affect the results.

Finally, given the nature of the data, stationarity is a concern. The standard Dickey-Fuller test with no trend has been used to detect non-stationarity in all variables, with the exception of textile, clothing and leather product manufacturing that graphically seems to be the only industry with a trend. For each industry, the first test was performed with five lag periods and then, when the null hypothesis was not rejected, the test has been performed with four, three, etc. lag variables. In all, seven industries and none of the explanatory variables were found to be non-stationary (Table 5). It is somewhat surprising that non-stationarity is found given the initial dependent and independent variables depict the growth of the respective manufacturing industry. For the industries that were found to be non-stationary, the common solution of re-specifying the model to include the first difference of the growth was deemed insufficient. This solution may pose specification problems as essentially the first

⁸ p. 224 of Green "Econometric Analysis, 5th Edition"

difference of growth rates will show the acceleration or deceleration of growth which is conceptually not what the model is attempting to uncover. Further, the tests of non-stationarity can be weak and each series was retested using the Phillips-Perron test. Only two industries failed this additional test. For this reason, this non-stationarity will not be addressed through model re-specification and therefore the results for these industries, specifically for non-metallic mineral product manufacturing and furniture and related product manufacturing, which failed both tests, should be viewed with caution.

5. Results and Analyses

In general, this model provides results that explain much of the movements in manufacturing value added. The complete OLS output, including both resulting coefficients and relevant test statistics, is available in Table 4. The goodness of fit statistics for many of the industries indicate that the variation in the industries' growth is heavily related to the performance of the overall economy and to some extent to movements in the exchange rate. The only industry that the model does not help explain is Petroleum and Coal products. The goodness of fit statistic is the lowest of all industries at 0.06, and none of the estimated coefficients for that industry are significant, even at the 10% significance level.

Table 1
Goodness of Fit, R²

Industry	R²
<i>Group 1</i>	
Food manufacturing	0.26
Beverage and tobacco product manufacturing	0.22
Printing and related support activities	0.30
Petroleum and coal products manufacturing	0.06
Non-metallic mineral product manufacturing	0.66
<i>Group 2</i>	
Textile, clothing and leather product manufacturing	0.45
Chemical manufacturing	0.43
Plastics and rubber products manufacturing ¹	0.06
Primary metal manufacturing	0.62
Fabricated metal product manufacturing	0.61
Computer and electronic product manufacturing	0.30
Electrical equipment, appliance and component manufacturing	0.61
Miscellaneous manufacturing	0.42
<i>Group 3</i>	
Wood product manufacturing	0.46
Paper manufacturing	0.30
Machinery manufacturing	0.64
Transportation equipment manufacturing ¹	0.30
Furniture and related product manufacturing	0.75

¹ Calculations use Newey and West's estimator of var(b)

The estimated coefficient of Canadian GDP growth yields significant results for 15 of the 18 selected industries at the 10% significance level. For some industries, the respective p-values were 0.0 indicating significance at all levels. This indicates, as expected, that aggregate GDP performance is a significant determinant of the performance of individual manufacturing industries. This confirms the findings of Bayoumi and Muhleisen (2006) who suggested that the overall strength of the economy will be a much larger determinant of the health of manufacturing industries than the exchange

rate. In all cases, the coefficient associated with economic growth was positive. Perhaps somewhat surprising is the magnitude of many of the GDP coefficients. All coefficients are positive indicating that GDP increases positively affect each of the manufacturing industries, but in many cases, the coefficients are greater than one. In several cases, the coefficients are greater than 3.0. This may indicate that movements in the aggregate economy have amplified effects on individual industries.

The real exchange rate variable also provides significant results for some industries. In all cases where the coefficient is significant, it is also positive. The sign of these coefficients fits with expected results as the exchange rate variable is based on Canadian dollars relative to American dollars meaning a Canadian currency appreciation, which should put downward pressure on Canadian manufacturing, is indicated by a fall in this index. A depreciation of the real exchange rate has a positive impact on sector GDP growth. Conversely, a real exchange rate appreciation has a negative impact on the sector GDP.

The model was run with two specifications of the real exchange rate variable: this paper used Canadian and US CPI's in one case and the respective industrial product price indexes in the other. The two alternatives lead to similar results and the real exchange rate based on Industrial Product Price indexes was used for the calculations shown. It is not surprising that these two alternative real exchange rate measures lead to comparable results given the similar movements in each in index. The alternative indexes have a correlation coefficient of 0.88 and, while diminished somewhat when comparing growths, the correlation coefficient of the growth rates is a very high 0.84.

The non-OECD import variable gives far less conclusive results. The coefficients associated with imports from non-OECD nations are only significant for two industries; Primary metal manufacturing and Machinery Manufacturing. In both of these cases, contrary to what may have been expected under the assumption that these imports would represent increased competition for Canadian manufacturers, the coefficient is positive. This may indicate that these industries were more likely to benefit from economic expansion in foreign economies as additional markets for their products.

5.1 Analyses of Trade Exposure

As aforementioned, the industries have been evaluated and grouped by trade exposure as of 2002. Reviewing industries by group suggests that net trade exposure may be related to the impact of exchange rate movements as evaluated through this model. Within the first group, representing industries with less than 15% trade exposure, only food manufacturing reveals a significant relationship for the real exchange rate. Within the second group (15-30 % trade exposure), two of the eight possible industries result in significant coefficients associated with the real exchange rate variable. In the case of the third group (greater than 30%) again one of the five possible industries results in significant coefficients. The number of significant exchange rate coefficients by group therefore suggests that perhaps trade exposure does not have an impact on the results by industry in this model. The magnitudes of the coefficients, however, are interesting. In comparing the significant coefficients, the magnitude increases as trade exposure increases. This may suggest that the severity of the impact of exchange rate

movements is amplified by the degree of trade exposure of the given industry. This result would mirror the finding in Ghanem and Cross (2008) who concluded that net trade exposure can be a determinant of industries' performance during times of exchange rate appreciation. Similarly, the above listed studies on investment movements as a result of exchange rate shifts support the idea that trade exposure, both in Canada and in studies on foreign countries, is a determinant of whether exchange rate appreciation leads to an increase or decrease in investment.

The other variables in the model, and their possible significance, or the magnitude of their coefficients, do not seem to be related to trade exposure. Interestingly, however, when comparing industries by group, the respective goodness of fit statistics tend to increase with trade exposure.

The number of significant coefficients related to the real exchange rate may be fewer than what was initially expected given the amount of media coverage dedicated to the recent exchange rate appreciation and the negative effects on Canadian manufacturing. This is however, similar to the results found by Zhao (2007) in her attempt to link investment with exchange rate movements. She was able to find significant results for four of the manufacturing industries reviewed. Not surprisingly, there are similarities between the two studies concerning the industries where the exchange rate coefficient was found to be significant. In both studies, textile products and furniture manufacturing resulted in significant results. As noted by Dion et al. (2005), the difficulty in empirically isolating the effect of the exchange rate on individual industry performance is related to the many factors affecting an individual industry. These external factors tend to

outweigh the impact of the exchange rate at any given time. For this reason, it is inappropriate to make concrete determinations on the effect of the exchange rate appreciation on individual industries, but rather the pattern of increasing impact based on trade exposure and the result that the health of the overall economy is a much more common and significant determinant of industry performance.

6. Conclusions

The appreciation or depreciation of the real exchange rate has been found to have a significant impact on the performance of certain Canadian manufacturing industries. In the cases where the effect has been found to be significant, currency appreciation is related to downward pressure on that industry. Further, there is some evidence that import or export trade exposure affects the severity of exchange rate movement impacts. The overall economic growth, however, is a much more consistent determinant on the health of specific Canadian manufacturing industries.

These results are similar to those found in other studies that looked at exchange rate appreciation in relation to investment as well as the conclusions of Bayoumi and Muhleisen who suggested that the overall health of the economy versus exchange rate movements will be the primary determinant of Canadian manufacturing production.

Finally, it was not possible to draw the expected conclusion that increased foreign competition from developing countries was negatively affecting Canadian manufacturing. In fact, the opposite effect of a positive relationship between increased

non-OECD imports and the production of certain industries was detected. This may indicate that these industries are benefitting from growth in developing economies. Due to the weakness of the proxy used in this analysis, these results should be viewed with great caution. This is a potential area for further exploration.

It is also worth noting that given the relatively few observations used in analyses, and the fact that selected industries failed the initial test, and the second test, for non-stationarity, some results must be viewed with caution.

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Table 2 - Net Annual Interprovincial Migration

	1998	1999	2000	2001	2002
Newfoundland and Labrador	-7,971	-3,916	-4,884	-3,914	-3,187
Prince Edward Island	-15	212	-62	268	65
Nova Scotia	-1,571	947	-1,393	-1,946	-256
New Brunswick	-2,935	-638	-1,748	-1,914	-164
Quebec	-14,512	-11,712	-11,233	-6,388	-4,228
Ontario	11,466	18,424	23,292	10,622	5,065
Manitoba	-3,097	-2,387	-4,188	-5,025	-2,733
Saskatchewan	-1,786	-7,146	-8,301	-8,600	-7,431
Alberta	40,125	19,692	24,397	24,614	17,883
British Columbia	-17,521	-12,413	-14,783	-7,278	-5,216
Yukon	-1,114	-601	-654	-246	-115
Northwest Territories	-1,057	-455	-514	-39	213
Nunavut	-12	-7	71	-154	104

	2003	2004	2005	2006	2007
Newfoundland and Labrador	-1,103	-2,651	-4,497	-3,964	-694
Prince Edward Island	224	-259	-237	-591	-237
Nova Scotia	142	-1,594	-3,679	-3,060	-546
New Brunswick	-1,277	-867	-2,708	-3,574	1,100
Quebec	218	-3,297	-6,834	-12,915	-14,444
Ontario	-5,074	-8,222	-14,500	-32,318	-17,762
Manitoba	-3,162	-3,153	-9,298	-7,658	-1,390
Saskatchewan	-4,590	-6,027	-9,737	-2,856	10,174
Alberta	10,254	19,348	44,968	58,166	10,625
British Columbia	4,055	7,551	7,434	10,221	13,385
Yukon	273	-156	89	-379	71
Northwest Territories	258	-482	-896	-809	-278
Nunavut	-218	-191	-105	-263	-4

* Taken from Statistics Canada CANSIM database, Table 051-0017, October 2008

Table 3 – Growth by Manufacturing Industry, 1997 – 2002 vs 2002 - 2007

Industry	Growth: 1997- 2002	Growth: 2002- 2007
Food manufacturing [311]	20%	10%
Beverage and tobacco product manufacturing [312]	-3%	-17%
Textile, clothing and leather product manufacturing [31X]	8%	-39%
Wood product manufacturing [321]	30%	-9%
Paper manufacturing [322]	9%	-14%
Printing and related support activities [323]	20%	-11%
Petroleum and coal products manufacturing [324]	12%	-3%
Chemical manufacturing [325]	25%	6%
Plastics and rubber products manufacturing [326]	39%	-3%
Non-metallic mineral product manufacturing [327]	31%	20%
Primary metal manufacturing [331]	25%	6%
Fabricated metal product manufacturing [332]	40%	2%
Machinery manufacturing [333]	13%	18%
Computer and electronic product manufacturing [334]	9%	26%
Electrical equipment, appliance and component manufacturing [335]	19%	-20%
Transportation equipment manufacturing [336]	15%	7%
Furniture and related product manufacturing [337]	54%	-12%
Miscellaneous manufacturing [339]	36%	13%

* Taken from Statistics Canada CANSIM database Table 379-0027, October 2008

Table 4 – OLS Results

* The following OLS results have been calculated using the software package SHAZAM. When covariance matrix has been adjusted to account for heteroskedasticity or autocorrelation it is noted.

All Models run with 26 observations

Industry	Food manufacturing	Beverage and tobacco product manufacturing	Printing and related support activities	Petroleum and coal products manufacturing
NAICS Code	311	312	323	324
Group	1	1	1	1
R^2	0.2575	0.2197	0.3024	0.0616
Real Canada GDP	0.4093	0.83526	1.8089**	0.77749
<i>t-stat</i>	1.399	1.677	2.482	1.16
Non-OECD Imports	1.94E-02	5.27E-02	-9.89E-03	-7.68E-02
<i>t-stat</i>	0.3271	0.5228	-0.06698	-0.5657
Real Exchange Rate	0.27933**	0.15763	0.39017	0.11173
<i>t-stat</i>	2.268	0.752	1.272	0.396
Constant	4.22E-03	-3.65E-02**	-4.53E-02**	7.44E-03
<i>t-stat</i>	0.513	-2.606	-2.212	0.3946

¹ Calculations use Newey and West's estimator of var(b)

* Significant at 10%

** Significant at 5%

Data Test Statistics (p-values)

Durbin Watson				
<i>Positive Autocorrelation</i>	0.322	0.61	0.304	0.3
<i>Negative Autocorrelation</i>	0.678	0.39	0.696	0.7
Heteroskedasticity				
<i>Breush-Pagan-Godfrey</i>	0.898	0.229	0.2	0.623
<i>Arch Test</i>	0.281	0.673	0.534	0.078
Jarque-Bera Normality Test	0.483	0.034	0.75	0.533

Industry	Non-metallic mineral product manufacturing	Textile, clothing and leather product manufacturing	Chemical manufacturing	Plastics and rubber products manufacturing ¹
NAICS Code	327	31X	325	326
Group	1	2	2	2
R ²	0.6594	0.4462	0.4338	0.0616
Real Canada GDP	2.9825**	2.3751**	1.3417**	0.77749*
<i>t-stat</i>	5.125	3.475	2.93	1.743
Non-OECD Imports	3.47E-02	-3.80E-02	5.55E-02	-7.68E-02
<i>t-stat</i>	0.2943	-0.2744	0.5983	-0.6688
Real Exchange Rate	0.087693	0.50199*	0.013416	0.11173
<i>t-stat</i>	0.358	1.745	0.06962	0.384
Constant	-6.23E-02**	-7.90E-02**	-1.05E-02	7.44E-03
<i>t-stat</i>	-3.81	-4.112	-0.8142	0.4478

¹ Calculations use Newey and West's estimator of var(b)

* Significant at 10%

** Significant at 5%

Data Test Statistics (p-values)

Durbin Watson				
<i>Positive Autocorrelation</i>	0.252	0.511	0.077	0.007
<i>Negative Autocorrelation</i>	0.748	0.489	0.923	0.993
Heteroskedasticity				
<i>Breush-Pagan-Godfrey</i>	0.168	0.475	0.783	0.447
<i>Arch Test</i>	0.182	0.82	0.796	0.756
Jarque-Bera Normality Test	0.832	0.319	0	0.696

Industry	Primary metal manufacturing	Fabricated metal product manufacturing	Computer and electronic product manufacturing	Electrical equipment, appliance and component manufacturing
NAICS Code	331	332	334	335
Group	2	2	2	2
R ²	0.6191	0.6072	0.3018	0.6109
Real Canada GDP	1.7068**	3.1549**	3.9392**	2.891**
<i>t-stat</i>	3.211	4.808	2.44	3.976
Non-OECD Imports	0.24499**	-1.21E-02	-5.10E-02	1.58E-01
<i>t-stat</i>	2.276	-0.09138	-0.1561	1.075
Real Exchange Rate	0.33037	0.14234	-0.41691	0.74135**
<i>t-stat</i>	1.477	0.5155	-0.6136	2.423
Constant	-3.66E-02**	-5.89E-02**	-3.14E-02	-9.30E-02**
<i>t-stat</i>	-2.451	-3.193	-0.6911	-4.552

¹ Calculations use Newey and West's estimator of var(b)

* Significant at 10%

** Significant at 5%

Data Test Statistics (p-values)

Durbin Watson				
<i>Positive Autocorrelation</i>	0.075	0.444	0.145	0.185
<i>Negative Autocorrelation</i>	0.925	0.556	0.855	0.815
Heteroskedasticity				
<i>Breush-Pagan-Godfrey</i>	0.704	0.544	0.338	0.739
<i>Arch Test</i>	0.12	0.677	0.487	0.302
Jarque-Bera Normality Test	0.128	0.066	0	0.09

Industry	Miscellaneous manufacturing	Wood product manufacturing	Paper manufacturing	Machinery manufacturing
NAICS Code	339	321	322	333
Group	2	3	3	3
R ²	0.4232	0.4647	0.3008	0.6383
Real Canada GDP	2.4618**	3.0217**	1.2502**	2.5435**
<i>t-stat</i>	3.341	3.588	2.247	3.402
Non-OECD Imports	-3.29E-02	-4.66E-03	4.57E-02	0.34724**
<i>t-stat</i>	-0.2208	-0.0273	0.4055	2.293
Real Exchange Rate	-0.047034	0.32595	0.20941	0.22269
<i>t-stat</i>	-0.1517	0.9197	0.8944	0.7076
Constant	-3.37E-02	-5.14E-02**	-3.16E-02*	-5.50E-02**
<i>t-stat</i>	-1.628	-2.171	-2.021	-2.619

¹ Calculations use Newey and West's estimator of var(b)

* Significant at 10%

** Significant at 5%

Data Test Statistics (p-values)

Durbin Watson				
<i>Positive Autocorrelation</i>	0.581	0.29	0.338	0.138
<i>Negative Autocorrelation</i>	0.419	0.71	0.661	0.862
Heteroskedasticity				
<i>Breush-Pagan-Godfrey</i>	0.65	0.502	0.905	0.292
<i>Arch Test</i>	0.433	0.5	0.604	0.836
Jarque-Bera Normality Test	0.774	0.01	0.602	0.823

Industry	Transportation equipment manufacturing¹	Furniture and related product manufacturing
NAICS Code	336	337
Group	3	3
<hr/>		
R ²	0.3018	0.7498
Real Canada GDP	3.9392**	3.8369**
<i>t-stat</i>	2.588	6.309
Non-OECD Imports	-5.10E-02	2.85E-02
<i>t-stat</i>	-0.2106	0.2316
Real Exchange Rate	-0.41691	0.84766**
<i>t-stat</i>	-0.7303	3.312
Constant	-3.14E-02	-7.76E-02**
<i>t-stat</i>	-0.5809	-4.541

¹ Calculations use Newey and West's estimator of var(b)

* Significant at 10%

** Significant at 5%

Data Test Statistics (p-values)

Durbin Watson		
<i>Positive Autocorrelation</i>	0.044	0.631
<i>Negative Autocorrelation</i>	0.956	0.369
Heteroskedasticity		
<i>Breush-Pagan-Godfrey</i>	0.139	0.637
<i>Arch Test</i>	0.623	0.056
Jarque-Bera Normality Test	0.616	0.938

Table 5 – Test for Unit Root

Tests of Non-Stationarity - Critical value @ 10% significance level = -2.57

Variable	Dickey Fuller Test Statistic	Phillips- Perron Test Statistic
Canada GDP	-2.86	-2.96
Non-OECD Imports	-3.14	-5.02
Real Exchange Rate	-2.74	-2.85
Food manufacturing [311]	-2.65	-4.38
Beverage and tobacco product manufacturing [312]	-2.57	-5.63
Textile, clothing and leather product manufacturing [31X]*	-2.17	-3.25
Wood product manufacturing [321]	-2.33	-3.8
Paper manufacturing [322]	-4.23	-4.23
Printing and related support activities [323]	-1.65	-4.14
Petroleum and coal products manufacturing [324]	-3.1	-4.46
Chemical manufacturing [325]	-3.8	-3.8
Plastics and rubber products manufacturing [326]	-2.82	-2.79
Non-metallic mineral product manufacturing [327]	-2.44	-2.43
Primary metal manufacturing [331]	-3.81	-3.75
Fabricated metal product manufacturing [332]	-4	-4.01
Machinery manufacturing [333]	-4.64	-4.66
Computer and electronic product manufacturing [334]	-2.94	-4.25
Electrical equipment, appliance and component manufacturing [335]	-1.92	-3.27
Transportation equipment manufacturing [336]	-1.9	-3.61
Furniture and related product manufacturing [337]	-2.48	-2.53
Miscellaneous manufacturing [339]	-2.23	-4.79

* Uses constant, with trend model for test

* The above test statistics were generated using the software package SHAZAM.