INSTITUTO DE ECONOMÍA

DOCUMENTO de TRABAJO

455

2014

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www.economia.puc.cl • ISSN (edición impresa) 0716-7334 • ISSN (edición electrónica) 0717-7593

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Abstract

I study the evolution of productivity in Canada relative to the United States during two trade liberalization episodes: the 1965 Auto Pact and the 1989 Free Trade Agreement. I find that Canada's productivity grew more than U.S. productivity in the liberalized sector, which is consistent with the idea that openness increases productivity. This study reveals new evidence of productivity during the Auto Pact. Regarding the Free Trade Agreement, existing studies find that manufacturing productivity grew less in Canada than in the United States following the agreement. I argue that this is due to the use of prices that are not comparable across countries. Once these prices are made comparable, my findings are that manufacturing productivity grew more in Canada than in the United States. The results of this study suggest there are productivity gains associated with trade liberalization, and models of international trade should account for them.

JEL Classifications: F11; F12; F13; F14
Keywords: Auto Pact, US - Canada Free Trade Agreement, Productivity Gains from Trade.

Acknowledgements: Financial support from the Spanish Ministry of Science and Innovation (ECO2008-01300 and ECO2011-27014) is gratefully acknowledged.

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Abstract

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I. Introduction

The effects of trade liberalization on economic outcomes are heavily debated in the economic literature, and, while most economists believe that trade liberalization increases productivity, the evidence in favor of this view is, at best, mild. In this paper, I study the behavior of productivity during two episodes of trade liberalization between the United States and Canada: the Auto Pact in 1965 and the Free Trade Agreement between 1989 and 1998.

I find that industry productivity grew more in Canada during the liberalization periods. If trade liberalization increases productivity, then the increase should be larger where trade is more important. Thus, my findings suggest that trade increases productivity.

The first agreement I study is the Auto Pact. Signed in 1965, it eliminated tariffs related to automobiles and auto parts. Trade volumes increased by a factor of seven. Associated with this, Canadian automotive productivity grew 22% more than U.S. productivity.

The Free Trade Agreement has been the subject of many papers in the literature, although not many focus on productivity.[2] This episode is puzzling because different studies find different results. Trefler (2004) finds significant productivity gains from trade in Canadian industries. On

[2] See Kehoe (2003) for a survey of the literature.

the other hand, Van Ark et al. (2002) find that Canadian manufacturing productivity grew less than U.S. manufacturing productivity.

One explanation for the different results is that the U.S. gained from trade liberalization as much as Canada, but this is hard to acknowledge given that trade as a percentage of GDP is much larger in Canada. Also, Bernard and Jensen (1999) and Rubini (2011) estimate that the free trade agreement had very mild effects on U.S. manufacturing productivity.

Another potential explanation is that productivity changes are the result of many different factors interacting. Trade is only one of these factors. In spite of the large gains from trade, other factors may have affected Canadian manufacturing productivity adversely enough to make the aggregate worse off relative to manufacturing productivity in U.S.

While this may well be the case, the data at a more disaggregate level suggests otherwise. Out of 26 manufacturing industries, in 17 of them Canadian productivity outgrew U.S. productivity between 1989 and 1998, the years of the Free Trade Agreement. The value added in these 17 industries represented three fourths of total manufacturing value added in each country.

Of the remaining nine industries, only in two U.S. productivity performed far better than Canadian productivity, and these industries together account for only about 5% of total manufacturing value added in the United States and 1% in Canada. These industries contain computers and semiconductors.

Computers and semiconductors are heavily intensive in information and communication technology. As Van Ark et al. (2003) point out, the fast change in quality of these sectors during the years of the free trade agreement has made it very hard for the national accounts to come up with reasonable price deflators that can be compared across countries. While both U.S. and Canada use price deflators that adjust for the changing quality, these are not consistent with each other. Using Canadian price deflators to measure real value added in these sectors in both countries, I find that Canada's productivity grew more than United States'.

The analysis of these two trade agreements suggest that trade liberalization has important consequences on productivity. This is problematic in light of existing models. Gibson (2006) and Burstein and Cravino (2012) show that models such as Eaton and Kortum (2002) and Melitz (2003) cannot account for any increase in productivity from a reduction in trade costs when productivity is measured as in the national accounts given a reduction in trade costs.[3]

To fully understand the effects of trade liberalization, we need to incorporate mechanisms that allow for productivity gains from trade, measured as in the national accounts. Some of these mechanisms have already been proposed. Rubini (2011) shows that introducing innovation into a Melitz (2003) model as in Atkeson and Burstein (2010) can account for increases in measured productivity. Bernard et al. (2003) show that introducing Bertrand competition into an Eaton and Kortum (2002) model can do the same.

This paper is organized as follows. Section 2 documents the main components of the Auto Pact.

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[3] Burstein and Cravino argue that this is no longer the case if trade barriers that include physical goods (as opposed to tariffs) are included in the price deflator. In this paper, we study the role of tariffs.

Section 3 does similarly for the Free Trade Agreement. Section 4 discusses the success of existing models in accounting for the increase in productivity associated with tariff reductions. Section 5 concludes.

II. The Auto Pact

The Auto Pact was signed in January 1965 and eliminated all tariffs to trade in cars, commercial vehicles, and auto parts. Prior to 1965, the car industry in Canada consisted mostly of U.S. manufacturers selling in Canada. The same manufacturers in the U.S. sold domestically. The effect of the Auto Pact was to profit from scale benefits in both countries. Factories in Canada would produce different models than factories in U.S., and sell in both markets.

Tariffs in Canada were of 17.5% for motor vehicles and auto parts before the agreement. In the United States, tariffs were of 8.5% for auto parts and 6.5% for motor vehicles, as described by Mason (1987) and Wonnacott (1987). These were eliminated in 1965.[4]

Figure 1 shows the ratio of bilateral trade to Canadian value added in the car industry. It was about 50% in 1961. By 1973, it had grown to almost 350%. This is exports from Canada to U.S. plus exports from U.S. to Canada in transportation equipment relative to value added in the transportation equipment sector in Canada. Data are from the OECD database, Statistics Canada and exchange rates are from the World Development Indicators database (WDI).

Figure 2 compares the evolution of trade in the car industry with all other bilateral trade. Both series are normalized to 1 in 1961. Clearly, there is no change in the trade series for non-auto trade, but huge changes in the auto trade series.

Next I turn to productivity in the automotive sector. The main problem is the lack of good, comparable data. I found no measures of sector value added per hour or per worker for this period in both countries, much less data on capital. There is however data on output per worker in both countries, so I define this as my measure of productivity. Statistics Canada provides data on output per hours worked in Canada since 1961 on the Transportation Equipment Manufacturing industry (NAICS code 336). The Bureau of Labor Statistics provides data on the Motor Vehicles and Equipment industry (SIC 371) for the U.S. since 1958. Figure 3 plots the productivity of the Canadian car industry divided by the productivity of the American car industry from 1961 to 1973.[5]

Following the Auto Pact, the productivity of the Canadian car industry grew 22% more than the

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[4] While some non-tariff barriers were introduced by the agreement, Fuss and Waverman (1986) conclude that they were mostly non-binding. For example, a car subject to no tariffs should contain at least 50% of Canadian or U.S. content. The actual content all through the period 1965-1980 was actually higher.

[5] I stop in 1973 because after that the oil crisis contaminates the sample. While the U.S. was subject to international oil prices, Canada introduced oil export taxes and therefore was not subject to the high world prices. This affected output per worker differently in each country.

productivity of the American car industry from 1965 to 1973. This evidence suggests that the Auto Pact had the effect of increasing productivity in Canada more than in the U.S. Figure 3 plots the evolution of the productivity in the automotive sector in Canada relative to the U.S.

III. The Free Trade Agreement

The Free Trade Agreement between Canada and the United States came into effect on January 1989. The agreement specified a sequence of tariff and non-tariff barrier reductions that would completely eliminate trade barriers within the course of ten years. A group of goods eliminated tariffs immediately. A second group eliminated them gradually over five years (20% per year). A third group eliminated them gradually over ten years (10% per year). Trefler (2004) calculates bilateral tariffs for all manufacturing codes at the 4-digit level from 1980 to 1996. Figure 4 plots average tariffs in the U.S. and in Canada.

Figure 5 shows trade volumes. The figure plots exports from Canada to U.S. plus exports from U.S. to Canada over Canadian manufacturing value added. Trade data is from the OECD database. Manufacturing value added is from the GGDC 60 industry database (Groningen Growth and Development Centre). I use exchange rates from the World Development Indicators. Trade volumes doubled during the Free Trade Agreement.

Next I turn to manufacturing productivity. Trefler (2004) finds that the tariff drops led to an average increase in Canadian manufacturing productivity of between 5 and 8.3 percent. Rubini (2011) finds that the increase in U.S. productivity was almost negligible. Bernard and Jensen (1999) estimate that the productivity gains from trade in the U.S. are, if anything, very small. Thus, we should expect Canada's manufacturing productivity to have grown much more than U.S. manufacturing productivity.

However, Van Ark et al. (2002) find this is not the case. This conclusion comes from studying the data collected by the GGDC 60 industry database. Figure 6 plots manufacturing productivity in Canada relative to manufacturing productivity in the United States between 1988 and 1998. The figure shows real manufacturing value added per hour worked in Canada relative to the United States. The series are normalized to 1 in 1979. The box represents the years with tariff drops. The figure shows Canada actually lost ground relative to the United States, a loss of about 40%.

To explore this in greater detail, I turn to more disaggregate industry specific productivities. Figure 6 plots the evolution of productivity in Canada relative to the United States for each manufacturing industry in the GGDC 60 industry database.[6]

In 17 out of 26 industries, Canadian productivity grew faster than U.S. productivity. These industries accounted for three fourths of manufacturing value added in each country. Thus, it must be the case that in some of the 9 industries in which the U.S. outgrew Canada, the differential rates of growth were spectacular enough to account for the fact that aggregate manufacturing productivity grew much more in the United States.

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[6] Canada does not report anything for Other Instruments, so I exclude the industry.

This is true for only two industries: Office machinery and Electronic Valves and Tubes. Office Machinery contains mainly computers, and Electronic Valves and Tubes semiconductors. In the United States, the productivity in Office Machinery grew by a factor of over 210 between 1988 and 1998. In Electronic Valves and Tubes U.S. productivity grew by a factor of 12. In Canada, the respective sector productivity growths are 11 and 2. Thus, U.S. productivity grew almost 20 times more in Office Machinery, and 6 times more in Electronic Valves and Tubes. Figure 7 shows the growth rates in the remaining industries. These are nowhere near the spectacular growth of Office Machinery or Electronic Valves and Tubes.

A well-known problem in comparing internationally the Office Machinery and Electronic Valves and Tubes industries lies in the price deflator. As Van Ark et al. (2003) argue, it is extremely hard for countries to account for the changes in the capabilities of computers and semiconductors, which have improved tremendously during the period of analysis. Only a few countries have an adequate system for measuring prices of computers and semiconductors. While the United States and Canada have their methods, these differ enormously, which makes statistics hard to compare.

To give an idea of how much these price deflators differ, consider their growth rates throughout the period. These price deflators are normalized to 100 in 1995. In the United States, the price deflator for Office Machinery in 1988 was equal to 1550, and it dropped to 16 by 1998. In Canada, the respective numbers are 962 and 120. Something similar happens in the Electronic Valves and Tubes sector. The price deflator in the U.S. in 1988 was 294, dropping to 51 by 1998. In Canada, the deflator increased slightly from 91 to 97.

In light of this problem, I use the same price deflators in both countries. Van Ark et al. (2003) use a common ICT price deflator to compare Canadian, U.S. and European industries. These authors use U.S. price deflators in the countries analyzed. The problem with this choice is that U.S. prices change so much that the change in the industries affected by these prices has an enormous impact on the aggregate. It is equally justified to use Canadian price deflators, and in this way these industries will weigh in much less on the aggregate. Thus, I reconstruct the series of U.S. constant price value added using Canadian prices adjusted for relative inflation for these two industries. The details of how I do this are in the appendix.

Figure 8 shows the change in the evolution of productivity in Office Machinery before and after the adjustment in U.S., and Figure 9 shows it for Electronic Valves and Tubes. The differential growth rates are much milder under the adjusted price deflators.

The results at the aggregate level using the adjusted series overturn the previous results. Aggregate manufacturing productivity in Canada spiked relative to manufacturing productivity in the United States after the start of the tariff removal program, as Figure 10 shows. In fact, my results show that manufacturing productivity in Canada increased relative to the United States by about 15%. Trefler finds that about half of this increase is due to tariff drops. In sum, this new evidence shows that manufacturing productivity grew faster in Canada than in U.S., as in the case of the Auto Pact; again suggesting that trade liberalization is associated with productivity increases. The productivity increase is larger where trade is more important.

IV. International Trade Models and Productivity Gains

The two analyzed episodes of trade liberalization between Canada and the United States suggest that productivity in Canada grew more than productivity in the United States following the agreements. Since trade is more important in Canada, it is natural to expect that trade liberalization was responsible. This presents a puzzle in the light of most current models of international trade, which cannot account for any gains in productivity from the reduction of trade barriers. These models include Krugman (1980), Melitz (2003), and Eaton and Kortum (2002). Gibson (2006) and Burstein and Cravino (2012) point out that increased trade does not translate to increased productivity in these models.[7] I next describe what the problem of these models is and what kind of models can successfully generate the increase in productivity from a reduction in trade barriers.

A. Models where trade costs do not affect productivity

These models include the most commonly used models, such as Melitz (2003) and Eaton and Kortum (2002). The intuition is as follows. In these models trade liberalization reallocates resources from firms that do not export to firms that do. This would only increase measured aggregate productivity if exporters had higher measured productivity. But they do not. Measured productivity is the same for all firms in these models. Therefore, the reallocation of resources does not increase measured productivity.

Consider the Melitz (2003) model. The reason why exporters do not have higher measured productivity is the following. While exporters are "technologically better" in the sense that they produce more units of physical output per worker, these firms set relatively lower prices, which lowers their value added (price times quantity). With Dixit-Stiglitz preferences, the drop in price exactly offsets the additional physical output per worker, so in equilibrium all firms have the same value added per worker, that is, measured productivity.

More specifically, define $\Omega_t \subset \mathbb{R}$ as the names of the goods available in period t. Good $\omega \in \Omega_t$ inputs $n(\omega)$ units of labor services and outputs $y(\omega)$ units of the good, where $y(\omega) = \gamma(\omega)\, n(\omega)$, and $\gamma(\omega): \Omega_t \to \mathbb{R}_+$ is a firm specific technological parameter. The mechanism in Melitz is based on the fact that exporting entails a fixed cost, so only some firms can finance it. These are the firms whose exporting profits exceed this cost. Since higher γ make higher profits, only high γ firms export.

A reduction in the fixed trade cost drives more firms into the export market. Of the ones that did not export before, these are the ones with the relatively higher γ. Moreover, since these firms increase output, the demand for labor in the economy increases, increasing wages, and reducing the profits of those firms who still do not export. When there is a fixed production cost, this implies that some firms close down. These are the ones with relatively low γ. So there is a reallocation of resources from firms with low γ to firms with high γ. This is a gain in welfare, but

[7] Burstein and Cravino show that this is true when variable trade costs are not included in the price deflator. I discuss further this point later.

it is not a gain in measured productivity.

To see this, consider the measured productivity of firm ω. In the data, this is calculated as value added per worker. That is

$$\frac{VA(\omega)}{n(\omega)} = \frac{p(\omega)y(\omega)}{n(\omega)}$$

where $VA(\omega)$ is value added of firm ω, and $p(\omega)$ is the price. Since this model incorporates Dixit Stiglitz preferences, price is a constant mark-up over marginal cost, that is, $p(\omega) = \mu \frac{w}{\gamma(\omega)}$ where μ is the mark-up, w is the wage rate and $\frac{w}{\gamma(\omega)}$ is marginal cost. Setting $w = 1$ as the numeraire, value added per worker in firm ω becomes

$$\frac{VA(\omega)}{n(\omega)} = \frac{p(\omega)y(\omega)}{n(\omega)} = \frac{p(\omega)\gamma(\omega)n(\omega)}{n(\omega)} = \frac{\mu w}{\gamma(\omega)}\gamma(\omega) = \mu$$

so that firm productivity is independent of γ and constant across firms. This implies that the reallocation from trade liberalization, while increasing welfare, does not increase measured productivity. To see this, we need to construct a measure of aggregate productivity as it is constructed in the NIPA accounts. This is

$$\Delta Prod_{t,0} = \frac{\dfrac{\int_{\bar{\Omega}} p_t(\omega)y_t(\omega)}{\int_{\bar{\Omega}} n_t(\omega)}}{\dfrac{\int_{\Omega_0} p_0(\omega)y_0(\omega)}{\int_{\Omega_0} n_0(\omega)}}$$

where Ω_0 is the set of goods available in period 0 and $\bar{\Omega}$ is the set of goods available in both periods 0 and t. Now assume that period 0 is before trade liberalization, and period t is after. From the previous equation, it is clear that $\Delta Prod_{t,0} = 1$.

In words, regardless of the change in trade costs, measured productivity remains unchanged in the Melitz world. The key to this result is that a policy change such as a change in trade costs does not affect relative prices, and therefore cannot affect measured productivity.

Burstein and Cravino (2012) show that when the change in variable export cost (iceberg cost, for example) is included in the price deflator, then there are gains from trade. However, in this paper we are analyzing the role of tariffs, which are commonly not included in the price deflator.

B. Models where changes in trade costs affect productivity

In light of the results in this paper, the fact that these models cannot account for measured productivity gains from trade is a shortcoming. We need to develop models that can generate these gains. And to do that, a change in trade costs must affect relative prices.

Rubini (2011) shows that models with innovation as in Atkeson and Burstein (2010) produce changes in relative prices, and therefore change aggregate measured productivity. These work by endogenizing the technologies of firms by making the parameter γ endogenous. The way to endogenize this parameter is via innovation, where innovation is any investment that increases firm productivity. Firms can incur a fixed cost to increase their productivity. As a result, an expansion in market size will drive firms to increase their productivity, and therefore reduce their price. A reduction in trade costs increases the market size for exporters.

Consider the problem in Rubini (2011). The environment is as in Melitz (2003), except that firms endogenously determine their productivity by innovating. Heterogeneity comes from a technology parameter γ that determines how effective the investment in technology is. Let $\gamma(\omega): \Omega_t \to \mathbb{R}_+$ be the function that maps a good's name to the goods technology parameter. The production function of firm $\omega \in \Omega_t$ is $y(\omega; z) = \gamma(\omega)zn$, where z is an endogenous variable to be determined at a cost and $n(\omega)$ is labor services. The cost of z is z^{α}labor units, $\alpha > 1$. To export, firms pay a fixed export cost and a variable export cost τ.

Firms maximize profits by choosing whether to export, prices, quantities, and innovation level z taking the demand of the consumers as given. Since preferences are Dixit Stiglitz preferences, demands are isoelastic. That is, the only change with respect to Melitz is that productivity now is endogenous, but depends on a heterogeneous technology parameter γ. The problem of the firm is

$$\max_{z,I,p_d,p_x,y_d,y_x,n_d,n_x} p_d y_d + I p_x y_x - w(n_d + n_x) - I\,\kappa - w z^{\alpha}$$

$$subject\ to$$

$$y_d = q_d(p_d, R), y_x = q_x(p_x, \tau, R^*), y_d + y_x = \gamma(\omega) z(n_d + n_x)$$

$$z \in \mathbb{R}_+, I \in \{0,1\}, p_d \in \mathbb{R}_+, p_x \in \mathbb{R}_+, q_d \in \mathbb{R}_+, q_x \in \mathbb{R}_+, n_d \in \mathbb{R}_+, n_x \in \mathbb{R}_+$$

where $q_d(p_d, R)$ and $q_x(p_x, \tau, R^*)$ are the domestic and foreign demand functions, respectively, that depend on the price and revenue (R). Foreign demand also depends on tariffs τ. Under Dixit Stiglitz preferences, these demands are isoelastic, which implies that price will be a mark-up over marginal cost:

$$p(\omega) = p_d(\omega) = p_x(\omega) = \mu \frac{w}{z(\omega)\gamma(\omega)}$$

where $z(\omega)$ solves the firm problem.

It is straightforward to show that, for an exporter (that is, $I(\omega) = 1$), a reduction in tariffs increases the optimal innovation level $z(\omega)$. This follows from the fact that the price paid by the importer is $(1+\tau)p_x(\omega)$ and that the law of demand holds. Applying the envelope theorem shows that

$$\frac{\partial z(\omega)}{\partial \tau} < 0$$

This implies that the revenues for exporting firm ω $(p_d(\omega)y_d(\omega) + p_x(\omega)y_x(\omega))$ increase, since demands are elastic.

For non exporters ($I(\omega) = 0$) that choose not to export even with the low tariff,

$$\frac{\partial z(\omega)}{\partial \tau} = 0$$

Thus, the price of exports drops relative to the price of goods that are not exported, changing relative prices. Thus, revenues of non-exporters stay constant. Measuring productivity in this model gives:

$$\Delta Prod_{t,0} = \frac{\dfrac{\int_{\overline{\Omega}} p_t(\omega) y_t(\omega)}{\int_{\overline{\Omega}} n_t(\omega)}}{\dfrac{\int_{\Omega_0} p_0(\omega) y_0(\omega)}{\int_{\Omega_0} n_0(\omega)}} > 1$$

This follows because the numerator increases due to the increase in exporter revenue.[8] This shows that a model with innovation can potentially reproduce the increase in measured productivity observed in the data.

Innovation is not the only way to generate increases in productivity. Models with endogenous mark-ups can also achieve this. Such is the case of Bernard et al. (2003). They introduce Bertrand competition to an Eaton and Kortum (2002) model. In equilibrium, an exporter sets the price equal to the cost of the closest competitor. When trade costs are lower, exporters face lower costs but do not change their prices, increasing mark-ups and therefore the ratio of value added per worker of a firm. The reallocation of resources toward these firms increases measured aggregate productivity.

Other models of endogenous mark-ups generate reductions in measured productivity from reductions in trade costs. This is the case of Melitz and Ottaviano (2008). Pricing to market implies that accessing a larger market reduces markups, and therefore measured productivity.

V. Conclusion

I have explored the effects on productivity of two important trade liberalization episodes between the United States and Canada. The first is the Auto Pact in 1965. The second is the Free Trade Agreement that started in 1989. It has been widely understood that these pacts have had large effects on the volume of trade, but the effects on productivity are more puzzling. Regarding the Auto Pact, the reason for our narrow understanding is the lack of data. In this paper, I have constructed a dataset that can help us understand and compare the behavior of Auto productivity in these two countries. The analysis of this data concludes that following the Auto Pact, Canadian Auto productivity grew more than productivity in the United States.

In the case of the Free Trade Agreement, our lack of understanding stems from the different results that different databases yield. Trefler (2004) finds that the agreement increased productivity in Canada. Rubini (2011) finds that it hardly produced any changes in U.S. productivity. In spite of this, Van Ark et al. (2002) find that aggregate manufacturing productivity in the United States grew more than in Canada.

I find the conclusion in Van Ark et al. (2002) is driven by the use of price deflators that are not comparable in the computers and semiconductors industries. When using comparable price deflators for both countries, I find that Canadian productivity actually grew more than U.S. productivity, consistent with Trefler (2004).

The evidence collected suggests that trade liberalization produces productivity gains. This is puzzling in light of current trade models as Melitz (2003) or Eaton and Kortum (2002), where aggregate productivity is independent of trade costs.

[8] This is true in partial equilibrium. In general equilibrium, Rubini (2011) shows that a drop in tariffs reduces income R, which delivers $\frac{\partial z(\omega)}{\partial \tau} > 0$, so it is no longer clear whether the numerator increases. However, quantitatively, it does in Rubini's exercise.

However, some extensions of these models are suitable for generating gains in measured productivity from reductions in trade costs. Rubini (2011) shows that introducing innovation to a Melitz (2003) model as in Atkeson and Burstein (2010) can generate increases in measured productivity. Bernard et al. (2003) shows that introducing Bertrand competition to an Eaton and Kortum (2002) model can generate increases in measured productivity as well. We need to concentrate on these types of model to understand the effects of trade liberalization on economic outcomes.

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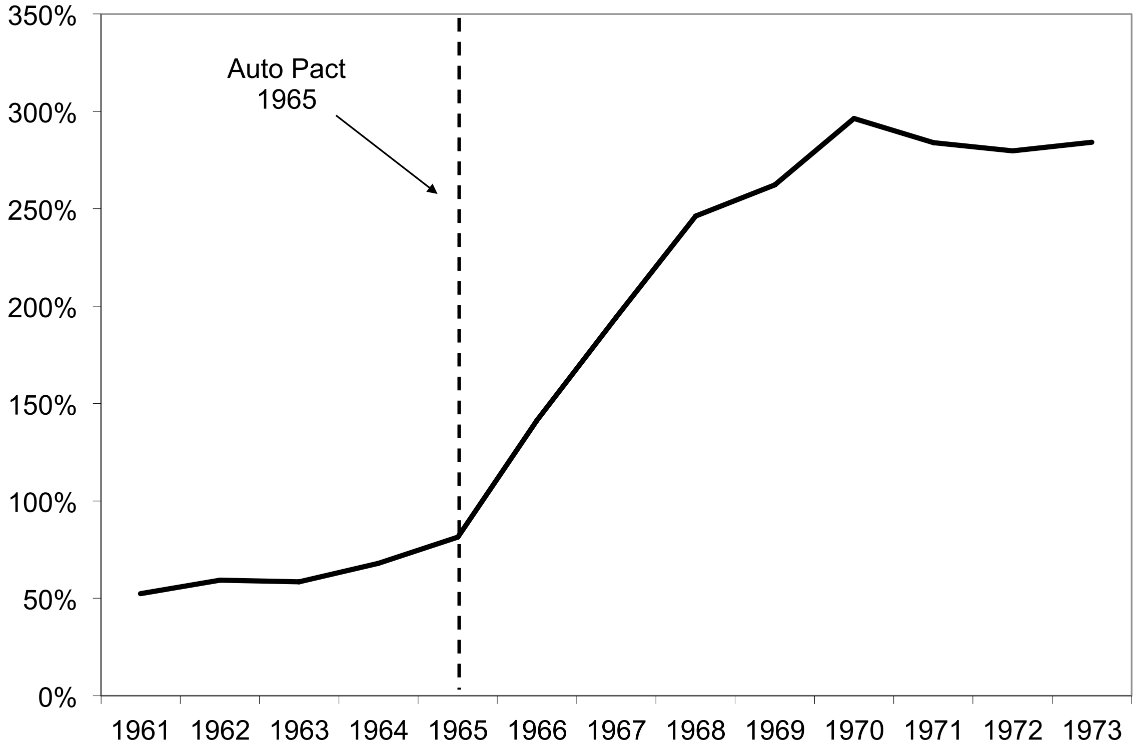
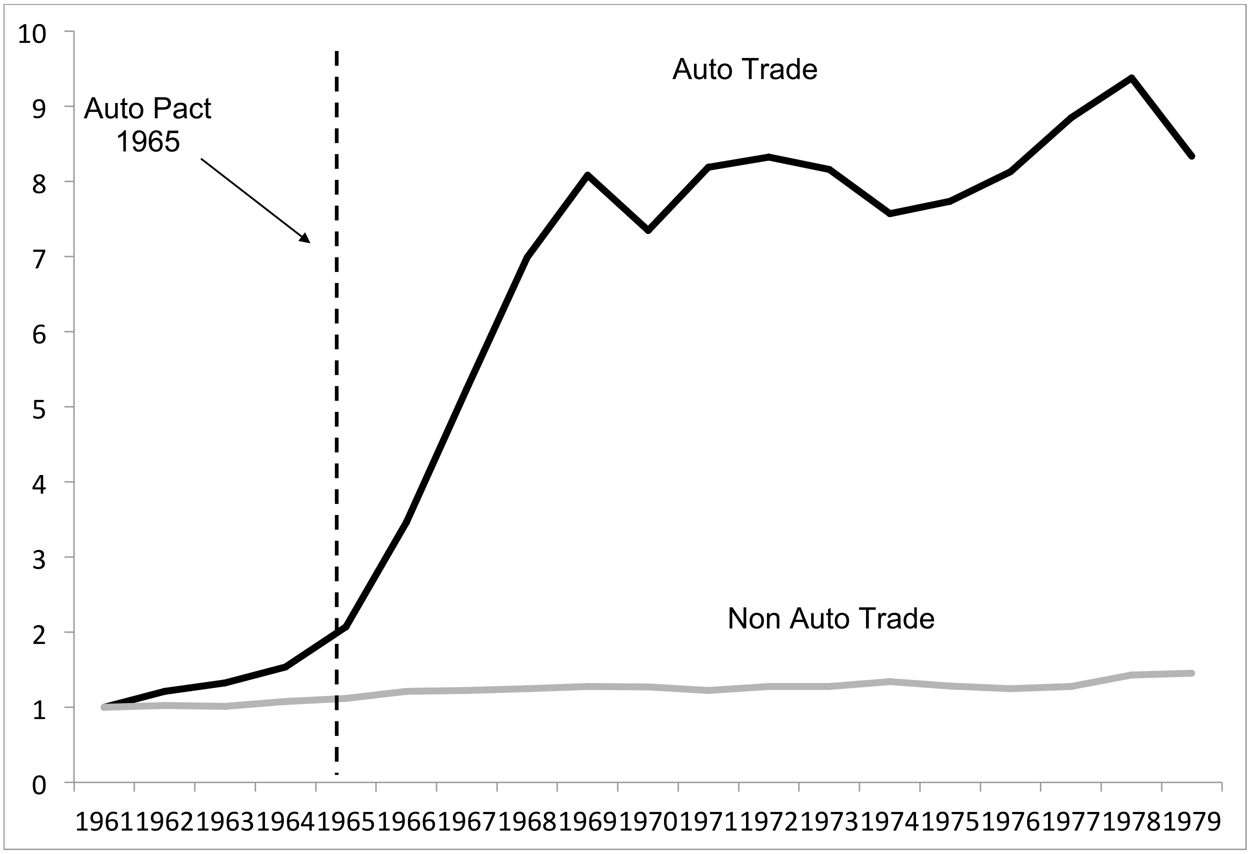
Appendix: Figures

Figure 1: Automotive Bilateral Trade Relative to Canadian Auto Value Added



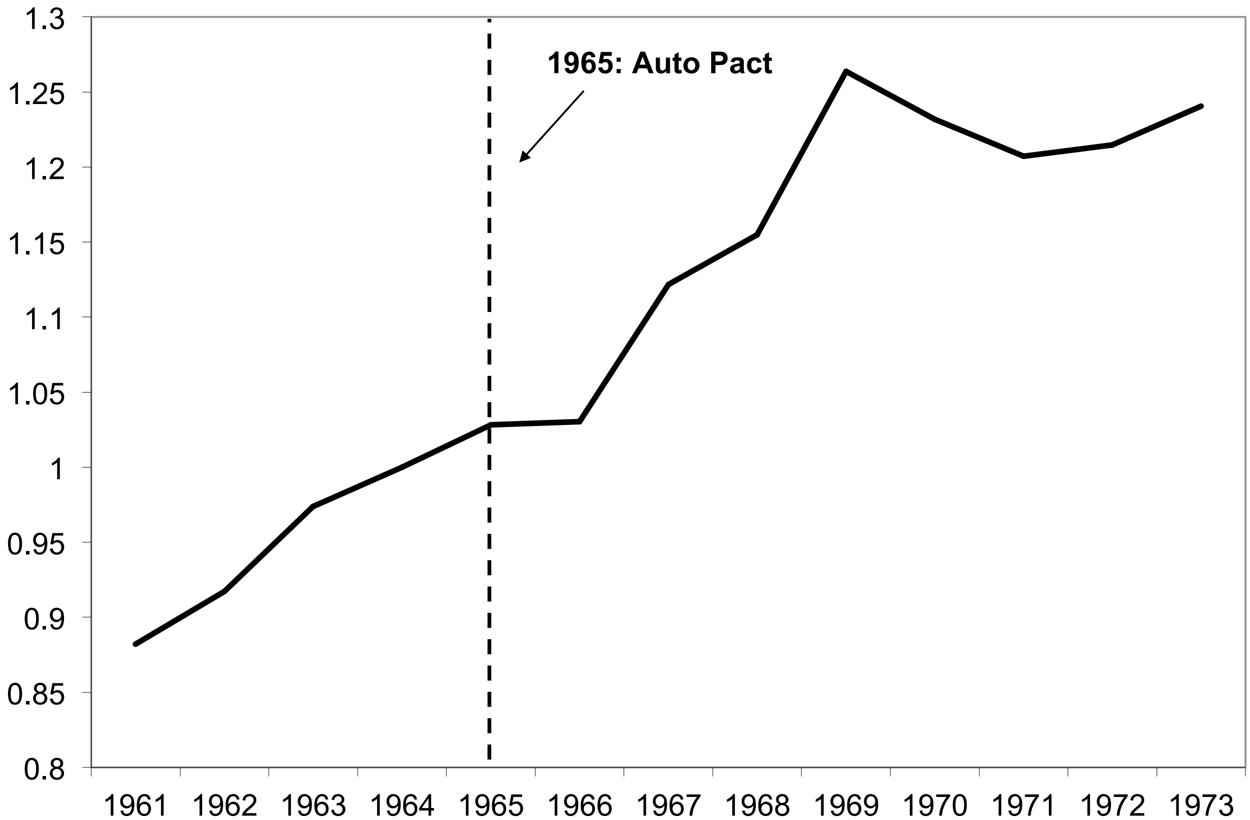
Note: Bilateral trade includes exports from Canada to U.S. and from U.S. to Canada.
Source: OECD, Statistics Canada and World Development Indicators.

Figure 2: Auto vs. Non Auto Trade



Note: Figure plots the sum of exports from Canada to U.S. and from U.S. to Canada. The black line includes the automotive trade, while the grey line includes all other trade. The series are normalized to equal 1 in 1961.
Source: OECD and Statistics Canada.

Figure 3: Automotive Productivity in Canada Relative to U.S.



Note: Productivity is revenue divided by number of workers. The figure plots this ratio for Canada divided by the ratio for the U.S. The series is normalized to equal 1 in 1964.
Source: Statistics Canada and Bureau of Labor Statistics.

Figure 4: Average Tariffs in Canada and U.S. for bilateral trade

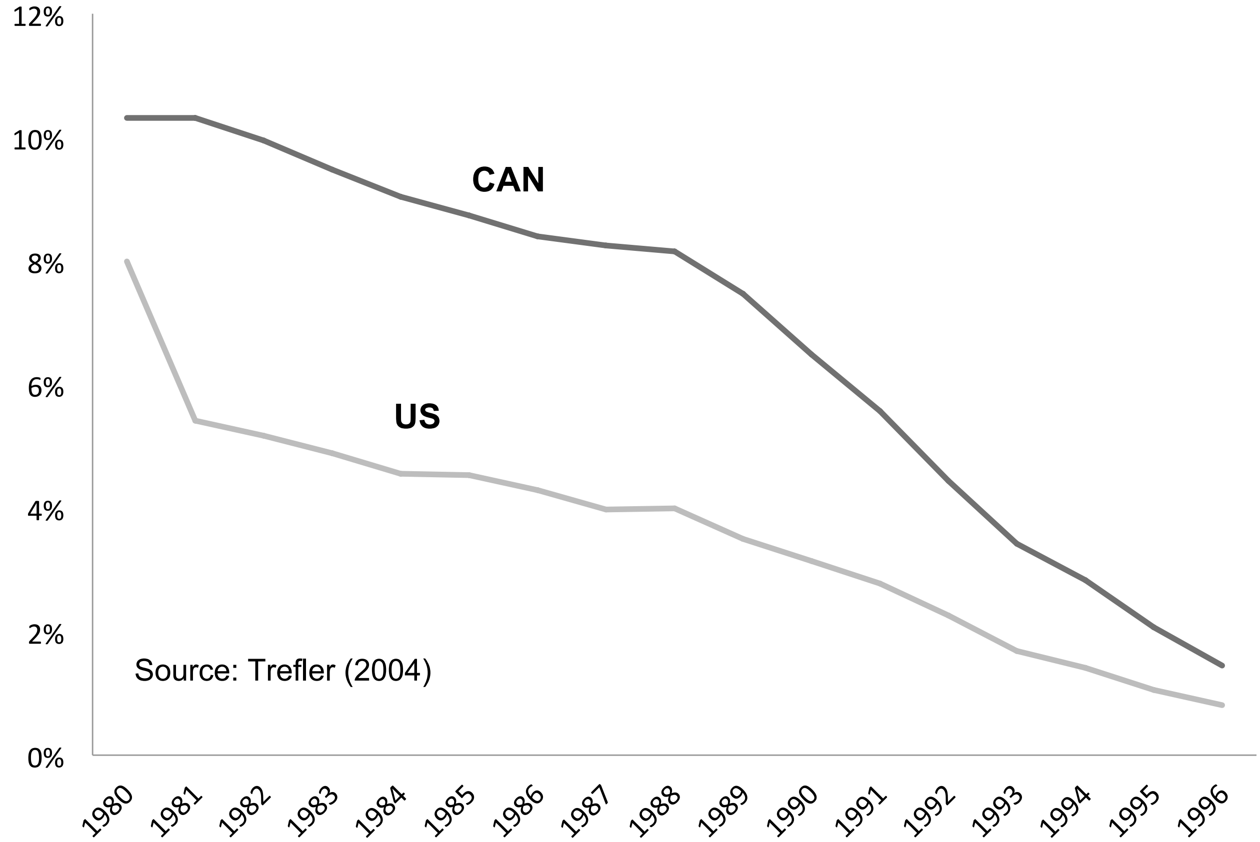
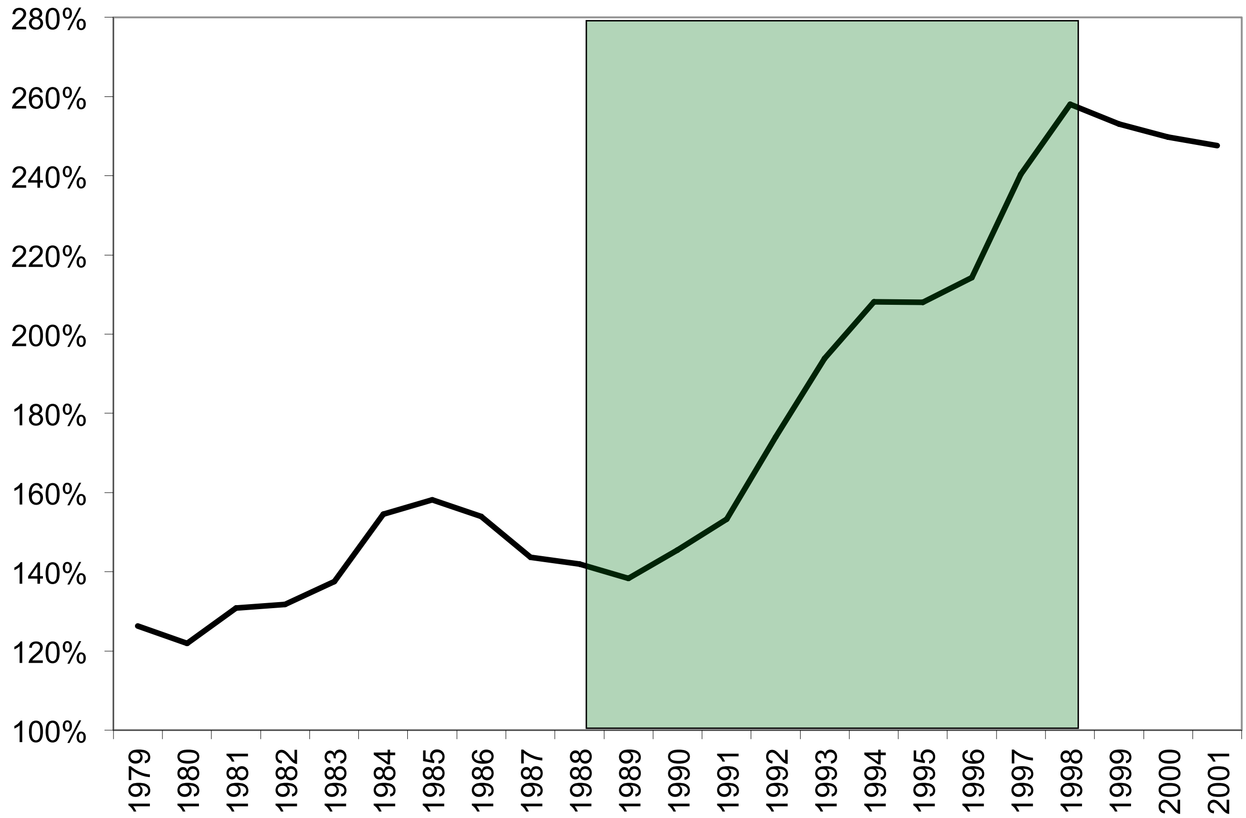
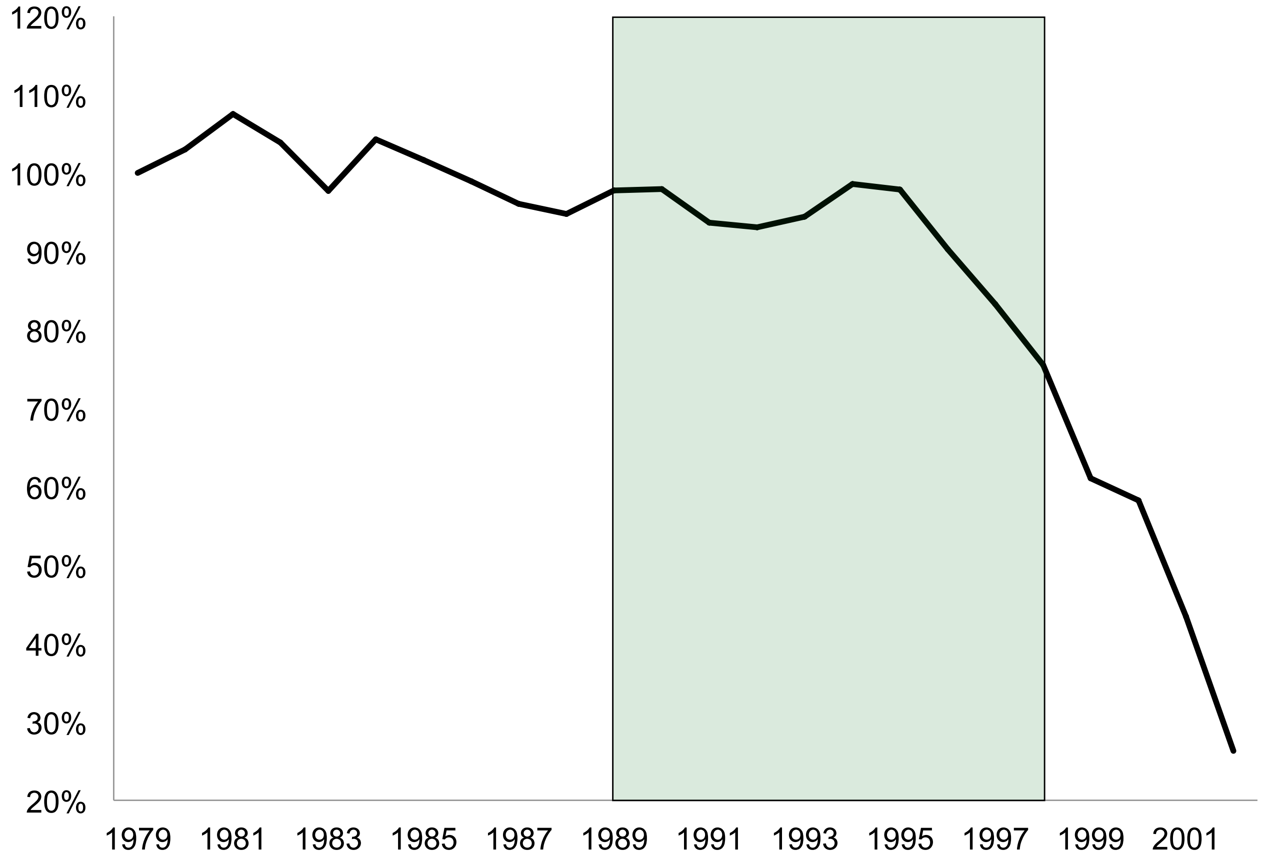


Figure 5: Bilateral Trade Relative to Value Added



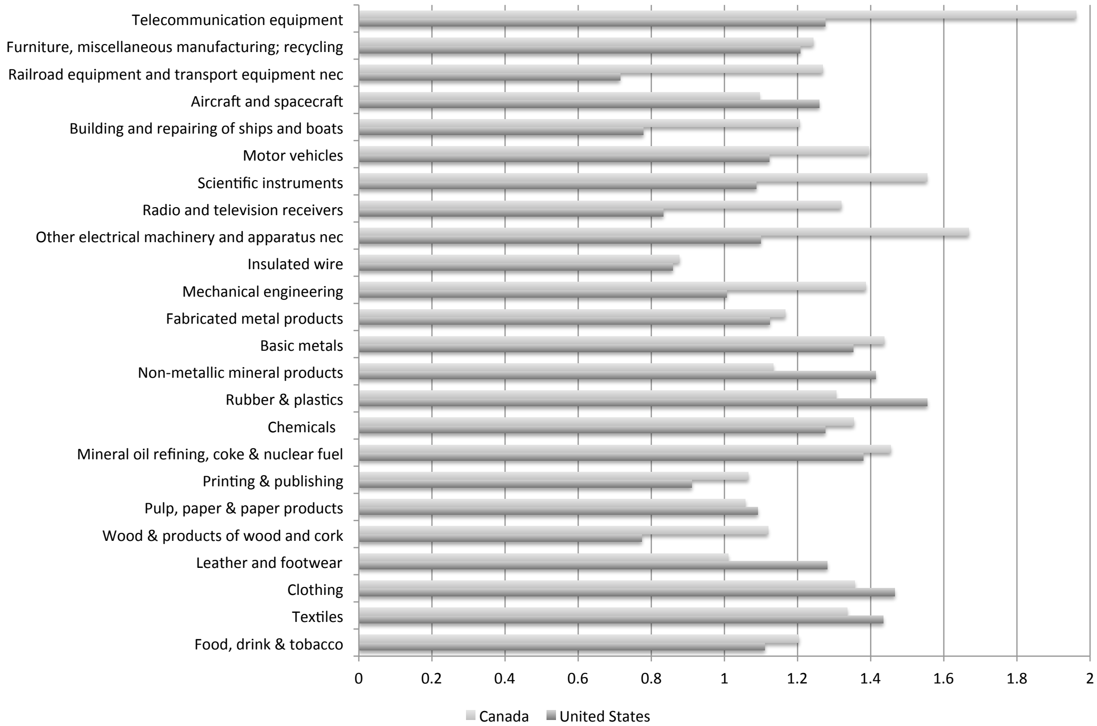
Note: Figure shows the ratio of the sum of exports from Canada to U.S. plus exports from U.S. to Canada relative to Canadian manufacturing value added. The shaded area represents the years in which the Free Trade Agreement was in practice.
Source: GGDC 60 Industry Database, World Development Indicators and OECD.

Figure 6: Productivity in Canada relative to U.S. in Van Ark et. al. (2003)



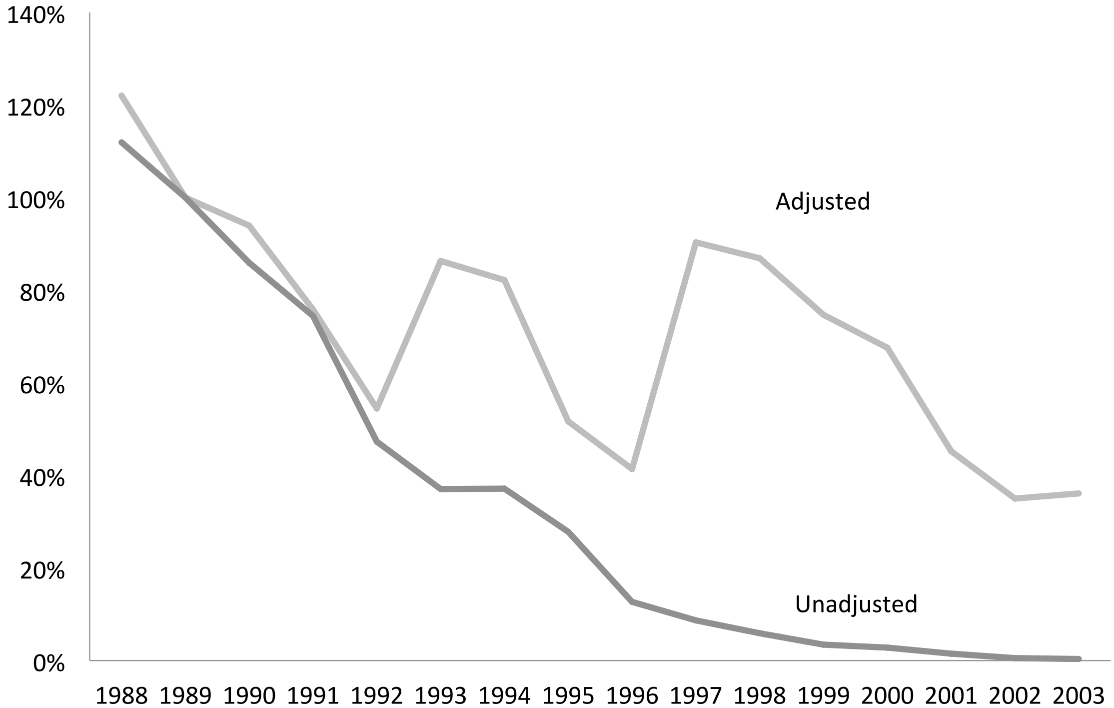
Note: Figure plots the aggregate manufacturing productivity in Canada relative to U.S. using raw data from the GGDC 60 industry database, as in Van Ark et. al. (2003). The shaded area is the period covered by the Free Trade Agreement.
Source: GGDC 60 industry database.

Figure 7: Growth in Productivity per Industry



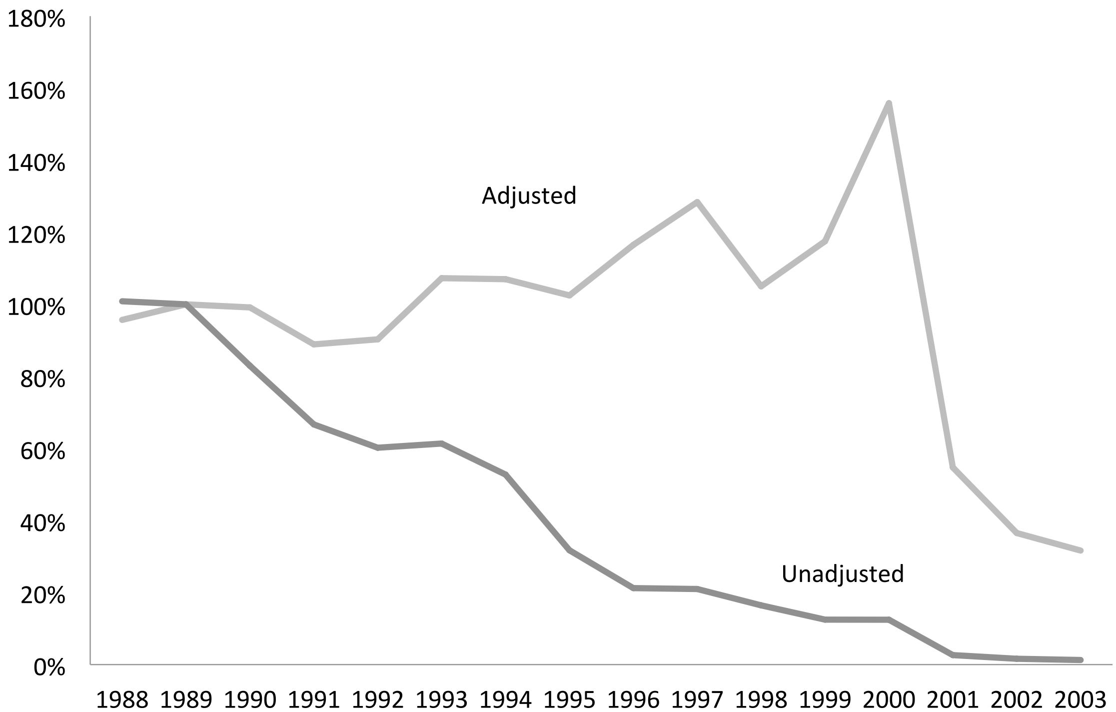
Note: the bars show the growth in productivity per industry for Canada and U.S., using all the manufacturing industries in the GGDC 60 industry database, except for Office Machinery and Electronic Valves and Tubes.
Source: GGDC 60 Industry Database.

Figure 8: Adjusted and Unadjusted Relative Productivity in Office Machinery



Note: The lines show the productivity in the Office Machinery industry, Canada relative to U.S. The pale grey line shows the data from the GGDC 60 Industry database. The darker line uses Canadian price deflators (adjusted by the difference in inflation rates) to compute U.S.
Source: Author's calculations based on GGDC 60 Industry Database and World Development Indicators.

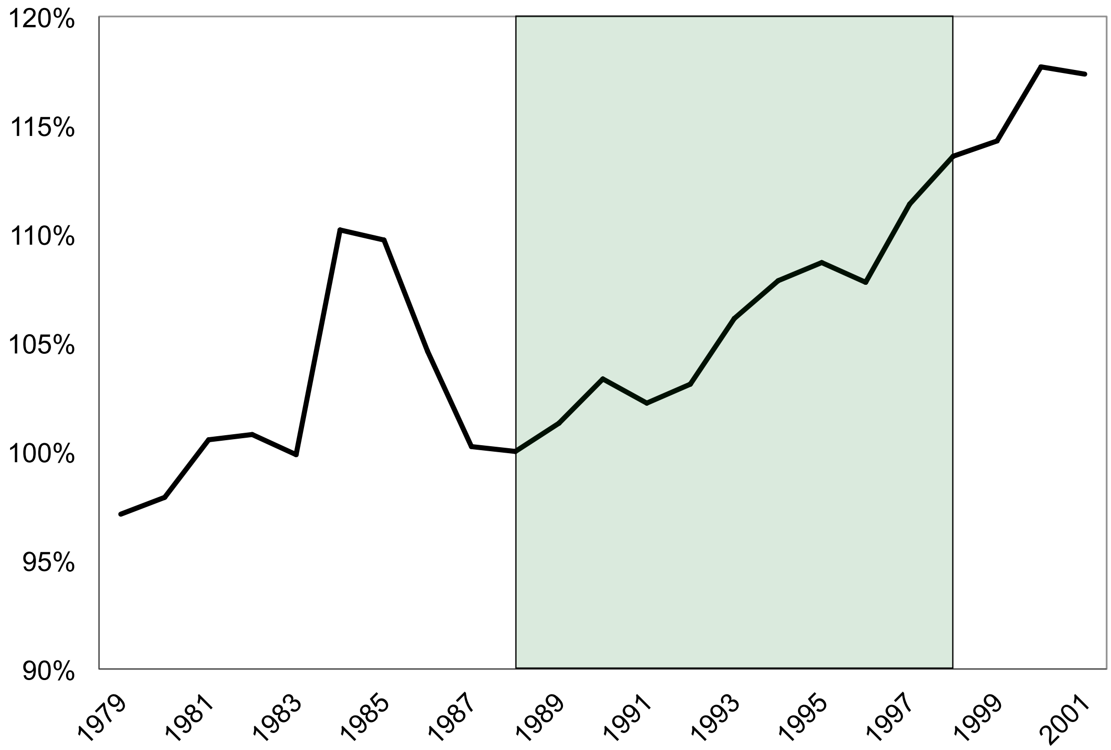
Figure 9: Adjusted and Unadjusted Relative Productivity in Electronic Valves and Tubes



Note: The lines show the productivity in the Electronic Valves and Tubes industry, Canada relative to U.S. The pale grey line shows the data from the GGDC 60 Industry database. The darker line uses Canadian price deflators (adjusted by the difference in inflation rates) to compute U.S.

Source: Author's calculations based on GGDC 60 Industry Database and World Development Indicators.

Figure 10: Productivity in Canada relative to Adjusted Productivity in U.S.



Note: Figure plots the aggregate manufacturing productivity in Canada relative to U.S. using data from the GGDC 60 industry database adjusted by using the Canadian price deflators for the Office Machinery and Electronic Valves and Tubes in U.S. The shaded area is the period covered by the Free Trade Agreement.

Source: Author's calculations based on GGDC 60 industry database and World Development Indicators.