An Empirical Assessment of the Impact of Chinese Imports on Employment in Ontario

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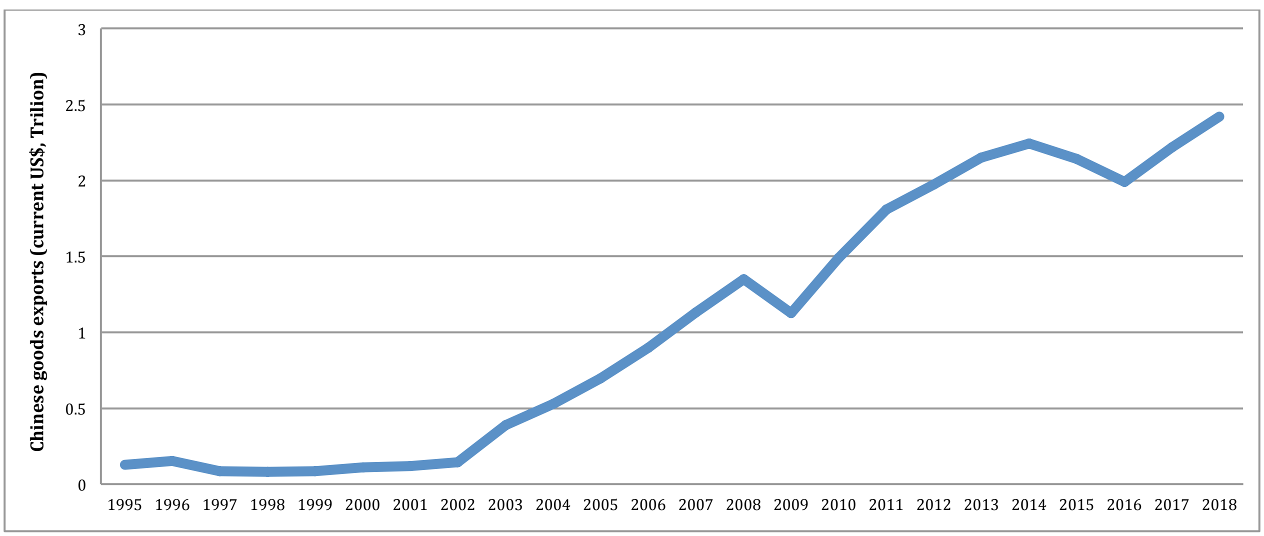
Abstract

In this research paper, we investigate how China as the world's largest exporter has affected the labor market outcome in the manufacturing industry of the Canadian province of Ontario. For our analysis, we use monthly data and the method of Autor, Dorn, and Hanson (2013) to study this effect. We find a 19.99% decline in employment in the manufacturing industry of Ontario over the period from 2002-2019.

Section 1: Introduction

China is the largest trading nation in the world since it surpassed the United States in 2013. According to the World Bank, Chinese merchandise exports were $2.417 trillion in 2018, which accumulated to a 12.57% share in the world's total exports. After joining the World Trade Organization (WTO) in 2001, China became a key global trade player within a few years by allowing foreign investment. The government encouraged companies to invest in China for their production need since they had an abundance of labor with lenient labor laws. This movement of capital into China made that country a manufacturing hub of the world. Figure 1, demonstrates that after 2001 Chinese exports increased twenty times in value. This exponential increase in the share of world total exports is due to the cheap skilled labor, cheap raw material, and technological innovation, which has made China the world's largest goods exporter.

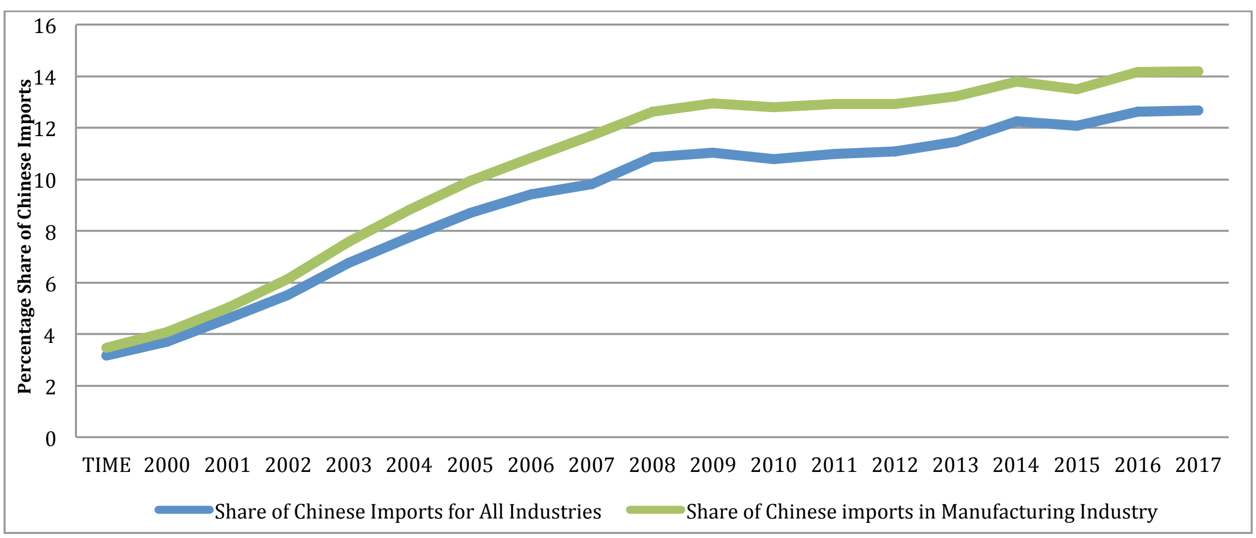
Figure 1 Chinese Goods Export (1995-2018) **Source: Data | World Bank**



Regarding Canada, China is its second-largest trading partner. After the end of the Chinese war in 1970, trade between Canada and China increased rapidly from about CDN$4.7 billion in 1992 to CDN$103 billion in 2018 (DATA | Statistic Canada). In 2018, imports from China accounted for 12.7% of Canada's total imports, which was just about 1.6% in 1992 (DATA | Statistic Canada). Of these 14.2% are imports into the manufacturing industry (DATA | Statistic Canada). Figure 2 demonstrates that a share of imports from China into all Canadian industries other than manufacturing is much lower than its share in the Canadian manufacturing industry.

Canada is considered a progressive trading nation because in 2018 its total trade was 65.8% of its GDP (DATA | Statistic Canada). Typically, the focus has been on the impact of the Canada-USA Free Trade Agreement (FTA) or the North American Free Trade Agreement (NAFTA), on the Canadian labor market and less attention has been paid to the impact of the trade from other countries.

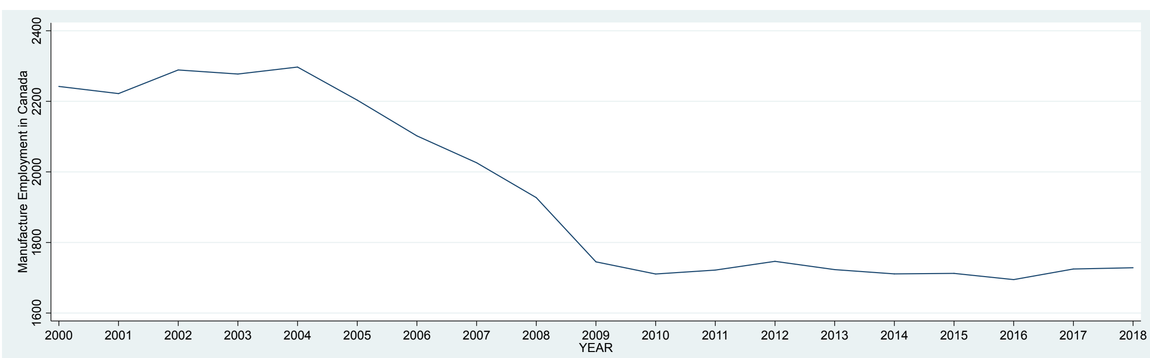
Figure 2 Share of Chinese Imports in All Canadian Industries and Share of Chinese Imports in All Canadian Manufacturing Industry



Source: Data | Statistics Canada

In this paper, we investigate the impact of an increase in Chinese imports on Canadian labor specific to the province of Ontario. The most common view is that international trade has negatively impacted the labor market in developed countries. The amount of labor employed in most low-skilled manufacturing jobs is affected in developed countries when jobs are relocated to countries with lower wages. We can see from Figure 3 that between 2000 and 2018, about 500,000 jobs were lost in the Canadian manufacturing industry (Data | Statistics Canada). This huge drop in employment after 2004, is not unique to Canada. Manufacturing jobs have been disappearing in just about every developed economy for the past two decades. For example, the United States has lost about 4.5 million jobs between 2000 and 2018 (Data | Federal Reserve Economic Data). This continuous increase in unemployment in the manufacturing sector is because globalization has made it easier for firms to move their production to countries where the cost of production is lower.

Figure 3 Canada's Employment in Manufacturing Sector **Source: Data | Statistics Canada**



The goal of this paper is to analyze how this increase in Chinese imports has affected the labor market in the province of Ontario, Canada. We aim to measure this effect empirically using monthly data from January 2002 to July 2019. There is some literature on how an increase in imports affects country labor markets but to our knowledge, no one has yet quantified the impact of Chinese imports on the labor market in the Canadian province of Ontario.

We base our approach on the methodology suggested by Autor, Dorn, and Hanson (2013). The study has examined the impact of Chinese imports on the labor market of the US, whereas we examine a similar impact on one province in Canada. We find that a one-percentage point increase in imports from China will result in a decline in employment in the manufacturing industry of Canada by -0.141 percentage points. This negative correlation between change in Chinese imports per worker for manufacturing in Ontario, and employment for manufacturing in Ontario, shows that increase imports from China strongly affected the employment in Ontario.

The remainder of the paper is organized as following. Section 2 reviews previous literature on the effect of imports on the labor market. Section 3 explains the methodology previously used by other papers to measure the empirical effect of imports on the labor market. In Section 4, we explain our modeling strategy and also we look at the dataset use in detail. In Section 5 we use reports to discuss our result. Section 6 provides a conclusion.

Section 2: Literature Review

Early research on this topic was conducted using the trade model of Heckscher-Ohlin. Some of the papers are Lawrence and Slaughter (1993) and Borjas, Freeman, Katz, Dinardo, and Abowd (1997), in which the price approach was used to examine the impact of imports on the labor market. A similar approach has also been used in more recent literatures, such as in Orbeta (2002) and Kovak (2013). According to Greenaway, Hine and Wright (1999), one of the major implications concerning the Heckscher–Ohlin model is that when trade barriers are removed, the import sector shrinks and the export sector expands, resulting in an initial decline in employment. However, in the long run, employment always increases, considering all other sectors remain constant.

Gibson (2011) argues that only in the case of developing countries, Heckscher–Ohlin's model is not an ideal trade model, but to analyze the impact of international trade on employment, in high-income countries, this model can be used. Nevertheless, most of the literature such as Greenaway, Hine and Wright (1999), Autor, Dorn, and Hanson (2016), Autor, Dorn, and Hanson (2013) and Acemoglu, Autor, Dorn, Hanson and Price (2013) agree that Heckscher–Ohlin framework is not an ideal trade model to study the impact of international trade on the labor market outcome due to its dependency on the assumption that final goods produced by the country must be equal to primary factors.

Feenstra and Hanson (1997) suggest that it is possible to use the H-O model by focusing on changes in trade quantities instead of changes in trade prices. They find that foreign direct investment in Mexico is positively correlated with relative demand for labor. Similarly, Autor, Dorn, and Hanson (2013) and Acemoglu, Autor, Dorn, Hanson and Price (2013), use a quantity-based approach in examining the impact of imports on the labor market. They find that trade is negatively correlated with the relative demand for labor in the manufacturing sector.

In general, most of the early researches, such as Greenaway, Hine and Wright (1999), find that an increase in imports have an adverse effect on the labor market. They use a labor demand framework to examine the impact of total imports on the labor market of the United Kingdom, which is discussed in more detail in section 4. According to their analysis, over the period of 1981 to 1991, the UK lost about 1.5 million jobs in the manufacturing sector due to an increase in total imports.

Our analysis is based on the approach developed by Autor, Dorn, and Hanson (2013), who investigate the impact that a rising trend of imports from China have on the employment in the manufacturing sector of the United States. They use an instrumental variable strategy to examine this effect (which is discussed in more detail in section 4). Autor, Dorn, and Hanson (2013) find quite a large negative impact on the labor market of the United States due to a rise in Chinese imports, that is, a 21% reduction in the US manufacturing employment from 1990 to 2007. There are other research papers that have also highlighted a similar negative impact of Chinese imports on the labor market of the United States such as Acemoglu, Autor, Dorn, Hanson and Price (2013). These authors use an instrumental variable strategy in order to examine the effects of Chinese imports on employment (which is discussed in more detail in section 4). The study shows that due to a rise in Chinese imports, the United States' manufacturing industry lost about 2.4 million jobs between 1990 and 2011.

Other works, which investigate the impact of imports on the labor market other than the United States have also found adverse effects of imports on the labor market such as Balsvik, Jensen, and Salvanes (2014), and Edwards & Jenkins (2015). Balsvik, Jensen, and Salvanes (2014) use the same empirical method developed by Autor, Dorn, and Hanson (2013) to examine the impact of an increase in Chinese imports on the labor market of Norway. They found that a 10% reduction in employment in the manufacturing sector resulting from increased Chinese imports. Similarly, Edwards & Jenkins (2015) also find a negative impact of imports on the labor market. They found that about 145,000 jobs in the South Africa manufacturing sector were lost during 1991 to 2010 due to an increase in Chinese imports.

The literature on the effect of imports on the labor market is not specific to the manufacturing sector. Chinembiri's (2010) work is among the ones that shed's some light on the effect of imports on the different sectors of the labor market. The author uses the same labor demand framework as Greenaway, Hine and Wright (1999) to examine the effect of imports on the labor market of South Africa. The study finds that an increase in imports negatively impacted the labor demand in agriculture, fishery forestry, agriculture, manufacturing, construction and utility industries. A most recent study by Autor, Dorn, and Hanson (2016) also examines and compares the impact of Chinese imports on employment in the manufacturing and non-manufacturing sector of the United States. The study found that about 60% of unemployment in the manufacturing sector and about 18% of employment in non-manufacturing in the United States resulted from an increase in the exposure of Chinese imports. On the other hand, Hsieh & Woo (2005)'s research, among many others, suggests that an increase in imports does not adversely affect the labor market. Their study discusses that Hong Kong lost about 30% of its low-skilled jobs in the manufacturing sector; however, they have suggested that there is strong evidence of an increase in the high-skilled labor as a result of an increase in Chinese imports.

The above shows that most of the existing research focuses on the impact of trade on US employment. Regarding Canada, one paper that examines the impact of imports on domestic employment is Gaston and Trefler (1997). Such studies have examined the impact of the Canada-US Free Trade Agreement (CUSTA) on Canadian employment and found that a 15% loss of manufacturing employment in Canada resulted from a reduction in tariff due to CUSTA. Similarly, Beaulieu (2000) and Polaski (2006) also found that as a result of a reduction in tariff due to CUSTA, employment in the manufacturing sector was decreased. However, Polaski (2006) also found that a small amount of increase in the manufacturing employment of Canada was due to the North American Free Trade Agreement (NAFTA).

The literature on the impact of trade on Canadian employment is very thin. To our knowledge, there are no studies that measure the impact of an increase in Chinese imports on the manufacturing employment for the Canadian province of Ontario notably using instrumental variable strategy.

Section 3: Methodology

In this section, we discuss in detail, different empirical approaches developed to examine the impact of trade on labor market outcomes.

There are some studies that focus on the same quantity base approach as used by Autor, Dorn, and Hanson (2013) and Acemoglu, Autor, Dorn, Hanson and Price (2013) but with a completely different methodology. Greenaway, Hine and Wright (1999) is one of the papers that uses a different methodology to examine the impact of trade on labor market outcomes. According to their analysis, from 1981 to 1991 UK lost about 1.5 million jobs in the manufacturing sector due to an increase in total imports. They use regression base approach in the dynamic model of labor demand by assuming the Cobb – Douglas production function as shown by equation (1).

$$Q_{it} = A^{\gamma} K_{it}^{\alpha} N_{it}^{\beta} , \qquad (1)$$

where Q_{it} is a real output at time t in industry i of the UK. A^{γ} is total factor productivity, while γ is a parameter that determines the efficiency of the production process. K_{it} is a capital stock at time t of a in industry i of the UK and N_{it} is the amount of labor used at time t in industry i of the UK.

Greenaway, Hine and Wright (1999) above Cobb- Douglas production function equation by first eliminating the capital and then taking logarithms as shown by equation (2) and (3) respectively.

$$Q_{it} = A^{\gamma} \left(\frac{\alpha N_{it}}{\beta} \frac{w_i}{c} \right)^{\alpha} N_{it}^{\beta} , \qquad (2)$$

where w_i is a wage at time t in industry i of the UK. c is a user cost of a industry.

$$\ln N_{it} = \emptyset_0 + \emptyset_1 \ln \frac{w_i}{c} + \emptyset_2 \ln Q_{it} \ , \qquad (3)$$

where $\emptyset_0 = -\frac{\gamma \ln A + \alpha \ln \alpha - \alpha \ln \beta}{\alpha + \beta}$; $\emptyset_1 = -\frac{\alpha}{\alpha+\beta}$; $\emptyset_2 = \frac{1}{\alpha+\beta}$

where N_{it} is number labor used at time t in industry i of the UK. Q_{it} is a real output at time t in industry i of the UK. w_i is a wage at time t in industry i of the UK. c is a user cost of an industry in UK. A is a total factor productivity of an industry in UK. Here α and β represents factor share coefficient and γ represent factor changing the efficiency of the production process.

Greenaway, Hine and Wright (1999) thought that there might be a correlation present because technical efficiency of the production process increases over time and that the rate of technology adoption and increases in *x*-efficiency would be correlated with changes in trade. To account for the correlation they proposed parameter A in the production function varies with time as shown by equation (4).

$$A_{it} = e^{\delta_0 T_i} M_{it}^{\delta_1} X_{it}^{\delta_2} \ , \qquad (4)$$

$$\delta_0, \delta_1, \delta_2 > 0$$

where A_{it} is a total productivity at time t in industry i of the UK. M denotes imports, M_{it} is UK total imports at time t in industry i of the UK. X denotes exports, X_{it} is UK total exports at time t in industry i of the UK. T_i is a time index that measures time span observation in industry i of the UK.

By solving equation (3) and (4) Greenaway, Hine and Wright (1999) was able to develop following empirical equation to examine the affect of trade on labor market outcome.

$$\ln N_{it} = \emptyset_0^* + \mu_0 T - \mu_1 \ln M_{it} - \mu_2 \ln X_{it} + \emptyset_1 \ln \frac{w_i}{c} + \emptyset_2 \ln Q_{it} \ , \qquad (5)$$

with $\emptyset_0^* = -\frac{\alpha \ln \alpha - \alpha \ln \beta}{\alpha + \beta}$; $\mu_0 = \mu\delta_0$; $\mu_1 = \mu\delta_1$; $\mu_2 = \mu\delta_2$; $\mu = \frac{\gamma}{\alpha+\beta}$

where N_{it} is number labor used at time t in industry i of the UK. T is a time index that defines time span between observations. M denotes imports, M_{it} is UK total imports at time t in industry i of the UK. X denotes exports, X_{it} is UK total exports at time t in industry i of the UK. w_i is a wage at time t in industry i of the UK. c is a user cost of an industry in UK. Q_{it} is a real output at time t in industry i of the UK.

The empirical work done by Acemoglu, Autor, Dorn, Hanson and Price (2013) follows a different approach. They use an instrumental variable strategy to examine the impact of imports from China on the manufacturing employment of the United States. They find that the United States manufacturing industry lost about 2.4 million jobs between 1990 to 2011 due to an increase in Chinese imports. Their import measure is given by

$$\Delta IP_{jT} = \frac{\Delta M_{jT}^{UC}}{Y_{j,91} + M_{j,91} - E_{j,91}} \ , \qquad (6)$$

where IP_{jT} is an index that defines the time T imports from China to the US per worker in an industry j of the US. ΔM_{jT}^{UC} is time T imports from China (C denotes China) into industry j of the US (U). Y denotes value of shipments, $Y_{j,91}$ is US total value of shipments in year 1991 in industry j of the US. M denotes imports, $M_{j,91}$ is US total imports in year 1991 in industry j of the US. E denotes exports, $E_{j,91}$ is US total exports in year 1991 in industry j of the US. The delta symbol denotes a change in this index.

To account for a bi-directional causality, Aemoglu et al (2013) develop as an instrumental variable, the growth in Chinese imports in other high-income countries. The variable is measured as the ratio of a change in Chinese imports in other high-income countries to the initial absorption in industry j in 1988 as shown by equation (7).

$$\Delta IPO_{jT} = \frac{\Delta M_{jT}^{OC}}{Y_{j,88} + M_{j,88} - E_{j,88}} \;, \qquad (7)$$

where IPO_{jT} is an index that defines the time T imports from China to the eight other countries per worker in an industry j of the other countries. ΔM_{jT}^{OC} is time T imports from China (C denotes China) into industry j of the eight other high income countries (O). Y denotes value of shipments, $Y_{j,88}$ is US total value of shipments in year 1988 in industry j of the US. M denotes imports, $M_{j,88}$ is US total imports in year 1988 in industry j in year 1988of the US. E denotes exports, $E_{j,88}$ is total US exports in year 1988 in industry j of the US. The delta symbol denotes a change in this index.

Our analysis is based on the empirical approach developed by Autor, Dorn, and Hanson (2013). These authors find a 21% reduction in the United States' manufacturing employment from 1990 to 2007 as a result of an increase in import exposure from China.

Their paper uses an instrumental variable strategy to examine the effects of Chinese imports on manufacturing employment of the US. For their empirical model, they construct the import exposure variable as shown by equation (8).

$$\Delta IPW_{uit} = \sum_{j} \frac{L_{ijt}}{L_{ujt}} \frac{\Delta M_{ucjt}}{L_{it}} \ , \qquad (8)$$

where IPW_{uit} is an index that defines the time t imports from China to the US per worker in a region i of the US; u indicates that imports are arriving into the US. L denotes labor, L_{ijt} is the labor used at time t in industry j of the region i of the US, and L_{ujt} describes the labor used in industry j in all of the US (u). The ratio $\frac{L_{ijt}}{L_{ujt}}$ is thus the weight of the labor in region i relative to the whole of the US for industry j. ΔM_{ucjt} is time t imports from China (c denotes China) into industry j of the US (u), while L_{it} is the time t total labor in region i of the US. The delta symbol denotes a change in this index, which is the sum of labor-weighted changes in imports across all the j industries of the US.

To account for a bi-directional causality, Autor, Dorn, and Hanson (2013) suggest an instrumental variable to instrument for United States' imports by using the change in Chinese imports by other high-income economies as shown by equation (9).

$$\Delta IPW_{oit} = \sum_{j} \frac{L_{ijt-1}}{L_{ujt-1}} \frac{\Delta M_{ocjt}}{L_{it-1}} \ , \qquad (9)$$

where IPW_{oit} is an index that defines the time t imports from China to the eight other developed countries per worker in a region i of the US; o indicates that imports are arriving into the eight other developed countries. L denotes labor, L_{ijt-1} is the labor used at time t-1 in industry j of the region i of the US, and L_{ujt-1} describes the labor used in industry j in all of the US (u). The ratio $\frac{L_{ijt-1}}{L_{ujt-1}}$ is thus the ten-year lag weight of the labor in region i relative to the whole of the US for industry j. ΔM_{ocjt} is time t imports from China (c denotes China) into industry j of the US (u), while L_{it-1} is the time t-1 total labor in region i of the US. The delta symbol denotes a change in this index, which is the sum of ten-year lag US labor-weighted changes in imports of the other developed countries across all the j industries of the US.

Section 4: Data and Empirical Approach

Section 4.1: DATA

The monthly data from January 2002 to July 2019 are obtained from Statistics Canada and include data on Canadian imports. Statistics Canada provides data on Canadian international merchandise trade by industry for all countries and under the North American Industry Classification System (NAICS). The North American Industry Classification System classifies each industry based on its production. For our analysis, we are using two digits designation i.e [31-33] for the manufacturing industry, which is that for the large business sector. The list of all manufacturing industries that are included in our analysis is shown in table 1.

Table 1 List of Manufacturing Industries

Industries included in Manufacturing Sector	
Food manufacturing	Furniture and related product manufacturing
Beverage and tobacco product manufacturing	Miscellaneous manufacturing
Textile mills	Electrical equipment, appliance and component manufacturing
Textile product mills	Transportation equipment manufacturing
Clothing manufacturing	Fabricated metal product manufacturing
Leather and allied product manufacturing	Machinery manufacturing
Wood product manufacturing	Computer and electronic product manufacturing
Paper manufacturing	Plastics and rubber products manufacturing
Printing and related support activities	Non-metallic mineral product manufacturing
Petroleum and coal product manufacturing	Primary metal manufacturing
Chemical manufacturing	

Source: Statistics Canada (2018)

The data on Chinese imports derived from Statistics Canada's database is the total value of Chinese imports in Canadian dollars, which is seasonally adjusted. There were no missing data for Chinese imports in manufacturing. For our analysis, we need the change in Chinese imports, which was calculated by equation (10).

$$\Delta CI_{Cjt} = \frac{CI_{Cjt} - CI_{Cjt-1}}{CI_{Cjt-1}} \ , \qquad (10)$$

where ΔCI_{Cjt} is a change in Chinese imports in industry j for Canada C for time period t, CI_{Cjt} is Chinese imports in industry j for Canada c for time period t and CI_{Cjt-1} is Chinese imports in industry j for Canada c for time period t-1.

The employment data for January 2002 - July 2019 for Ontario and Canada, which was obtained from Statistics Canada's database, provides data on labor force characteristics by industry, scaled by thousands of people. Therefore, to scale the employment data according to the rest of the data used in our paper, we multiply the employment data by one thousand. For our analysis, we included anyone aged 15 years and older with full time or part-time job. Since the data provided by Statistics Canada is not seasonally adjust. We de-seasonalized the data using monthly dummy variables. We therefore first created a seasonal dummy variable for each month except January, to avoid the dummy variable trap. After creating seasonal dummies, we regress the seasonally non-adjusted variable on the seasonal dummies.

After seasonally adjusting the employment data, we calculate a change in the employment for Ontario and Canada. This was calculated by the equation below (11).

$$\Delta L_{jt} = \left(\frac{L_{jt} - L_{jt-1}}{L_{jt-1}}\right) \times 100 \;, \qquad (11)$$

where ΔL_{jt} is a change in employment in industry j for time period t, L_{jt} is a total employment in industry j for time period t and L_{jt-1} is a total employment in industry j for time period t-1.

Our analysis includes some control variables to better understand the effect of change in imports from China on the labor market outcome for the Canadian province of Ontario. Given the fact that Canada is rich in its oil resources, one of the control variables that we used in our analysis is the change in global oil prices, to take into account any changes in oil prices that might affect employment. For our analysis, we used Western Texas Intermediate (WTI) as Global oil prices. Data on the global oil price for January 2002 – July 2019 was obtained from the Federal Reserve Economic Data's (FRED) database. We de-seasonalized the data using our monthly seasonal dummies. The change in the global oil price was obtained mathematically by equation (12).

$$\Delta oil_t = \left(\frac{oil_t - oil_{t-1}}{oil_{t-1}}\right) \times 100 \,, \qquad (12)$$

where Δoil_t is a change in global oil price at time t, oil_t is global oil price at time t and oil_{t-1} is global oil price at time t-1.

Another control variable that we include is the change in US employment, to account for any changes in the US labor market that might have had an impact on the labor market outcome for the Canadian province of Ontario. Data on US employment for January

2002 – July 2019 was obtained from the Federal Reserve Economic Data (FRED) database. The data provided by the Federal Reserve Economic Data (FRED) database is scaled by thousands of persons, which is seasonally adjusted. To scale US employment data according to the rest of the data used in this paper, we multiplied US employment data by one thousand. The change in US employment data was obtained mathematically by equation (13).

$$\Delta E_t = \left(\frac{E_t - E_{t-1}}{E_{t-1}}\right) \times 100\,, \qquad (13)$$

where ΔE_t is a change in US employment at time t, E_t is US employment at time t and $E_{t-1}$is US employment at time t-1.

Changes in the US house prices is an additional control variable that we used in our analysis because taking into account any spillover effect from the changes in the US house prices on the labor market outcome for the Canadian province of Ontario. Data on the US house prices for January 2002 – July 2019 was obtained from the Federal Reserve Economic Data (FRED) database. The data provided by the Federal Reserve Economic Data (FRED) database is Real Residential Property Prices. We de-seasonalized the data using our monthly seasonal dummies. The change in US house prices is obtained mathematically as shown in equation (14)

$$\Delta H_t = \left(\frac{H_t - H_{t-1}}{H_{t-1}}\right) \times 100\,, \qquad (14)$$

where ΔH_t is a change in US house prices at time t, H_t is US house prices at time t and H_{t-1} is US house prices at time t-1.

We also take into account changes in employment due to labor disputes, personal illness or disability, vacation, and other reasons. So we include the changes in the number of people absent from work by reason in Ontario, as one of the control variables in our analysis. Data on the number of people absent from work by reason, for January 2002 – July 2019, are obtained from Statistics Canada's database. The data provided by Statistics Canada is scaled by thousands of people and is not seasonally adjusted. To scale the data according to the rest of the data, we have multiplied the number of people absent from work by reason by one thousand. We deseasonalized this data as discussed above. The change in the number of people absent from work by reason is obtained mathematically as shown in equation (15).

$$\Delta ABS_t = \left(\frac{ABS_t - ABS_{t-1}}{ABS_{t-1}}\right) \times 100 \,, \qquad (15)$$

where ΔABS_t is change in number of person absent from work by reason at time t, ABS_t is number of person absent from work by reason at time t and ABS_{t-1} is number of person absent from work by reason at time t-1.

A change in the Real GDP of Canada is another control variable that we used in our analysis, to account for any effect on employment in the Canadian province of Ontario due to changes in the Canadian economy. Data on the Real GDP of Canada for January 2002 – July 2019 are obtained from Statistics Canada's database. The data on Real GDP of Canada provided by Statistics Canada is scaled by one million Canadian dollars and is presented on a 2012 reference year basis, which is seasonally adjusted at annual rates. To scale the data according to the rest of the data, we multiplied the Real GDP of Canada by one million and divided it by twelve. The change in Real GDP of Canada was obtained mathematically as shown in equation (16).

$$\Delta GDP_t = \left(\frac{GDP_t - GDP_{t-1}}{GDP_{t-1}}\right) \times 100\,, \qquad (16)$$

where ΔGDP_t is a change in Real GDP of Canada at time t, $GDP_t$is Real GDP of Canada at time t and GDP_{t-1} Real GDP of Canada at time t-1.

Finally, we included a control variable for the 2008 recession in our analysis to account for any effect on employment in Ontario during the 2008 recession. The dummy term d takes on a value of 1 for the month of Oct to Dec in 2008 and Jan to June in 2009 and is 0 otherwise.

Section 4.2: Empirical Model

The empirical approach that we use in our analysis is based on an empirical approach developed by Autor, Dorn, and Hanson, 2013, the instrumental strategy of to examine the effects of Chinese imports on manufacturing employment in the Canadian province of Ontario. In our case, equation (8) is adapted to represent the index of imports for the manufacturing industry in Ontario. Therefore, j=1 (that is, only the manufacturing industry is considered), and i=1 (only Ontario is considered). Changes in the exposure per Ontario worker in the manufacturing industry to Chinese imports is given according to equation (17) below.

$$\Delta CIEO_{t\,mnf} = \frac{L_{Ot\,mnf}}{L_{Ct\,mnf}} \times \Delta CI_{t\,mnf}\,, \qquad (17)$$

where $CIEO_{t\,mnf}$ is an index that defines the time t imports from China to the Ontario per worker in manufacturing industry (mnf) of Ontario. L denotes labor, $L_{Ot\,mnf}$ is the labor used at time t in manufacturing industry (mnf) of Ontario (O), and $L_{Ct\,mnf}$ describes the labor used in manufacturing industry (mnf) in all of the Canada (C). The ratio $\frac{L_{Ot\,mnf}}{L_{Ct\,mnf}}$ is thus the weight of the labor in Ontario relative to the whole of the Canada for manufacturing industry (mnf). $\Delta CI_{t\,mnf}$ is time t imports from China into manufacturing industry (mnf) of the Canada (C). The delta symbol denotes a change in this index, which is the sum of labor-weighted changes in imports across all the manufacturing industries of Ontario.

To account for a bi-directional causality, we use an instrumental variable strategy in our empirical model. We use lag variables of one month to account for any change in the Chinese import exposure per Ontario worker in the manufacturing industry, as shown by the equation below (18).

$$\Delta NCIEO_{t\,mnf} = \Delta CIEO_{\,t-1\,mnf}\,, \qquad (18)$$

where $\Delta NCIEO_{t\,mnf}$ is an instrumental variable and $\Delta CIEO_{j\,t-1}$ is an index that defines the time t-1 imports from China to the Ontario per worker in manufacturing industry (mnf) of Ontario.

Section 5: Results and Discussion

The regression model to measure the impact of change in Chinese imports in manufacturing industry j on Ontario employment in manufacturing industry j is shown in equation (19).

$$\Delta L_{ot\,mnf} = \alpha + \beta_1 \Delta CIEO_{t\,mnf} + \beta_2 X_t + \varepsilon_t\,, \qquad (19)$$

where X_t is a vector of all control variables (which include lagged values of Canadian GDP, global oil price, US house price, US employment and change in number of person absent from work by reason in Ontario) at time t. To account for any multi-collinearity between controlled variables and employment in Ontario, we only used the lagged values of the control variables mentioned above.

To estimate equation (19), we use as instrument the lag value of change in Chinese imports per worker for manufacturing in Ontario, for one month. To account for two-way causality between contemporaneous right-hand side terms in equation (19) and changes in employment, we use lags 1 to 24 of each of our control variables in our estimation.

The estimation results in column (1) of Appendix table 1, show evidence that change in Chinese imports per worker for manufacturing in Ontario is -0.141, which is statistically significant at the 10% level. This means that a one percentage point increase in imports from China will result in a decline in employment in the manufacturing industry of Canada by -0.141 percentage points. This means that increase imports from China account for 19.99% percent of the overall decline in Ontario's manufacturing employment between 2002 and 2019.

The R-squared value for estimation results in column (1) of Appendix table 1 is 0.304 and Root MSE is 1.072, which means the standard deviation of unexplained variables is 1.072. The lower value of Root MSE means that observed data points are much closer to the model's predicted values. This shows a better fit of the model.

We use the Cumby-Huizinga test for testing the residual autocorrelation in time-series data. According to Cumby & Huizinga (1990), this test is much better for testing autocorrelation than Breusch-Godfrey's LM test, Box-Pierce-Ljung's Q test and Durbin's h test because these tests are not applicable when the model contains heteroskedasticity, endogenous regressors or when a serial correlation is present at a higher order.

Results of the Cumby-Huizinga test in column (1) of Appendix table 1, show evidence that residuals are serially correlated for 3 out of 12 lags examine. This existence of medium-term residual correlation means that some additional control variables are missing and this may bias the estimate of the import index variable coefficient.

We use the method developed by Staiger & Stock (1997) to determine if the instruments used in our estimation are weak or strong. According to Staiger & Stock (1997), instruments should still be considered weak if we reject the null hypothesis at a standard level of significance, only if the value of F-statistic is less than 10.

The strength test for the instrument in column (1) of Appendix Table 1 shows that p-value =0.0002 and F=14.27 is greater than 10, which means we can reject the null hypothesis. Hence the instrument used for estimating equation (19) is strong.

In estimating equation (19) for column (1) of Appendix Table 1, and as a robustness check, we also use as instruments the lagged values of change in Chinese imports per worker for manufacturing in Ontario at twelve and twenty-four months but according to resulting F-test, they are week instruments. Hence we use an instrument the lag value of change in Chinese imports per worker for manufacturing in Ontario, for one month.

In column (2) of Appendix table 1, we introduced a dummy variable for the 2008 recession to control for any negative impact on employment for the manufacturing sector in Ontario during that time. The estimation results in column (2) of Appendix table 1, show evidence that the dummy variable is -2.535, which is statistically significant at the 1% level.

The estimation results in column (2) of Appendix table 1, show evidence that change in Chinese imports per worker for manufacturing in Ontario is -0.135, which is statistically significant at the 10% level. This means that a one-percentage increase in imports from China will result in a decline in employment in the manufacturing industry of Canada by 0.135 percentage points. This means that increase imports from China accounts for 19.14% percent of the overall decline in Ontario's manufacturing employment between 2002 and 2019.

The R-squared value for estimation results in column (2) of Appendix table 1 is 0.346 and Root MSE is 1.039, which means the standard deviation of unexplained variables is 1.039. The lower value of Root MSE means that observed data points are much closer to the model's predicted values. This shows a better fit of the model.

Results of the Cumby-Huizinga test in column (2) of Appendix table 1, show evidence that residuals are serially correlated for 3 out of 12 lags examine. This existence of medium-term residual correlation means that some additional control variables are missing and this may bias the estimate of the import index variable coefficient.

In column (2) of Appendix table 1, we use the same instrument as in column (1) of Appendix Table 1. In estimating equation (19) for column (2) of Appendix Table 1, and as a robustness check, we also use as instruments the lagged values lagged values change in Chinese imports per worker for manufacturing in Ontario at twelve and twenty-four months but according to resulting F-test, they are week instruments.

The strength test for the instrument in column (2) of Appendix Table 1 shows that p-value =0.0003 and F=14.11 is greater than 10, which means we can reject the null hypothesis. Hence the instrument use, as lag value change in Chinese imports per worker for manufacturing in Ontario at one month is strong.

Section 6: Conclusion

This paper has analyzed how an increase in Chinese imports has affected the labor market outcome in the Canadian province of Ontario. From 1992-2018, Canadian imports from China have increased almost nine folds and Canada has become China's second-largest trading partner after the United States. For our analysis, we investigated the effects of Chinese imports on employment for manufacturing sector in the Canadian province of Ontario over the period from 2002-2019.

We began our analysis by constructing an index that represents the Chinese import exposure per worker in the manufacturing sector for Ontario. To account for any correlation present between the import demand and the labor demand, we used the lagged value of this variable as an instrument for the import index at time t. Furthermore, we included controlled variables to better understand the effects of a change in Chinese imports on the labor market outcome for the Canadian province of Ontario, which includes a 2008 recession dummy. We found that an increase in Chinese imports has negatively impacted the manufacturing employment in Ontario. We have also controlled for the 2008 recession and still found that an increase in Chinese imports has negatively impacted the manufacturing employment in Ontario. Both models that we have estimated are not perfect as our estimated values may be biased, which means that the estimate of one of the parameters is too high or too low.

Appendix

Table 1: Results of IV Regression of equation (19)		
	(1)	(2)
Change in Employment of Manufacturing in Ontario	b/se	b/se
Change in Chinese imports per worker in Ontario for Manufacturing	-0.141* (.082)	-0.135* (.081)
Lag t-8 Change of Hours lost in Ontario	-0.003** (0.00)	-0.003** (0.00)
Lag t-6 of GDP	0.765** (0.32)	0.803** (0.31)
Lag t-4 of Global Price of Oil	-0.026** (0.01)	-0.031*** (0.01)
Lag t-6 of Global Price of Oil	-0.033*** (0.01)	-0.034*** (0.01)
Lag t-10 of Global Price of Oil	-0.029** (0.01)	-0.031*** (0.01)
Lag t-12 of Global Price of Oil	-0.025** (0.01)	-0.018* (0.01)
Lag t-1 of USA house price	0.033 (0.02)	0.039* (0.02)
Lag t-3 of USA house price	0.061* (0.03)	0.046 (0.03)
Lag t-5 of USA house price	0.070** (0.03)	0.046 (0.03)
Lag t-9 of USA house price	-0.048* (0.03)	-0.049** (0.02)
Lag t-10 of USA house price	-0.074*** (0.03)	-0.085*** (0.03)
Lag t-11 of USA house price	-0.045 (0.03)	-0.054** (0.03)
Lag t-3 of USA employment	-0.560 (0.44)	-1.153*** (0.44)
Lag t-4 of USA employment	1.210*** (0.44)	0.678 (0.47)
Lag t-11 of USA employment	0.501 (0.40)	0.739* (0.40)
Dummy variable		-2.535*** (0.84)
Constant	-0.262 (0.20)	0.111 (0.22)

Number of obs	198	198
R-Square	0.304	0.346
Root MSE	1.072	1.039
Instrument		
Lag t-1 change in Chinese imports per worker in Ontario for Manufacturing	-0.308*** (0.00)	-0.308*** (0.00)
Strength test of the Instrument		
Robust F (1,136)	14.27	14.11
Prob > F	0.0002	0.0003
Cumby-Huizinga test for autocorrelation (Ljung-Box) **H_0: disturbance is MA process up to order q** **H_A: serial correlation present at specified lags >q**		
	P-value	P-value
Lag 1	0.133	0.057
Lag 2	0.759	0.889
Lag 3	0.505	0.643
Lag 4	0.248	0.180
Lag 5	0.028	0.008
Lag 6	0.961	0.987
Lag 7	0.048	0.272
Lag 8	0.931	0.704
Lag 9	0.028	0.379
Lag 10	0.139	0.068
Lag 11	0.548	0.396
Lag 12	0.728	0.480

* p<0.1, ** p<0.05, *** p<0.01

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