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Rising Import Competition in Canada and its Employment Effect by Skill Group: Evidence from the 'China Shock'

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Abstract

It is well known that there has been a secular decline in the manufacturing share of total employment in Canada, with the decline accelerating after 2000. Among the factors that contributed to that trend, this report focuses on rising Chinese import competition in Canada, which also accelerated after 2000. We find that the trade-induced job loss in manufacturing amounts to 113.5 thousand during the 2001-2011 period but the loss was not equally distributed across skill groups. We estimate that the loss was largely driven by: low-skilled occupations (89.8 thousand) when analyzed by skill level; and occupations in services (57.6 thousand), technical/paraprofessional (12.1 thousand), and production (51.8 thousand) when analyzed by skill type. We also find that the labour reallocation in response to a trade shock is important in offsetting the negative employment effect, but the degree of adjustment is found to vary across skill groups.

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Rising Import Competition in Canada and its Employment Effect by Skill Group: Evidence from the 'China Shock'

Executive Summary

It is well known that there has been a secular decline in the manufacturing share of total employment in Canada. From 1991 to 2015, the manufacturing share of total Canadian employment fell from 14.7 per cent to 9.5 per cent, with the decline accelerating after 2000. Among the factors that contributed to that trend, this report focuses on rising Chinese import competition in Canada, which also accelerated after 2000.

Recent literature focusing on trade with China find evidence that manufacturing employment in developed countries was negatively affected by rising Chinese import competition (*e.g.* Acemoglu, Autor, Dorn, Hanson, and Price, 2016, Balsvik, Jensen, and Slavanes, 2015; Murray, 2017). However, the previous literature tends to focus on the *overall* employment effect within import-competing sectors (*i.e.* manufacturing sectors). However, it is important to study how the loss and gain are distributed among workers.

By constructing an occupation-specific trade exposure measure, we focus on how occupation-level characteristics interact with import shocks over time. In particular, we classify four-digit occupations in the National Occupation Classification (NOC) according to their skill level (high, mid, and low) and skill type (management, professional, technical/paraprofessional, other services, and production), respectively.

Skill level and skill types are two distinct dimensions characterizing a given occupation. Skill level is associated with the amount of education or training required to enter and perform the main duties of an occupation while skill type is the type of work performed in an occupation. Therefore, analyzing the effect of a trade shock in the two dimensions separately would allow one to draw various policy implications.

Empirical Approach

We estimate differential employment effects across distinct skill groups based on the two following samples: occupations within manufacturing in Canada to estimate the direct effect of rising Chinese import competition; and occupations in both manufacturing and non-manufacturing in Census Metropolitan Areas and Census Agglomerations (CMAs/CAs) across Canada to account for labour reallocation and demand effects operating within local labour markets.

An instrumental variables strategy is employed to deal with potential endogeneity of Canadian trade exposure. Following Autor, Dorn, and Hanson (2013) and Acemoglu *et al*. (2016), we exploit the fact that during 1991-2011, the growth in Chinese imports were mostly stemmed from factors internal to China such as urbanization, opening to foreign investment, and accession to the WTO. To capture the variation in Chinese import penetration driven by China's expanding exporting capacity, we instrument for changes in Chinese import to Canada using the changes in imports in eight other advanced economies.

Results

1. Direct effect of trade with China

Our main finding is that rising Chinese import penetration led to a loss of 113.5 thousand jobs in manufacturing over the period in which Chinese import penetration rose substantially (*i.e.* 2001-2011). Importantly, we find that the loss is largely driven by low-skilled occupation. Low-skilled occupations had a trade-induced job loss of 89.8 thousand. Note that this job loss accounts for 26.9 per cent of the total decline in their employment during this period. We find no statistical evidence that high- and mid-skilled groups were negatively affected by trade with China.

We also find that the trade-induced job loss was not equally distributed across skill types. When analyzed by skill type, the following groups had substantial trade-induced job losses during the 2001-2011 period:

- Occupations in other services – a loss of 57.6 thousand (86.9 per cent of the total decline in other services employment).

- Occupations in technical/paraprofessional - a loss of 19.5 thousand (59.9 per cent of the total decline in technical/paraprofessional employment)

- Occupations in production – a loss of 51.8 thousand (16.9 per cent of the total decline in production employment)

We find no evidence that the other three skill types (management, professional, trades/construction/transportation) were negatively affected by rising Chinese import penetration.

The key message is that the distributional effect of trade is evident in both skill level and type dimensions and that within the skill type dimension, the relative importance of Chinese import penetration in explaining the observed decline in employment varies greatly across skill groups.

One important implication from the results by skill level is that trade with China did not lead to "employment polarization" in Canada: a U-shaped employment growth in skill level where mid-skilled experiencing a relatively slower employment growth than low- and high-skilled.

2. Indirect effects of labour reallocation and demand spillovers

By exploiting variations in local employment rates and local trade exposure across 122 CMAs/CAs in Canada, we also assess the net effect of labour reallocation and demand effects operating within localities. We find that the labour reallocation is important in offsetting the negative direct effects but the degree of reallocation within local labour markets varies across skills. The labour reallocation to unaffected sectors was less successful for low-skilled occupations when analyzed by skill level and for production occupations when analyzed by skill type. For those two skill groups, we conclude that the labour reallocation is presumably inhibited by negative demand effects operating within local labour markets.

Our report focuses on the cost side of the trade with China with emphasis on the employment effect. Policymakers should also pay attention to potential benefits from trade as much as we do to distribution concerns of trade. We would like to emphasize that costs should be set against benefits in a balanced and principled manner so that one can assess the full picture on trade. Lastly, the China shock is only one factor contributing to the broad trend of contracting manufacturing employment. Factors other than trade, such as for instance technological change, should also be considered when examining the causes behind the declining manufacturing share in the total employment in Canada.

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Rising Import Competition in Canada and its Employment Effect by Skill Group: Evidence from the 'China Shock'[1]

I. Introduction

It is well known that there has been a secular decline in the manufacturing share of the total employment in Canada. From 1991 to 2015, the manufacturing share of the total Canadian employment fell from 14.7 per cent to 9.5 per cent, with the decline accelerating after 2000. In light of the falling manufacturing share in total employment, researchers have paid attention to rising Chinese exports, which also accelerated after 2000.

Chart 1 shows the manufacturing share in the total Canadian employment along with the Chinese import penetration ratio in Canada. We see that the manufacturing share in total employment recovers and stabilizes during the 1991-2001 period. In the post 2001 period, however, the negative relationship between the two variables is evident. Consequently, the causal relationship between the two has been studied extensively in the literature.

The post 2001 period is associated with increasing trade between developing and developed economies. Theory suggests such trade *could* have negative effects on employment and wage for unskilled workers in developed economies. However, the consensus in the literature in the early 2000 seems to support the argument that trade does not lead to adverse distributional effects.[2] Recent literature focusing on trade with China argues that it does (*e.g.* Acemoglu, Autor, Dorn, Hanson, and Price, 2016, Balsvik, Jensen, and Slavanes, 2015; Murray, 2017).

However, limitation of the previous literature on trade with China is that it often focuses on the *overall* employment effect within import-competing sectors (*i.e.* manufacturing sectors). However, it is important to study how the loss and gain are distributed among workers. The negative employment effect at the aggregate level found in the literature (*e.g.* Acemoglu, *et al.*, 2016; Murray, 2017) could have been driven by unskilled workers or a group of workers with a particular skill. In other words, trade could have harmed unskilled workers or a particular group of workers disproportionately more. Disaggregating the overall employment effect into different skill groups would also shed some light on whether trade has led to "employment polarization" – specifically, a U-shaped employment growth in skill level. In this report, we focus on the employment effect of Chinese import competition by skill both within manufacturing and across the broader industrial sectors within local labour markets in Canada.

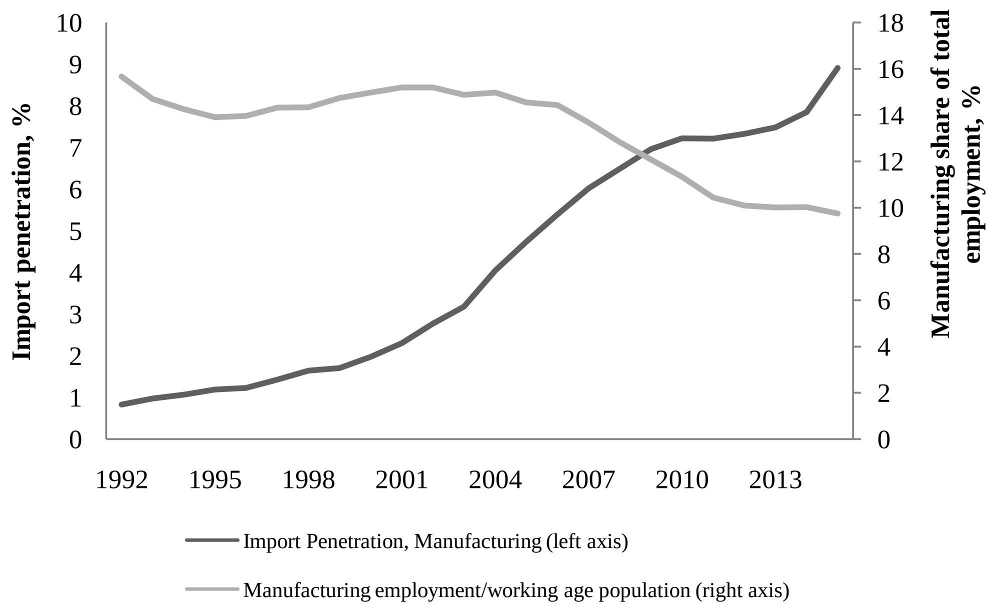
[1] This report was written by CSLS economist Myeongwan Kim under the supervision of CSLS Executive Director Andrew Sharpe for Global Affairs Canada. The Centre for the Study of Living Standards would like to thank Global Affairs Canada for financial support for this research. The author thanks Bert Waslander, Alexander Murray at Finance Canada , and Aaron Sydor at Global Affairs Canada for comments. An earlier version of the report was presented at the annual meeting of the Canadian Economic Association held in Montreal, Canada, June 1-3, 2018. Email: daniel.kim@csls.ca.

[2] See Autor, Dorn, and Hanson (2016) for a comprehensive review on this literature.

Inasmuch as the demand for output produced in a particular tradable sector could be hurt by an import shock, the demand for a particular skill could be negatively affected by the shock. Consider a domestic sector j whose products are being replaced by Chinese import over time. Also, let employees in occupation k form a majority of the employees in sector j. If there are many exposed sectors in which occupation k forms a large share in the sectoral employment, then one may conjecture that we would see a decline in the demand for occupation k as the affected sectors contract. Then, two important questions arise: 1. What is the skill level of the employees required in occupation k?; and 2. What type of task do employees in occupation k perform?

The two questions are associated with two distinct dimensions of individual occupation's characteristics: skill level and skill type. Skill level is associated with the amount of education or training required to perform the main duties of an occupation while skill type is the type of economic activity performed in an occupation (not the same as industrial categorization which is about the type of economic activity carried out by an *establishment*). Recent studies find that skill-level and skill-type are important characteristics in distinguishing the impact of trade exposure (*e.g.* Becker, Ekholm, and Muendler, 2013, Ebenstein, Harrison, McMillan, and Phillips, 2014, Hummels, Jørgensen, Munch, and Xiang, 2014, and Hakkala and Huttunen, 2016). Therefore, analyzing the employment effect of a trade shock in the two dimensions separately would allow one to draw various policy implications.

Chart 1: Import penetration ratio for Canada from China and Manufacturing Share of Total Employment, 1992-2015



Source: Statistics Canada, Labour Force Survey (CANSIM Table 282-0001), CANSIM Table 304-0014, and Innovation, Science and Economic Development Canada, Trade Data Online.

Moreover, skill could be as important as industry experience in terms of readjustment in response to an import shock. Hence, focusing on the industry-level exposure to import penetration may not capture the full range of the impact of trade liberalization.[3] A particular skill may be more easily employable in other (unaffected) sectors offsetting a potential negative employment effect of import shocks. On the other hand, there could be a skill group not easily employable in other sectors prolonging unemployment spell for affected workers. If skills have a varying degree of adjustment following an import shock, it is important to identify skill groups that are less resilient. An analysis in this regard would have important policy implications in terms of how to distribute compensation and re-training opportunities among those who lose from international trades.

By constructing *occupation-specific* trade exposure following Ebenstein *et al*. (2014), we capture potential employment effects by focusing on how occupation-level characteristics with import shocks over time. In this report, we classify four-digit occupations in National Occupation Classification (NOC) according to their skill level (high, mid, and low) and skill type (management, professional, technical/paraprofessional, other services, trades/construction/transportation, and production), respectively.

The empirical approach taken in this report is largely based on Acemoglu *et al*. (2016), Autor *et al.* (2013), and Murray (2017). Although they primarily focus on *industry-level* employment effects of the China shock, their conceptual framework and the associated empirical approach are applicable to an occupation-level analysis. Following the work cited above, we use an instrumental variable approach to estimate the causal impact of Chinese import penetration on Canadian employment using four-digit occupations in NOC as the unit of analysis.[4] We first estimate the direct effect of Chinese import penetration on employment by skill group in manufacturing industries. Then, we take into account indirect effects of labour reallocation and demand effects operating at the occupational level within local labour markets across Canada.

The key finding is that the distributional effect of trade on employment is evident in both skill level and type dimensions and that within the skill type dimension, the relative importance of Chinese import penetration in explaining the observed decline in employment varies greatly across skill groups.

[3] For example, Ebenstein *et al.* (2014) show that there exists a clear distinction between the impact of occupational exposure and industry exposure to globalization. They find that there is no significant negative effect of international trade on wages of all types of workers if exposure is measured at the industry-level but there is large and significant effect when measured at the occupation-level.

[4] Following Autor *et al.* (2013) and Acemoglu *et al*. (2016), we exploit the fact that during 1991-2011, the growth in Chinese imports were mostly stemmed from factors internal to China such as urbanization, rising competitiveness of Chinese manufacturing industries, and accession to the WTO. To capture the variation in Chinese import penetration driven by China's expanding exporting capacity, we instrument for changes in Chinese import to Canada using the changes in imports in eight other advanced economies.

During the period in which Chinese import penetration rose significantly (*i.e*. 2001-2011), a trade-induced job loss amounted to 113.5 thousand in manufacturing. Within manufacturing, the negative employment effect was substantial for low-skilled occupations: a loss of 89.8 thousand low-skilled jobs (26.9 per cent of the total decline in low-skilled jobs). We find no evidence that high- and mid-skilled groups were negatively affected by trade with China.

By skill type, we find that the following groups had large job losses due to trade with China: Occupations in other services – a loss of 57.6 thousand (86.9 per cent of the total decline in other services); occupations in technical/paraprofessional - a loss of 12.1 thousand (59.9 per cent of the total decline in technical/paraprofessional); and); occupations in production – a loss of 51.8 thousand (16.9 per cent of the total decline in production). We find no evidence that the other three skill types (management, professional, trades/construction/transportation) were negatively affected by rising Chinese import penetration.

We also find that the labour reallocation to unaffected sectors in response to a rise in local exposure to Chinese import is important in mitigating the job loss occurred in affected sectors within a given local labour market. However, the degree of labour reallocation within local labour markets varies across skill groups. The labour reallocation to sectors not directly exposed to Chinese import was less successful for low-skilled occupations when analyzed by skill level and production occupations when analyzed by skill type.

Focusing on the two skill dimensions results in distinct sets of estimates of the marginal effect of the China shock on employment. This suggests that the two dimensions reflect important characteristics of occupations that interact differently with rising import competition in the economy over time. Hence, it provides policymakers with a useful framework for assessing various distributional effects of rising import competition.

We would like to emphasize, however, that the employment effect is a quite narrowly-defined criteria to assess the overall consequences of trade with China. Policymakers should take into account a wide scope of the impact to evaluate the overall welfare implication of trade.

The remainder of the report is structured as follows. In Section II, we briefly introduce a conceptual framework to motivate our empirical strategies. We also define skill levels and skill types to group four-digit occupations in NOC by skill. In Section III, we summarize recent trends in Canadian trade, employment, and the degree of import competition faced by each occupation in Canadian manufacturing sectors. In Section IV, we describe the construction of an occupation-specific import exposure variable along with our data sources. Section V and VI describes the two empirical approaches and their results. Section VII concludes.

II. Conceptual Framework

A. Decomposing the Effect of Import Shocks

In this section, we outline the conceptual framework that motivates our empirical approach in this report. Following Acemoglu *et al.* (2013), we decompose the aggregate employment effect of an increase in Chinese import penetration as follows:

Aggregate employment effect = Direct effect on exposed occupations

+ Aggregate reallocation effects

+ Aggregate demand effects.

+ Indirect impact on occupations in linked industries

The direct effect is the change in employment in occupations in sectors whose outputs compete with Chinese imports. The reallocation effect captures the potential offsetting employment effect of absorption (in other sectors) of factors of production released from contracting industries. The aggregate demand effect is associated with the impact of Keynesian-type multipliers arising from change in consumption and investment at local or national level. Lastly, negative employment effects would be found in workers employed in industries linked to an affected industry through the input-output (I-O) matrix. Using industry-level data, Murray (2017) found that I-O linkage did not have a substantial impact of the measured employment effect in Canada. In this report, we do not estimate the effect through this channel.

The direct effect is captured in occupation-level regressions that estimate the marginal effect of a change in import penetration on employment in occupations within manufacturing. It is difficult to estimate the two indirect effects at the national level without a structure in our model. Hence, we take a local labour market as the unit of analysis to estimate the relative effect of the two indirect effects.

Local labour markets are treated as sub-economies subject to differential import shocks arising from the initial occupational employment structure. We define a local labour market as a Census Metropolitan Area (CMA) or Census Agglomeration (CA) and assess the employment impact of import shocks operating within a local labour market in Canada.[5] We decompose the total employment effect in a local labour market as follows:

[5] We use 122 CMAs/CAs available across all three census years (1991, 2001 and 2011) as our sample. In 2011, those 122 CMAs/CAs accounted for 80 per cent of the total Canadian population.

Local employment effect = Direct effect on exposed occupations

+ Local reallocation effects

+ Local demand effects.

+ Local impact on occupations in linked industries

It should be noted that the approach only captures the reallocation and demand effects operating *within* a local labour market. It does not capture an adjustment determined in the national and international equilibrium. If the extent of labour mobility across labour markets is large, our estimates would underestimate the positive reallocation effect in response to the China shock. Similarly, only the components of the demand effect operating at the local level would be captured in our estimates since the national components would be the same across all local labour markets. Hence, we acknowledge that local labour market is an appropriate unit of analysis only if a transmission of shocks across regions is small in Canada.

B. Defining Occupational Groups

The primary objective of this report is to quantify the effect of Chinese import penetration on employment by skill group. In our sample, we have 494 four-digit occupations defined in the National Occupation Classification system (NOC). Therefore, it would be more meaningful and convenient to aggregate the 494 occupations into some broader groups. However, such broader groups must be chosen carefully such that they represent important dimensions of occupation characteristics relevant for analyzing the impact of Chinese import shock.[6]

In this study, we classify 4-digit occupations by two criteria following a variant of NOC developed jointly by Statistics Canada and Human Resources and Skills Development Canada (HRSDC). Occupations are classified according to either skill-level and skill-type. See Appendix Table A2 for details.

1. Skill-level

Skill level is associated with the amount of education and training required to enter and perform the main duties of an occupation. Along with education and training, the experience required for entry, and the complexity and responsibilities typical of an occupation are also considered to determine skill level. Requirements for individual occupations may overlap between the skill levels. For example, some occupations can be entered with either a university degree or a college diploma. In this case, skill level is determined by considering several factors.

[6] Note that the cross-sectional unit in our framework is still 4-digit occupation. It is important to analyze trade shocks in general equilibrium but it requires researchers to empirically map trade shocks into a small number of aggregate outcomes. With a limited number of observations at aggregate level, it would be tricky to isolate the effect of shocks due to confounding factors. Hence, we estimate the direct effect of trade shocks using individual 4-digit occupations as the unit of analysis.

These factors include the requirements most generally demanded by employers, complexity of overall responsibilities and knowledge requirements, and further training and specialization obtained on the job. In the variant of NOC, occupations are classified into 4 skill levels: skill level A, skill level B, skill level C, and skill level D.

We define high-skilled group to include occupations in skill-level A. Mid-skilled group is defined to include skill-level B. Lastly, we define low-skilled group to include both skill-level C and D.[7] As a result, high-skilled group represents occupations that require at least Bachelor's degree to enter and perform the tasks. Mid-skilled group represents occupations that usually require college-level education, apprenticeship training, or occupation-specific on-the-job training. Occupations in the low-skilled group require secondary school education or short occupation-specific training, or no formal education (but require only on-the-job training).

2. Skill-type

Skill type represents the type of work performed on the job. Note that although some skill types tend to be associated with a particular industry, industry and occupation are two distinct variables which can be cross-tabulated to provide detailed information on employment. Industrial categorization is determined by the kind of economic activity carried out by an establishment (factory, mine, farm, store, etc.) while occupational categorization is determined by the kind of economic activity carried out by an individual worker.[8] An establishment can employ workers performing a completely different type of skill. In other words, the nature of the factory, business or service in which the worker is employed does not determine the classification of his or her occupation, except to the extent that it allows the nature of the tasks to be more clearly defined.

The occupational categories are chosen to distinguish different dimensions of task content of jobs that are relevant for analyzing the effects of increased importing. According to a variant of NOC developed jointly by Statistics Canada and HRSDC, the 2-digit occupations are re-classified into 10 broader groups. However, due to the limited number of observations in each group established by Statistics Canada and HRSDC, we further aggregate the 10 groups into 6 broader groups: 1. management; 2. professional; 3. technical and paraprofessional; 4. other services; 5. trade/construction/transportation; and 6. production.

It is important to note that a given skill level is not necessarily correlated with a specific skill type. In our classification, the high-skilled group (skill level A) is equally distributed across management and professional rather than concentrated on one specific group. Also, mid-skilled (skill level B) and low-skilled (skill level C and D) groups are readily found across the following three different skill types: technical/paraprofessional; other services; trades/construction/transportation; and production. Hence, the classifications by skill type and by skill level represent two distinct dimensions of a given occupation.

[7] For occupations in skill level C, workers are usually required to have secondary school and/or occupation-specific training. For skill level D, only on-the-job training is usually required.

[8] However, some occupations are found almost solely within one particular industry. For example, mining or automobile assembly occupations are found only within their respective industrial sectors. During the original research and development of the NOC, it was realized that in many industries, occupational mobility is determined more by internal job ladders than by functional specialization. In consequence, some unit groups include occupations in a particular skill level within an industry.

III. Recent Trends in Import and Employment in Canada

In this section, we review recent trends in import and employment in Canada. We briefly discuss the trends in imports to Canada over the period 1992-2015 at the aggregate level and for manufacturing.[9] Here, we focus more on the employment distribution across occupations both at the aggregate level and in the manufacturing industry. Specifically, we examine employment patterns across both skill levels (high- ; mid- ; low-skilled) and skill-types (management; professional; technical/paraprofessional; other services; production).[10]

Table 1: Canada's Imports from China and from All Trade Partners, All Industries and Manufacturing, Millions of Current Canadian Dollars, 1992-2015

				All industries			
	1992	1996	2000	2004	2008	2012	2015
China	2,453	4,931	11,294	24,104	42,628	50,723	65,650
All Countries	148,018	232,566	356,992	355,886	433,999	462,072	535,604
China Share (%)	1.7	2.1	3.2	6.8	9.8	11.0	12.3
				Manufacturing			
	1992	1996	2000	2004	2008	2012	2015
China	2,381	4,781	11,130	23,788	42,252	50,250	65,077
All Countries	131,142	206,421	321,144	314,050	360,983	389,058	471,212
China Share (%)	1.8	2.3	3.5	7.6	11.7	12.9	13.8
				Manufacturing Share of Imports (%)			
	1992	1996	2000	2004	2008	2012	2015
China	97.1	97.0	98.5	98.7	99.1	99.1	99.1
All Countries	88.6	88.8	90.0	88.2	83.2	84.2	88

Source: Table 1 in Murray (2017)

A. Import

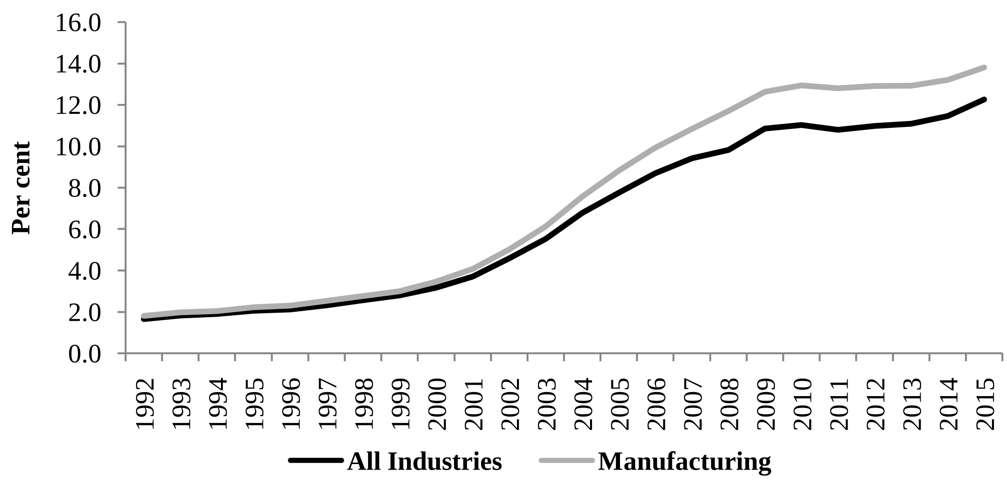
Table 1 summarize trends in Canada's imports from China and from all trade partners over the 1992-2015 period. By 2015, Canada imported goods and services valued at $535.6 billion (in current dollars). They grew by 5.8 per cent per year from $148.0 billion in 1992. Chinese imports reached $65.7 billion by 2015. It had increased by 15.4 per cent per year from $2.5 billion in 1992. During this period, Chinese share of Canada's total import increased from 1.7 per cent to 12.3 per cent, a 10.6 percentage point increase.

We observe a very similar trend in imported manufactured goods. First, most of the imports to Canada were manufactured goods. Manufactured goods accounted for 87.6 per cent of total imports on average over the 1992-2015 period. The share of manufactured goods is even greater if we focus on Chinese imports to Canada. Manufactured goods accounted for 98.4 per

[9] For detailed discussion, see Murray (2017).
[10] Refer to Appendix Table A2 for the two classification criteria.

cent of Chinese imports on average over the 1992-2015 period. It is important to emphasize that most of the increase in China's share of Canadian imports occurred after 2000 (Chart 2). Although the growth of Chinese imports somewhat slowed after 2000, the growth of Canada's total imports slowed by much more, resulting in a faster expansion in the Chinese share after 2000 than before.[11]

Chart 2: China's Share of Canadian Imports, All Industries and Manufacturing, Per Cent, 1992-2015



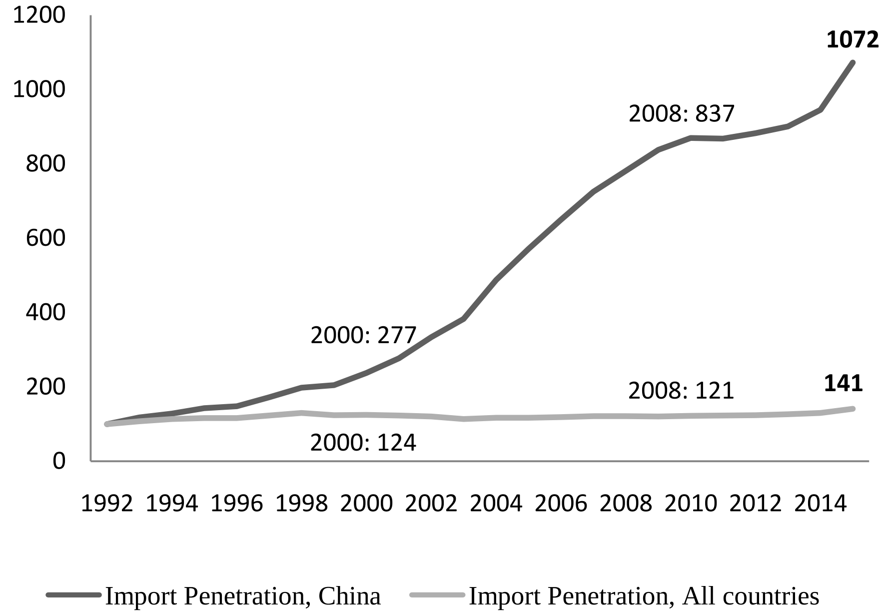
Source: Chart 1 in Murray (2017)

In this report, we quantify the degree of import competition in terms of import penetration ratio, the ratio of imports to total domestic absorption in that industry (see Section IV for detailed description of the variable). Appendix Table A1 presents trends in domestic absorption and import penetration for the manufacturing industry in Canada. Canadian manufacturing experienced a significant rise in import competition over the period 1992-2015. Over this period, the import penetration ratio rose from 45.7 per cent to 64.5 percent (increase by 18.8 percentage points). China played an important role in such increase in the import penetration ratio. Of the 18.8 percentage-point increase, 8.1 percentage points (43 percent of the total increase) were driven by rising imports from China.

Chart 3 depicts the index for the import penetration ratios for China and for all trading partners of Canada. Relative to the import penetration of all trading partners, Chinese penetration rose by more. Much of the increase in import competition from China relative to other trading partners occurred during the 2000-2008 period, which covers the period from the entry of China into the WTO in 2001 to the slowdown in global trade associated with the global recession of 2008 and 2009. Over that period, import penetration from China increased by 4.5 percentage points while overall import penetration fell by 1.6 percentage points.

[11] The growth rate of Chinese imports declined from 21.0 per cent per year over the 1992-2000 period to 18.1 per cent per year over the 2000-2008 period,

Chart 3: Import penetration (to Canada) ratio index, All countries and China, 1992-2015, (1992=100)



Note: Import penetration ratio is defined as the ratio of import to domestic absorption (total industry shipment less export plus import).
Source: Authors' calculation based on trade data base maintained by Innovation, Science, and Economic Development Canada.

B. Employment patterns across skill groups

1. Across skill levels

Next, we examine the employment distribution across skill levels both at the aggregate level and in manufacturing industry in Canada. Table 2 summarizes the employment pattern across the three skill levels over the 1991-2011 period. First of all, there is a divergence in aggregate employment growth between high-skilled and low-skilled occupations in Canada. High-skilled occupations experienced a robust 2.14 per cent growth per year over the period 1991-2011 while the low-skilled employment expanded at a 0.76 per cent per year. Mid-skilled employment stood in between, growing at 1.29 per cent per year. Similarly, within manufacturing, low-skilled occupations experienced a faster decline over the period than the other two skill groups.

Consistent with the above observation, the employment share of low-skilled occupations had been shrinking at 0.22 percentage points per year over the period 1991-2011. In contrast, the high-skilled share of the total employment in Canada had increased by 0.21 percentage points per year over time. The employment share of the mid-skilled occupations had remained stable over the two decades as it shrank during the first half of the period 1991-2011 and expanded during the second half. A similar trend is found within the manufacturing industry. The share of low-skilled occupations in total manufacturing employment declined, while the upper two skill groups gained. Such monotonic change in the employment share across the three skill levels is somewhat different from non-monotone changes observed in the United States.[12]

Table 2:Employment level and Employment share in total employment by skill level, All Industries and Manufacturing, 1991-2011, Canada

	High-skilled	Mid-skilled	Low-skilled
Panel A: Employment Level (thousand)			
All Industries			
1991	2981.9	4241.4	5641.0
2001	3753.3	4670.3	6222.9
2011	4556.2	5476.0	6562.9
Compound annual growth (%)			
1991-2001	2.33	0.97	0.99
2001-2011	1.96	1.60	0.53
1991-2011	2.14	1.29	0.76
Manufacturing			
1991	275.4	611.4	968.6
2001	285.3	659.5	1086.1
2011	248.9	523.7	752.5
Compound annual growth (%)			
1991-2001	0.35	0.76	1.15
2001-2011	-1.36	-2.28	-3.60
1991-2011	-0.51	-0.77	-1.25
Panel B: Employment in each group / Total employment (%)			
All Industries			
1991	23.2	33.0	43.8
2001	25.6	31.9	42.5
2011	27.5	33.0	39.5
Manufacturing			
1991	14.8	33.0	52.2
2001	14.0	32.5	53.5
2011	16.3	34.3	49.3

Source: The 1991 and 2001 Censuses and the 2011 National Household Survey.

[12] In the United States, employment shares increased (and at a faster rate) in the upper and bottom tails of the skill distribution while the median skill groups experienced either negative or slower growth in the employment share (U-shaped employment share changes across the skill distribution). See Autor and Dorn (2013).

During the period 2001-2011, the aggregate employment growth slowed relative to the period 1991-2001 (except for mid-skilled occupations).Within manufacturing, employment growth turned negative for all three skill levels with low-skilled occupations experiencing the fastest annual decline (-3.60 per cent). In terms of employment share, low-skilled was the only group that experienced a declining employment share during 2001-2011, the period associated with a significant rise in the Chinese import competition in Canada. High- and mid-skilled occupations actually saw an increasing employment share over the same period. This is in contrast to the previous decade (1991-2001) when both high- and mid-skilled occupations saw a slight decline in their employment share.[13]

The employment shift towards the upper skill levels is consistent with the conventional view of skill-biased technological change. Within the manufacturing industry, it may also be the case that a rising Chinese import competition in low-tech manufactured goods may have induced Canadian firms to invest more in high-skilled labour and high-tech capital or to focus more on high value-added niches. How much of the decline in low-skilled occupations can be attributed to the rising Chinese import competition? The question will be explored formally in the following regression analysis.

2. Across skill types

Next, we examine employment patterns across skill types in Canada over the period 1991-2011. Table 3 summarizes the employment level and employment share of each skill type in Canada over the period 1991-2011. First, occupations in Other services accounted for the largest share of the total employment in Canada. They accounted for 39.2 per cent of employed persons in 2011 although their share had decreased slightly over time (-0.13 percentage point per year). In turn, the employment shares of occupations in management, professional, and technical/paraprofessional increased over the 1991-2011.

In terms of the employment level, occupations in production was the only skill group that had a negative annual growth over the period 1991-2011. Some portion of the negative growth seems driven by a substantial fall in the production employment within manufacturing during the 2001-2011 period (a decline of 4.30 per cent per year). Of the 241.8 thousand decrease in production employment across all industries, 57.8 thousand occurred within manufacturing (or 24 per cent). The rest can be explained by the decline of the production occupations in primary sectors such as agriculture, forestry, and mining, oil, and gas extraction.[14]

[13] During 1991-2001, the employment level grew for the two skill levels but the total manufacturing employment expanded at a faster rate (driven by an expansion of low-skilled occupations) resulting in slight negative changes for their employment shares.

[14] Most of the production occupations are found in either the primary sector or manufacturing in the economy.

Table 3:Employment level and Employment share in total employment by skill type, All Industries and Manufacturing, 1991-2011, Canada

Panel A: Employment Level (thousand)

All Industries

	Management	Professional	Technical & Paraprofessional	Other services	Trades & Construction & Transportation	Production
1991	1316.8	1612.6	1170.5	5375.0	1920.7	1468.6
2001	1573.3	1984.5	1658.0	5779.3	2069.6	1581.8
2011	1731.6	2596.3	2170.9	6501.3	2368.2	1226.8
Compound Annual Growth (%)						
1991-2001	1.80	2.10	3.54	0.73	0.75	0.74
2001-2011	0.96	2.72	2.73	1.18	1.36	-2.51
1991-2011	1.38	2.41	3.14	0.96	1.05	-0.90

Manufacturing

	Management	Professional	Technical & Paraprofessional	Other services	Trades & Construction & Transportation	Production
1991	176.2	60.0	150.2	473.7	381.0	614.3
2001	177.5	39.1	200.9	333.9	416.0	863.4
2011	147.1	39.3	180.7	267.7	333.8	556.5
Compound Annual Growth (%)						
1991-2001	0.08	-4.19	2.95	-3.43	0.88	3.46
2001-2011	-1.86	0.03	-1.05	-2.19	-2.18	-4.30
1991-2011	-0.90	-2.10	0.93	-2.81	-0.66	-0.49

Panel B: Employment in each group / Total employment (%)

All Industries

	Management	Professional	Technical & Paraprofessional	Other services	Trades & Construction & Transportation	Production
1991	10.2	12.5	9.1	41.8	14.9	11.4
2001	10.7	13.5	11.3	39.5	14.1	10.8
2011	10.4	15.6	13.1	39.2	14.3	7.4

Manufacturing

	Management	Professional	Technical & Paraprofessional	Other services	Trades & Construction & Transportation	Production
1991	9.5	3.2	8.1	25.5	20.5	33.1
2001	8.7	1.9	9.9	16.4	20.5	42.5
2011	9.6	2.6	11.9	17.6	21.9	36.5

Source: The 1991 and 2001 Censuses and the 2011 National Household Survey.

Within manufacturing, for an obvious reason, occupations in production accounted for the largest share in total manufacturing employment. But it is interesting to see that: 1. during the period 1991-2001, production workers had a relatively robust increase in both the employment level and employment share; and 2. the share of production occupations in total employment fell during the period 2001-2011 while shares of other skill types rose. Such employment shifts partly reflect that Canadian manufacturing had shifted away from traditional manufacturing towards a higher value-added niche due to technological changes and import competition in low-tech manufactured goods.

It should be noted that occupations in other services accounted for a substantial share in total manufacturing employment. However, their share declined over time. It accounted for 17.6 per cent of the total manufacturing employment in 2011, down from 25.5 per cent in 1991. Within the manufacturing industry, the employment level of service occupations declined at the fastest annual rate over the1991-2011 period. The rate of decline is much faster than what we observe for the production occupations (-2.81 per cent vs. -0.49 per cent). This is so despite the fact that the employment level in production occupations declined at a much faster rate over the period 2001-2011.

However, such decline seems driven by factors other than the rising Chinese import competition during 2001-2011. Most of the decline in employment level occurred during 1991-2001. The rate of decline during the 2001- 2011 period is actually lower that that observed during the earlier period. Moreover, the employment share of other services actually increased during the 2001-2011 period in which occupations in production were the only group with a falling employment share.

C. Occupation-specific trade exposure

Based on equation (2) in Section IV, we compute import exposure for 140 three-digit NOC occupations in the manufacturing industry in Canada. Table 4 presents the occupations with the ten largest and ten smallest changes in Chinese import exposure over the 2001-2011 periods.

The top ten occupations include occupations with various skill types and skill levels.[15] Importantly, occupations with large annual increases in the import penetration ratio tend to have their employment concentrated in highly exposed sectors in manufacturing. For example, occupations that experienced the largest increase in import penetration were *Managers in communication (except broadcasting).* Note that 52 per cent of their total manufacturing employment was in *Communications equipment manufacturing* (NAICS 3342) in 2001. Among the manufacturing sectors, it experienced the largest increase in import penetration (7.23 percentage-point increase per year) over the period 2001-2011.

[15] We also examined occupations whose import penetration ratio increase was above the 75th percentile. Among them, about 43 per cent were in high-skilled; 31 per cent in mid-skilled; and 26 per cent in low-skilled. In terms of skill type, most of them were in management, technical/paraprofessional, and production.

The second largest is *Computer and Information Systems Professionals.* In 2001, their employment was concentrated in *Communications equipment manufacturing* (NAICS 3342) and *Semiconductor and Other Electronic Component Manufacturing* (NAICS 3344), the sectors with large annual increases in import penetration over the 2001-2011 period: 1.37 and 7.23 percentage-points respectively. Also included is *Machine operators and related workers in fabric, fur and leather products manufacturing*. Of their total manufacturing employment, 64 per cent were in *Clothing knitting mills* (NAICS 3151). The sector experienced a 5.22 percentage-point increase per year over the 2001-2011 period.

We observe the occupations in the bottom ten exhibit only negligible annual increases in their import exposure to China. Some of them tend not to be directly related to economic activities carried out in establishments in manufacturing. They include: 1. *Psychologists, Social Workers, Counsellors, Clergy and Probation Officers*; 2. *Assisting Occupations in Support of Health Services*; 3. *Other Occupations in Protective Service*; and 4. *Other Occupations in Travel, Accommodation, Amusement and Recreation.*

Two of the bottom ten are in mining, oil, and gas extraction: *Mine service workers and operators in oil and gas drilling* and *Supervisors, Mining, Oil and Gas*. For the former, of the total manufacturing employment in 2001, 38.6 per cent was in *Petroleum and coal product manufacturing* (NAICS 3241). For the latter, 54.8 per cent was in that sector. This sector was one of only few manufacturing sectors that faced a *declining* import penetration ratio during the 2001-2011 period.

Also included in the bottom ten are occupations in *Supervisors, Logging and Forestry*. In 2001, of their total manufacturing employment 67.3 per cent were in *Sawmills and Wood Preservation* (NAICS 3211). Also included is *Logging Machinery Operators*. For this occupation, 79.2 per cent of their total manufacturing employment was in *Sawmills and Wood Preservation* (NAICS 3211). This manufacturing sector exhibited a very small annual increase in its import exposure (0.001 percentage points per year).

We see some negative correlation between annual changes in import penetration and annual changes in employment. For example, occupations in *Managers in communication (except broadcasting)* exhibited the largest annual increase in import penetration over the 2001-2011 period. During this period, they experienced a quite fast decline in employment: -11.22 per cent decline per year. Following them was *Machine operators and related workers in fabric, fur and leather products manufacturing.* They had the second largest annual increase in import penetration (2.20 percentage points) and a considerably large decline in employment (a negative 10.95 per cent decline per year).[16] For the bottom ten occupations, they tend to be associated with positive or smaller negative rates of change in employment over the 2001-2011 period.

[16] The reason we see a particularly large number for annual employment growth at the 3-digit occupation level is that, *within* the manufacturing industry, some occupations saw a large jump or fall in its number of employed person over time. For example, the number of employed persons in *Other elemental service occupations* was 3,445 in 2001 and 575 in 2011. Also, the number of employed persons in *Managers in communication (except broadcasting)* was 970 in 2001 and 295 in 2011. Lastly, *Machine operators and related workers in fabric, fur and leather products manufacturing* had 62,475 employed persons in 2001 and 19,585 in 2011.

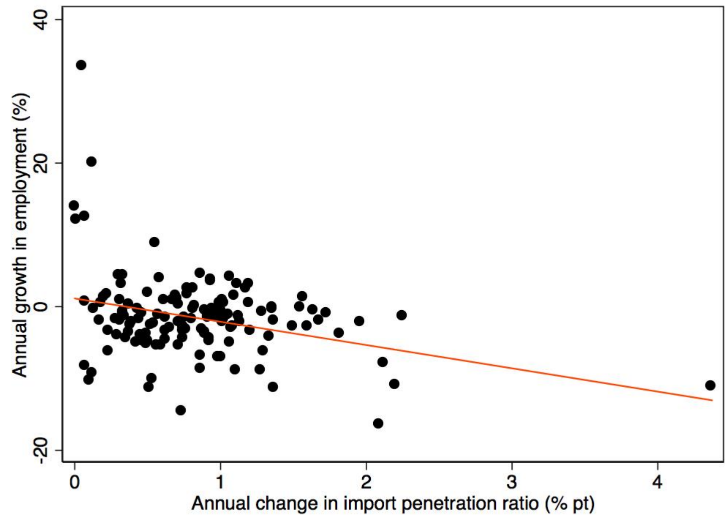
Table 4: Annualized percentage point change in Occupation-Specific Chinese Import Penetration Ratio and Annual per cent change in employment for Selected 3-digit NOC-S 2006, Manufacturing, 2001-2011

Ten largest	Δ in Import Penetration Ratio (% pt)	Employment growth (%)
A31 Managers in communication (except broadcasting)	4.37	-11.22
C07 Computer and Information Systems Professionals	2.25	-1.28
J16 Machine operators and related workers in fabric, fur and leather products manufacturing	2.20	-10.95
H51 Upholsterers, tailors, shoe repairers, jewellers and related occupations	2.12	-7.97
G98 Other elemental service occupations	2.09	-16.39
C18 Technical occupations in computer and information systems	1.96	-2.26
C14 Technical Occupations in Electronics and Electrical Engineering	1.82	-3.76
G81 Childcare and Home Support Workers	1.73	-0.91
H12 Carpenters and cabinetmakers	1.68	-2.00
A12 Managers in Engineering, Architecture, Science and Information Systems	1.64	-0.60
Ten smallest		
I12 Supervisors, Mining, Oil and Gas	0.17	-1.98
I14 Mine Service Workers and Operators in Oil and Gas Drilling	0.13	-0.43
I11 Supervisors, Logging and Forestry	0.12	-9.32
G73Other Occupations in Travel, Accommodation, Amusement and Recreation	0.12	20.11
I15 Logging Machinery Operators	0.10	-10.31
G94 Butchers and Bakers	0.08	0.60
G62 Other Occupations in Protective Service	0.07	-8.38
D03Assisting Occupations in Support of Health Services	0.07	12.47
I17 Fishing Vessel Masters and Skippers and Fishermen / women	0.06	33.51
E02 Psychologists, Social Workers, Counsellors, Clergy and Probation Officers	0.01	12.07

Source: Author's calculation based on the online trade data base maintained by Innovation, Science, and Economic Development Canada and the 1991 and 2001 censuses and 2001 National Household Survey.
Note: D01 (Physicians, Dentists, Veterinarians) has an annualized percentage point change in OIP of 0.00 but its employment level in 2001 is zero while the level in 2011 is 120 resulting in huge employment growth. Similarly, F13 (Announcers and Other performers) has an annualized percentage point change in OIP of 1.96 but its employment level in 2001 is 70 while the level in 2011 is zero (very large negative percent change). We excluded these two occupations in our analysis as we do not want occupations ostensibly unrelated to manufacturing to drive our main results.

To examine a correlation between the two variables among all 140 three-digit occupations, we plot employment growth against changes in import penetration ratio. Chart 4 depicts a scatter plot between annualized employment growth and annual change in import penetration ratio over the 2001-2011 period. We observe that occupations with a lower growth rate (or a greater rate of decline) in their employment tend to experience a larger increase in Chinese import competition and vice versa.

Chart 4: Annualized employment growth and annual change in import penetration ratio, 3-digit occupations, Manufacturing, Canada, 2001-2011



Source: Author's calculation based on the online trade data base maintained by Innovation, Science, and Economic Development Canada and the 1991 and 2001 censuses and 2001 National Household Survey.

IV. Empirical Strategy and Data Sources

A. Measure of occupation-specific import exposure

Following Ebenstein *et al*. (2014), we construct occupation-specific exposure to international trade using the distribution of workers employed in an occupation across industries. Specifically, this is done by weighting industry-specific exposure by an industry's start-of-period share in the total number of employed workers in a given occupation.

First, industry-level import exposure can be defined as follows:

$$\Delta IP_{j,\tau} \equiv \frac{\Delta M^{cc}_{j,\tau}}{Y_{j,92}+M_{j,92}-E_{j,92}} \tag{1}$$

where j denotes subsectors in the manufacturing industry. τ denotes the two sub-periods: 1992-2001 and 2001-2011. $Y_{manu,92} + M_{manu,92} - E_{manu,92} = \sum_{j=1}^{J}(Y_{j,92} + M_{j,92} - E_{j,92})$. $Y_{j,92}$ is industry shipments of sector j in 1992, $M_{j,92}$ and $E_{j,92}$ are imports and exports in sector j in 1992.[17] Hence, $Y_{j,92} + M_{j,92} - E_{j,92}$ represents the domestic absorption in sector j in the initial period. $\Delta M^{cc}_{manu,\tau} = \sum_{j=1}^{J} \Delta M^{cc}_{j,\tau}$ and $\Delta M^{cc}_{j,\tau}$ is the change in import from China in subsector j over τ.[18]

[17]Our starting year for $\Delta IP_{j,\tau}$ is 1992 instead of 1991 which is the starting year for our dependent variable. Trade data by industry for China are available only from 1992. Note that we annualize the change during 1992-2001 and most of the increase in Chinese import competition occurred after 2000. Therefore, this would not cause any serious problem.

[18] Note that our model based on Equation (1) would not account for the effect of manufacturing imports from other countries being replaced by Chinese imports. This effect could be non-negligible according to Chart 3. To the extent

All nominal values are converted to chained 2007 Canadian dollars using the household consumption expenditure deflator. Variation in ΔIP_j over time reflects only the change in the real value of Chinese imports, while the domestic market size is held constant at its initial value. A motivation for normalizing by initial domestic absorption is that variation in import exposure occurs only from changes in Chinese imports, not from other factors that might affect domestic market size during the period in which Chinese import rose.

Following Ebenstein *et al*. (2014), the change in trade exposure for occupation k (4-digit occupation) for a Canadian manufacturing industry over period τ is defined as follows:

$$\Delta OIP_{k,\tau} \equiv \sum_{j=1}^{J} \alpha_{kj,\tau} \cdot \Delta IP_{j,\tau} \qquad (2)$$

where $\alpha_{kj,\tau} \equiv \frac{L_{k,j,\tau}^{manu}}{L_{k,\tau}^{manu}}$. $L_{kj,\tau}^{manu}$ is the number of employed workers in occupation k in sector j at the start of τ. $L_{k,\tau}^{manu}$ is the number of workers in occupation k across all sectors in manufacturing industry at the start of τ.[19]

The above represents percent change in trade exposure of occupation k in the manufacturing industry over τ. Variation in ΔOIP *across* occupations arises from variations in the initial distribution of occupations across manufacturing sectors.[20]

B. Identification strategy

One issue with our estimation using (2) is that realized imports from China could be correlated with import demand shocks resulting in a biased OLS estimate (underestimate the true impact). This is due to the possibility that both Canadian employment and imports are correlated with unobserved shocks to demand for Canadian product.

Hence, an instrumental variable strategy is employed to deal with potential endogeneity of trade exposure. Following Autor *et al.* (2013) and Acemoglu *et al*. (2016), we exploit the fact that during 1991-2011, the growth in Chinese imports stemmed mostly from the rising competitiveness of Chinese manufacturing industries and lowering of trade barriers and accession to the WTO. To capture the variation in (2) driven by China's expanding exporting capacity, we instrument for changes in Chinese imports to Canada using the changes in import penetration in eight other advanced economies.[21]

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our model fails to account for such effect, one could expect that our estimate of the employment effect of the China shock is understated.

[19] Note that 1991 data are available rather than 1992. This is not consistent with industry-specific import penetration whose starting year is 1992. We assume employment structure in 1991 within locality was not fundamentally different from 1992. Hence, we use 1991 value for the employment.

[20] Variation may not be significant at a broader level (skill-type and skill-level). However, at the 4-digit occupation level, variation is substantial**.**

[21] The eight economies are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland. We exclude the United States because its economy is highly integrated with Canada and is likely to have experienced similar demand patterns.

$$\Delta IPE_{j,\tau} \equiv \frac{\Delta M_{j,\tau}^{EA}}{Y_{j,92}+M_{j,92}-E_{j,92}} \tag{3}$$

where $\Delta M_{j,\tau}^{EA}$ represents the change in the Chinese imports of eight other advanced economies in industry j over τ. The nominal values of imports of the eight economies are converted from USD to Canadian dollars using annual PPPs for personal consumption expenditure from the OECD, deflated to chained 2007 Canadian dollars using the Canadian PCE deflator.

Then, we obtain the following for occupation k.

$$\Delta OIPE_{k,\tau} \equiv \sum_{j=1}^{J} \alpha_{kj,\tau} \cdot \Delta IPE_{j,\tau} \tag{4}$$

The motivation for our identification strategy is that the eight advanced economies would have been exposed to China in a similar way in that Chinese import growth was driven by supply shocks in the country. Then, the key identifying assumptions are: 1. product demand shocks are uncorrelated across the eight countries; and 2. there are no strong increasing returns to scale in Chinese manufacturing such that Canadian demand shocks might increase efficiency in the Chinese manufacturing industries and lead them to export more to the eight other economies.[22] Although the former might contaminate (downwardly) our estimates of the impact of the China shock on employment, we think the latter is not likely to be a major concern since the size of Canadian economy is too small relative to the global economy.

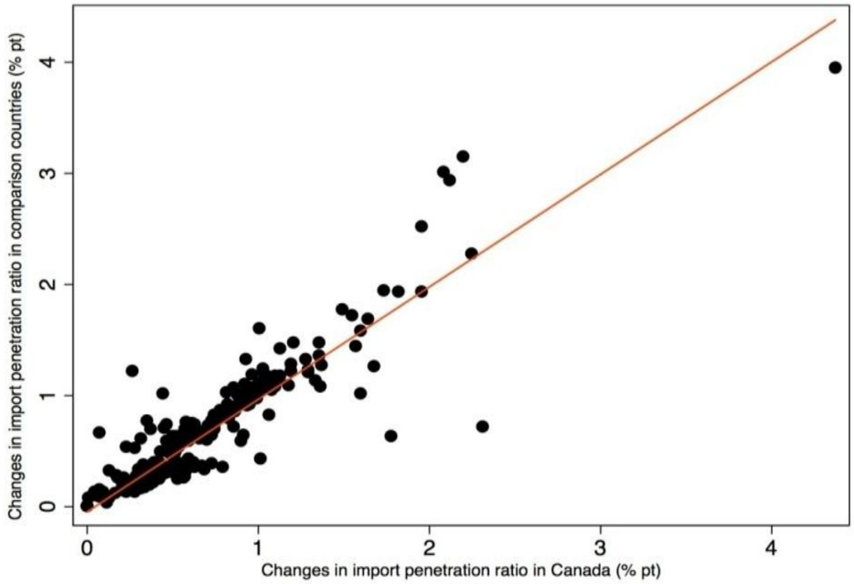
Our data suggest that approximately 82 per cent of the variation in occupation-specific import penetration is driven by exogenous supply shocks.[23] This suggests that import growth in the eight advanced economies has strong predictive power for Chinese import growth in Canada (see Chart 5). As a comparison, Acemoglu *et al*. (2016) find that 62 per cent of the total variation in Chinese imports to U.S. was driven by supply shocks. Balsvik *et al.* (2015) find that exogenous supply shocks can explain about 91 per cent of the total variation in Chinese imports to Norway.

[22] As pointed out in Goldsmith-Pinkham *et al.* (2018), in this IV setting, there could be a small number of occupations driving a large share of the identifying variations in our sample. Autor *et al.*(2013) also point out that the electronic computer industry in their sample could be a major source of endogeneity stemmed from correlated demand shocks across the U.S and eight other countries due to common innovations in the use of information technology. In our case, a group of occupations related to ICT (*e.g.* Information system analysts and consultants, Database analysts and data administrators, Software engineers and designers, Web designers and developers) may be a source of a similar endogeneity problem. As a crude test, we estimated the equation after we excluded ICT-related occupations in our sample. The estimated marginal effect was found to be slightly larger. This is consistent with our prediction that those occupations would contaminate the estimate downwardly.

[22] See Autor *et al*. (2013) for further discussion.

[23] This is based on regressing (2) on (4) for all 4-digit occupations in the Canadian manufacturing industries (equivalent to first-stage regression in our subsequent 2SLS estimation). The R-squared from such regression is 0.82.

Chart 5: Occupation-specific import exposure to China: Other advanced economies vs. Canada, 1991-2001 and 2001-2011



Source: Author's calculation based on the online trade data base maintained by Innovation, Science, and Economic Development Canada and the 1991 and 2001 censuses and 2001 National Household Survey.

C. Data Sources

Trade data required to construct the industry-level import penetration ratio and its instrument are provided by Alexander Murray. In Murray (2017), trade data for Canada are drawn from the Trade Data Online database maintained by Innovation, Science and Economic Development Canada (ISED). The database provides import and export statistics by detailed four-digit NAICS industry. Data are available for nominal values of total imports, total exports, and imports from China for 85 four-digit NAICS manufacturing industries for the 1992-2015 period. The import penetration measures are normalized by the industry's total domestic absorption (total industrial shipment plus imports minus export). Data on total shipments by four-digit NAICS manufacturing industry are drawn from CANSIM Table 304-0014.

In order to construct the instrumental variable, we need data on the Chinese imports of eight other advanced economies by four-digit NAICS industry. In Murray (2017), the data were obtained on each country's Chinese imports by six-digit HS product code from the UN Comtrade database. Then, the data are mapped into 85 four-digit NAICS manufacturing industries using a procedure developed in Pierce and Schott (2012).[24]

[24] There are 86 four-digit NAICS manufacturing industries. However, the mapping from HS products to NAICS industries had no products into NAICS 3328 (Coating, engraving, cold and heat treating and allied activities). Hence, the industry is dropped, leaving us with a sample of 85 manufacturing industries. We think that our analysis would not be sensitive to the exclusion; in the data from ISED, imports in this industry are close to zero.

To construct the occupation-specific import penetration ratio, we need employment data for each occupation across all manufacturing industries in Canada. We draw measures of employment by four-digit NOC occupations across 85 NAICS manufacturing industries from the 1991 and 2001 censuses and the 2011 National Household Survey. For our local-level analysis, we extract the employment data by industry and by occupation for each of 122 CMAs/CAs from the censuses.

However, industries and occupations are coded based on different classification systems across the three censuses. In the 1991 census, industries and occupations are coded according to the Standard Industrial Classification System (SIC) 1980 and NOC 1991; in the 2001 census, NAICS 1997 and NOC-S 2001; and in the 2011 census, NAICS 2007 and NOC-S 2006.

Concordance of the NOC (t year) -NOC (s year) (or SIC-NAICS) is a research question and some methods are suggested in the literature. Conveniently, in the 2001 census, both SIC 1980 and NOC 1991 are available. Hence, we use employment shares in the 2001 census based on the year's cross-tabulation of NOC 1991 - NOC-S 2001 and SIC 1980 -NAICS 1997 respectively. Based on the cross-tabulation, we can compute the share of each occupation in the NOC-S 2001 and each industry in NAICS-1997 across the occupations in NOC-1991 and the industries in SIC-1980, respectively. In other words, we get an employment share for each pair of NOC-1991 and NOC-S 2001 occupations and for each pair of SIC 1980 - NAICS 1997 industries for Canada and for each CMA/CA.

We apply the employment shares to the 1991 data assuming that the employment structure was the same in 1991 and 2001. This ignores a different distribution of occupations within each industry. However, it requires an infeasible number of computations to take into account an individual industry.[25] Thus, we take a more parsimonious approach by taking into account only the difference in the occupational distribution of employment across CMAs/CAs (*i.e.* we carry out concordance for each CMA/CA). This should not distort our analysis greatly because a major Chinese import penetration occurred only after the 2000s.[26]

V. Empirical Analysis 1: Occupation-Level Direct Effect

A. Model

To assess the direct effect of the China shock on Canadian employment across skill levels and skill types, we estimate the following regression equation.

[25] The number of computations required to take into account different distributions across industries is 13.3 billion (692 occupations in NOC 1991 x 520 in NOC-S 2001 x 300 industries in NAICS 1997 x 122 CMAs/CAs plus Canada total).
[26] The concordance between NAICS 1997 and NAICS 2007 and that between NOC-S 2001 and NOC-S 2006 are relatively straightforward for our purpose. Hence, we do not concord them using the same method described here. Instead, we refer to the concordance tables provided by Statistics Canada.

$$\Delta L_{k,\tau} = \alpha_\tau + \beta \Delta OIP_{k,\tau} + \varepsilon_{k,\tau} \qquad (5)$$

where $\Delta L_{k,\tau}$ is 100 times the log change (annualized) in employment level in 4-digit occupation k over τ.[27] $\Delta OIP_{k,\tau}$ is 100 times the annual change (percentage-point change) in the Chinese import penetration for 4-digit occupation k over τ. α_τ is a period-specific constant and $\varepsilon_{k,\tau}$ is an error term.

To estimate the marginal impact of trade exposure on each skill group, we estimate the following two fully-interacted regressions.[28]

$$\Delta L^s_{k,\tau} = \alpha_{s,\tau} + \beta_1 \Delta OIP_{k,\tau} \cdot \mathbb{I}\{s = high\ skiiled\} + \beta_2 \Delta OIP_{k,\tau} \cdot \mathbb{I}\{s = mid\ skiiled\} + \beta_3 \Delta OIP_{k,\tau} \cdot \mathbb{I}\{s = low\ skiiled\} + \varepsilon_{k,\tau} \qquad (6)$$

$$\Delta L^p_{k,\tau} = \alpha_{p,\tau} + \beta_1 \Delta OIP_{k,\tau} \cdot \mathbb{I}\{p = management\} + \beta_2 \Delta OIP_{k,\tau} \cdot \mathbb{I}\{p = professional\} + \cdots + k6\Delta OIPk,\tau \cdot \mathbb{I}\{p = production\} + \varepsilon k,\tau \qquad (7)$$

where s and p indicate skill level and skill type, respectively. Estimated coefficient $\hat{\beta}$ represent the marginal impact of import penetration on employment in a given skill group.

We estimate equation (5), (6), and (7) by two-stage least squares (2SLS) using $\Delta OIPE_{k,\tau}$ on a pooled sample of occupation-level changes in employment in manufacturing and import exposure over the two sub-periods: 1991-2001 and 2001-2011. Observations are weighted by employment levels in 1991, so that occupations with large initial employment receive greater weight. Standard errors are clustered within 140 three-digit NOC categories.

In order to quantify the direct effect of the China shock, we use our estimated coefficients from the above equations. Based on the coefficients, we compute an estimate of the direct employment effect for each skill group in Canadian manufacturing sectors.

To benchmark the impact of supply-driven Chinese import shocks on the employment level in Canada, we use the estimated coefficients to estimate changes in log employment induced by supply-driven Chinese import penetration over the periods 1991-2001 and 2001-2011, respectively.

In order to capture the variation induced by supply shocks, we discount the change in trade exposure to China by R-squared from the first stage regression. We define $\Delta\widetilde{OIP}_{k,t}$ to be the portion of the change in occupation k's exposure to Chinese import attributable to the Chinese export supply shocks. Lastly, we use the observed end-of-period employment level to

[27] We use employment data from a cross-tabulation of 85 four-digit NAICS manufacturing industries and 494 four-digit NOC occupations. The cross-tabulations referred here are the ones created after we carry the concordance between SIC-NAICS and SOC-NOC in our census files.

[28] Note that fully-interacted regressions are analogous to regressions on split samples.

convert from logs to levels. Hence, the implied employment effect can be seen as the causal effect of supply-driven increase in Chinese import penetration ratio over the period of interest.

The implied employment effect can be written as the following:

$$\Delta L_t^{cf} = \sum_k^K (L_{k,t} - L_{k,t}^{cf})$$

$$= \sum_k^K L_{k,t}(1 - e^{-\hat{\beta}\Delta\widehat{OIP}_{k,t}}) \qquad (8)$$

where $L_{k,t}$ is the actual employment level for occupation k at time t and $L_{k,t}^{cf}$ is the counterfactual level of employment for occupation k at time t.

B. Summary Statistics

Table 5 reports summary statistics for the three key variables used in the estimation of equation (5). First, changes in import penetration in Canada and in the eight other advanced economies are quite similar except for the 1991-2001 period. The distribution of changes in import penetration across occupations are right-skewed, with the mean increase exceeding the median by 0.11. This means that there are some occupations with a very large annual increase in import penetration in our samples. The same is true for the import penetration in the eight other advanced economies. It is right-skewed with the mean increase exceeding the median by 0.19.

In both Canada and the comparison countries, Chinese import penetration accelerated after 2001. The summary statistics for the two measures of import penetration for the sub-period 1991-2001 and 2001-2011 suggest that both measures accelerated after 2001. Their mean and median annual change are much higher during the 2001-2011 period. Also, the decline in employment started to accelerate after 2001.

Table 6 presents the same summary statistics but by skill level over the period 1991-2011. First, over the 2001-2011 period, all skill groups have a negative mean change in log employment, which is consistent with the fact that manufacturing industry as a whole experienced a decline in employment during this period. Among the three skill groups, low-skilled workers exhibit the fastest mean change in annual log employment, followed by mid-skilled workers. During the 1991-2001 period, annual change in log employment is highly left-skewed implying that negative means for all three skill levels are due to a small subset of occupations experiencing a very large decline in their employment.

Across the two sub-periods, high-skilled occupations exhibit the largest mean annual change in import penetration, followed by low-skilled. As previously shown, most of the occupations that experienced a large increase in import penetration were either high- or low-skilled (see Section III). Lastly, import penetration increased for all three skill levels after 2001.[29]

Table 7 summarize statistics by skill type. The two groups with the largest mean change in import penetration were Technical/paraprofessional and management. They consistently exhibit the largest mean change in import penetration across the two sub-periods. On the other hand, professional and trades/construction/transportation exhibit the lowest. Production and other services experienced a quite similar degree of change in import exposure over time.

During the 1991-2011 period, the mean change in log employment was the largest for professional occupations but it was largely driven by the development that occurred during the 1991-2001 period. Following professional occupations are occupations in other services and occupations in management and production.

[29] Note that, we do not see a clear correlation between log change in employment and change in import penetration at the highly-aggregated level. The high-skilled group had the largest mean increase in import penetration, they had the largest change in employment. At the same time, low-skilled faced the second largest change in import penetration but it had the lowest mean change in employment among the three skill groups. Within each skill group, however, we observe a negative correlation between the two variables at the 4-digit occupation level.

Table 5: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, Manufacturing Industries, Canada

	1991-2011 stacked		**Sub-periods**		
			1991-2001	**2001-2011**	**1991-2011**
	Mean	Median	Mean/Median	Mean/Median	Mean/Median
Annual change in Chinese Import Penetration (% pt)	0.51	0.40	0.37 / 0.34	0.65 / 0.64	0.55 / 0.51
Instrument for Chinese Import Penetration (% pt)	0.47	0.28	0.25 / 0.20	0.68 / 0.64	0.52 / 0.47
100 x Annual log change in Employment (%)	-1.89	-1.53	-0.49 / 1.44	-3.25 / -2.51	-3.59 / -1.68

Note: The annual change in Chinese import exposure is 100 x annual change in import penetration for occupation k. The instrument is 100 x annual change in import penetration for occupation k based on the average annual absolute change in imports from China in a set of eight comparator countries over the period indicated. The comparator countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland. Annual growth in employment is the annualized per cent change in employment level for each 494 four-digit occupations between 1991-2001 and 2001-2011 based on data from the 1991 and 2011 census and the 2011 National Household Survey. Observations are weighted by occupation-level employment in 1991.

Table 6: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, by Skill-Level, Manufacturing Industries, 1991-2011 by sub-period, Canada

	1991-2001		
	High-skilled	Mid-skilled	Low-skilled
	Mean/Median	Mean/Median	Mean/Median
Annual change in Chinese Import Penetration (% pt)	0.42 / 0.45	0.35 / 0.28	0.36 / 0.32
Instrument for Chinese Import Penetration (% pt)	0.27 / 0.28	0.23 / 0.18	0.26 / 0.20
100 x Annual log change in Employment (%)	-1.55 / 1.95	-0.57 / 1.66	-0.01 / 1.45
	2001-2011		
	High-skilled	Mid-skilled	Low-skilled
	Mean/Median	Mean/Median	Mean/Median
Annual change in Chinese Import Penetration (% pt)	0.86 / 0.89	0.58 / 0.59	0.67 / 0.67
Instrument for Chinese Import Penetration (% pt)	0.92 / 0.97	0.62 / 0.56	0.70 / 0.55
100 x Annual log change in Employment (%)	-1.53 / -1.39	-2.99 / -2.48	-3.83 / -3.34
	1991-2011 stacked		
	High-skilled	Mid-skilled	Low-skilled
	Mean/Median	Mean/Median	Mean/Median
Annual change in Chinese Import Penetration (% pt)	0.64 / 0.51	0.46 /0.38	0.52 / 0.39
Instrument for Chinese Import Penetration (% pt)	0.60 / 0.36	0.43 / 0.24	0.48 / 0.26
100 x Annual log change in Employment (%)	-1.54 / -1.21	-1.78 / -1.41	-1.92 / -2.05

Note: The annual change in Chinese import exposure is 100 x annual change in import penetration for occupation k in a given skill group. The instrument is 100 x annual change in import penetration for occupation k based on the average annual absolute change in imports from China in a set of eight comparator countries over the period indicated. The comparator countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland. Annual growth in employment is the annualized per cent change in employment level for each 494 four-digit occupations between 1991-2001 and 2001-2011 based on data from the 1991 and 2011 census and the 2011 National Household Survey. Observations are weighted by occupation-level employment in 1991.

Table 7: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, by Skill-Type, Manufacturing Industries, 1991-2011 by sub-period, Canada

	Management	Professional	Technical and Paraprofessional	Other services	Trades, Construction, Transportation	Production
1991-2001						
	Mean/Median	Mean/Median	Mean/Median	Mean/Median	Mean/Median	Mean/Median
Annual change in Chinese Import Penetration (% pt)	0.43 / 0.45	0.33 / 0.35	0.53 / 0.41	0.41 /0.39	0.22 / 0.18	0.37 / 0.21
Instrument for Chinese Import Penetration (% pt)	0.28 / 0.29	0.21 / 0.23	0.32 / 0.27	0.30 / 0.25	0.12 / 0.12	0.28 / 0.14
100 x Annual log change in Employment (%)	-0.72 / 1.20	-9.82 / -3.95	2.37 / 3.94	-4.62 / -3.38	0.29 / 2.16	2.54 / 3.31
2001-2011						
	Management	Professional	Technical and Paraprofessional	Other services	Trades, Construction, Transportation	Production
	Mean/Median	Mean/Median	Mean/Median	Mean/Median	Mean/Median	Mean/Median
Annual change in Chinese Import Penetration (% pt)	0.90 / 0.93	0.30 / 0.59	0.93 / 0.86	0.74 / 0.75	0.35 / 0.48	0.68 / 0.42
Instrument for Chinese Import Penetration (% pt)	0.94 / 0.97	0.42 / 0.63	1.01 / 0.87	0.80 / 0.78	0.32 / 0.57	0.71 / 0.42
100 x Annual log change in Employment (%)	-2.22 / -2.22	0.57 / -1.39	-1.47 / -1.29	-3.18 / -3.34	-2.39 / -2.38	-4.81 / -4.11
1991-2011 stacked						
	Management	Professional	Technical and Paraprofessional	Other services	Trades, Construction, Transportation	Production
	Mean/Median	Mean/Median	Mean/Median	Mean/Median	Mean/Median	Mean/Median
Annual change in Chinese Import Penetration (% pt)	0.67 / 0.51	0.32 / 0.35	0.73 / 0.56	0.58 / 0.48	0.29 / 0.23	0.52 / 0.30
Instrument for Chinese Import Penetration (% pt)	0.61 / 0.36	0.32 / 0.27	0.67 / 0.37	0.55 / 0.32	0.22 / 0.14	0.50 / 0.22
100 x Annual log change in Employment (%)	-1.47 / -1.34	-4.96 / -1.52	0.45 / 0.63	-3.90 / -3.34	-1.05 / -1.57	-1.14 / 0.01

Note: The annual change in Chinese import exposure is 100 x annual change in import penetration for occupation k in a given skill group. The instrument is 100 x annual change in import penetration for occupation k based on the average annual absolute change in imports from China in a set of eight comparator countries over the period indicated. The comparator countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland. Annual growth in employment is the annualized per cent change in employment level for each 494 four-digit occupations between 1991-2001 and 2001-2011 based on data from the 1991 and 2011 census and the 2011 National Household Survey. Observations are weighted by occupation-level employment in 1991.

C. Results

1. Regression results

We start by estimating the marginal effect of the China shock on the overall employment in Canadian manufacturing industries. Table 8 presents the results from estimating equation (5) by stacking the time periods 1991-2001 and 2001-2011. Alongside these estimates, we also present the results based on the two sub-periods: 1991-2001 and 1991-2001. These additional results based on the sub-periods allow us to examine the results before and after the commencement of the substantial rise in Chinese import competition in Canada.

In column (1), we only include the time dummies which reflect the mean annual growth rates of employment in each of the sub-periods. We observe that the time dummy for the 2001-2011 period is statistically significantly negative while that for the 1991-2001 is not statistically different from zero. This is consistent with our observation earlier that the employment in manufacturing did not experience any notable downward trend during the 1991-2001 period. Column (2) adds the observed change in import penetration without instrumentation. We see the estimated coefficient for the import penetration is negative but not statistically significant.

As noted earlier, the OLS estimate could be biased since growth in import could have been driven partly by changes in domestic supply and demand. Hence, in column (3) we mitigate the simultaneity bias by instrumenting the change in import penetration in Canada by the changes in import penetration in the eight comparison countries. Based on our 2SLS estimate, the coefficient for the change in import penetration is negative and statistically significant at 5 per cent significance level. The estimation implies that a 1 percentage point rise in the occupation-specific import penetration ratio reduces manufacturing employment growth by 1.17 percentage points per year.[30]

Columns (4) to (7) display bivariate estimates separately by sub-period. First, we find that the Chinese import penetration did not play any significant role in driving the employment growth in manufacturing before 2001. Our estimation indicates that, during the 1991-2001 period, there was no significant impact of rising occupation-specific import penetration on the manufacturing employment. However, we find a negative and statistically significant impact of a rise in import penetration on occupations in manufacturing industries: a 1 percentage-point rise in import exposure leads to a 1.34 percentage point annual decline in employment growth for occupations in manufacturing. These results suggest that our main results from column (3) are mainly driven by the 2001-2011 data points.

[30] Note that the smaller magnitudes of the impact estimated based on OLS (*i.e.* column 3 and 5) are consistent with our prediction that the estimate is likely to be biased downwardly without instrument due to exogenous product demand shocks driving up both employment and imports from China.

Table 9 presents the 2SLS estimation results by skill level. Column (1) shows the results from our stacked model for the 1991-2011 period. During the 1991-2011 period, occupations in the low-skilled group were negatively affected by the rising Chinese import competition. A 1-percentage-point increase in occupation-specific import penetration reduces the annual employment growth in low-skilled occupations by 1.73 percentage points. We find no statistical evidence that high- and mid-skilled are negatively affected by rising Chinese import penetration.

By sub-periods, we find that only the low-skilled occupations had a statistically significant impact from Chinese import competition during the 1991-2001. Note that the employment growth in this skill group is *positively* affected by the rising Chinese import competition. Further investigation reveals that such positive relationship is driven by six influential occupations.[31] Those six low-skilled occupations had large increases in the Chinese import penetration ratio during 1991-2001 (an annual change of 0.8 to 1.3 percentage-point) but did not experience a decline in their employment. If we fit a regression line separately for the low-skilled occupations excluding them, we observe a negative relationship. 2SLS estimates based on the sample without those six occupations indicate that there is indeed a negative relationship although the coefficient (-0.88) is not significant at any conventional significance level (*t* statistics = -0.72).

For the 2001-2011 period, the results are consistent with those from the stacked model: a 1 percentage-point increase in import penetration ratio reduces the employment growth in low-skilled occupations by 2.24 percentage points per year, respectively. Again, it seems that our main results from the stacked model are mainly driven by the data points in the 2001-2011 sample, the period associated with a rapid rise in Chinese import penetration in Canada.

For high- and mid-skilled occupations in manufacturing, the rising Chinese import penetration does not have any statistically significant effect on their employment. Such findings can be understood by noting that a majority of Chinese manufacturing goods exported to Canada had been in low-tech or low value-added replacing similar goods produced by Canadian firms. At the same time, Canadian manufacturing sectors might have shifted towards high-tech and high value-added niches in the face of the rising Chinese import competition. This is consistent with the pattern we find in Section III-- expanding high- and mid-skilled and contracting low-skilled both in terms of growth and share of total manufacturing employment.

Again, skill level is just one way to characterize occupations. We find above that the marginal employment effect is the greatest for low-skilled occupations. However, low-skilled occupations consist of more than one skill type (*e.g.* technical/paraprofessional, other service, trades/construction/transportation and production). Estimating the marginal employment effect in skill-type dimension would be informative.

[31] Note that there are 155 low-skilled occupations in the sample. The six occupations include the following 4-digit NOC occupations: Dry cleaning, laundry, ironing, pressing, and finishing occupations (Other elemental service occupations); Sewing machine operators; Fabric, fur and leather cutters; Inspectors and testers, fabric, fur and leather products manufacturing (Machine operators and related workers in fabric, fur, and leather products manufacturing); Electronics assemblers, fabricators, inspectors and testers (Mechanical, Electrical, and Electronics Assemblers); Other labourers in processing, manufacturing and utilities (Labourers in processing, manufacturing, and Utilities).

Table 10 presents the results by skill type. Based on the stacked model (column 1), we find that a rise in import penetration ratio has a negative and statistically significant impact on annual employment growth in all skill types except for management, professional, and technical and paraprofessional. Notably, the impact on the occupations in other services is estimated to be very large: 2.96 percentage-point decline in response to a 1-percentage-point increase in their import penetration ratio.

Note that none of the marginal effects appears to be statistically significant if the model is estimated based on the 1991-2001 period (column 2). When we focus on the period when Chinese import penetration rose substantially (*i.e.* 2001-2011, column 3), we find that occupations in technical/paraprofessional, other services, and production had a statistically significant impact from the China shock. A 1-percentage-point increase in import penetration reduced employment growth by 0.81 percentage points per year for occupations in technical/paraprofessional; 3.07 percentage point per year for occupations in other services; and 1.96 percentage point per year for occupations in production. Again, it appears that our main results from the stacked model are mainly driven by the data points in the 2001-2011 sample.

Table 8: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries, Canada: OLS and 2SLS Estimates

	Stacked Differences			By Sub-periods			
	1991-2001 and 2001-2011			1991-2001	1991-2001	2001-2011	2001-2011
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Annual change in Chinese Import Penetration	-	-0.57 (0.44)	-1.17** (0.54)	1.64 (1.06)	0.48 (1.26)	-0.87* (0.52)	-1.34** (0.66)
1{1991-2001}	-1.04 (0.71)	-0.83 (0.72)	-0.60 (0.72)	-	-	-	-
1{2001-2011}	-3.11*** (0.85)	-2.95*** (0.85)	-2.77*** (0.85)	-	-	-	-
Constant	-	-	-	-1.64** (0.75)	-1.21 (0.77)	-3.57*** (0.46)	-3.27*** (0.52)
Obs.	877	877	877	438	438	439	439
Estimation Method	OLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
First-stage F Statistic	-	-	158.36	-	60.60	-	294.33

Note: In all specifications, the dependent variable is the average annual growth rate of employment by four-digit occupation over the specified period. The number of observations in our sample for the regression is 438 (56 dropped) for the period 1991-2001 and 439 (55 dropped) for the period 2001-2011. This is due to the fact that some occupations have zero employment in all manufacturing sectors across the census years we consider. Examples are: *Legislators; Senior managers - Financial, communications, and other business services; Court officers and justice of the peace; and Post-secondary teaching and research assistants*. Standard errors in parentheses are clustered on 140 three-digit occupation groups. Observations are weighted by occupation employment in 1991.
* p<0.10
** p <0.05
*** p<0.01

Table 9: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries by Skill-Level, Canada: OLS and 2SLS Estimates

	Stacked Differences, 1991-2011	1991-2001	2001-2011
	(1)	(2)	(3)
Annual change in Chinese Import Penetration			
High-skilled	-0.29 (0.70)	5.27 (6.20)	-0.50 (0.83)
Mid-skilled	-0.11 (0.20)	-1.20 (2.46)	-0.08 (0.20)
Low-skilled	-1.73** (0.86)	1.94** (0.96)	-2.24** (1.04)
Obs.	885	442	443
Estimation Method	2SLS	2SLS	2SLS
First-stage F Statistic	2263.34	4275.62	733.24

Note: In all specifications, the dependent variable is the average annual growth rate of employment by four-digit occupation in the specified skill group over the specified period. Some of the observations are dropped as they have zero employment in all manufacturing sectors across the census years we consider. In column (1), the period dummy is interacted with the dummy for skill levels. In column (2) and (3), the constant term is interacted with the dummy for skill levels. Standard errors in parentheses are clustered on 140 three-digit occupation groups. Observations are weighted by occupation employment in 1991.

* p<0.10

** p <0.05

*** p<0.01

Table 10: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries by Skill-Type, Canada: 2SLS Estimates

	Stacked Differences, 1991-2011	1991-2001	2001-2011
	(1)	(2)	(3)
Annual change in Chinese Import Penetration			
	1.34	-2.53	1.57
Management	(2.52)	(10.24)	(2.68)
	1.89	21.17	1.79
Professional	(2.36)	(41.78)	(2.60)
	-0.72*	0.86	-0.81*
Technical and Paraprofessional	(0.38)	(1.37)	(0.41)
	-2.96**	-1.68	-3.07**
Other Services	(1.21)	(6.73)	(1.35)
	-1.00	-4.31	-0.83
Trades, Construction, and Transportation	(0.88)	(2.80)	(0.84)
	-1.49*	1.77	-1.96**
Production	(0.87)	(1.18)	(0.90)
Obs.	885	442	443
Estimation Method	2SLS	2SLS	2SLS
First-stage F Statistic	6439.98	64.67	91.63

Note: In all specifications, the dependent variable is the average annual growth rate of employment by four-digit occupation in the specified skill group over the specified period. Some of the observations are dropped as they have zero employment in all manufacturing sectors across the census years we consider. In column (1), we also control for the period dummy interacted with the dummy for skill types. In column (2) and (3), the constant term is interacted with the dummy for skill types. Standard errors in parentheses are clustered on 140 three-digit occupation groups. Observations are weighted by occupation employment in 1991.
* p<0.10
** p <0.05
*** p<0.01

2. Implied employment effects

Using the estimated coefficient in column (3) in Table 8, we estimate the total number of manufacturing jobs in Canada that did not exist in 2011 as a result of the increase in Chinese import competition over the 1991-2011 period. Here, we rely on Equation (8) along with the R-squared from the first-stage regression. We also estimate the employment effect by skill level and by skill type based on the estimated coefficient from column (1) in Table 9 and Table 10.[32]

Table 11 presents the estimated employment effect for occupations in manufacturing sectors. First, row (1) displays the employment effect for all occupations. During 1991-2011, the rising import competition from China led to a net loss of 198.7 thousand manufacturing jobs in Canada. Over the two decades, 85.2 thousand jobs were lost during 1991-2001 and 113.5 thousand jobs were lost during 2001-2011.

To contextualize the loss, we compare our estimates to the actual change in manufacturing employment over the period. Between 1991-2011, employment in manufacturing declined by 330.4 thousand. Our estimate implies that 60.1 per cent of the total job loss in manufacturing was due to the rising Chinese import competition. For the 2001-2001 period, 22.4 per cent of the total job loss was due to the rising import competition from China.[33]

Row (2) shows the employment effect by skill level. As implied by our estimated coefficient, low-skilled occupations experienced the largest job loss over the 1991-2011 period. According to our estimate, Chinese import competition accounted for a net loss of 166.2 thousand jobs in low-skilled occupations during this period. Had there been no increase in the Chinese import competition (and all other factors in the economy remained the same), the decline in low-skilled employment would have been 49.9 thousand instead of 216.6 thousand. This means that 76.9 per cent of the decline in low-skilled jobs in manufacturing was due to the Chinese import competition. This compares to 37.6 per cent for the high-skilled (10.0 thousand loss / 26.6 actual decline) and 5.7 per cent for the mid-skilled (5 thousand loss / 87.7 thousand actual decline).[34]

[32] Following Acemoglu *et al.* (2016) and Murray (2017), we compute employment effects using both statistically significant and insignificant coefficients from the stacked model.

[33] Compared to the estimates for the United States (Acemoglu *et al.*, 2016), our estimates imply twice as large impact of the China shock on the manufacturing employment during the 2001-2011 period. Their estimate suggests 9.7 per cent of the total decline in the U.S. manufacturing sector was due to Chinese import penetration. Some potential reasons for such difference would be: 1. the mean annual increase in import penetration for Canadian manufacturing was higher than that for the U.S. (0.65 percentage point vs. 0.50 percentage points); 2. the portion of the variation in Chinese import penetration that is driven by supply shocks was much higher than the case for the U.S. (82 per cent vs. 56 per cent).

[34] One should not give too much weight on the estimates on these two group since they are based on statistically insignificant coefficients. One may assume that the employment effect on the two is essentially zero.

Table 11: Implied Employment Changes Induced by Changes in Chinese Import Penetration, thousand, by Skill level and Skill type, Manufacturing sectors, Canada

Occupation Group(s)	Counterfactual Δ in employment level			Actual Δ in employment level			Implied Employment Effect		
	1991-2001	2001-2011	1991-2011	1991-2001	2001-2011	1991-2011	1991-2001	2001-2011	1991-2011
(1) All occupations	**258.0**	**-392.4**	**-134.4**	**175.5**	**-505.9**	**-330.4**	**-85.2**	**-113.5**	**-198.7**
(2) By Skill Level									
High-skilled	13.3	-29.9	-16.6	9.9	-36.5	-26.6	-3.4	-6.6	-10.0
Mid-skilled	50.4	-133.1	-82.7	48.1	-135.8	-87.7	-2.3	-2.7	-5.0
Low-skilled	194.0	-243.8	-49.9	117.6	-333.6	-216.1	-76.4	-89.8	-166.2
(3) By Skill Type									
Management	-7.7	-45.6	-53.3	1.3	-30.4	-29.1	9.0	15.2	24.2
Professional	-23.4	-3.3	-26.7	-20.9	0.1	-20.8	2.5	3.4	5.9
Technical/Paraprofessional	58.1	-8.1	50.0	50.7	-20.2	30.5	-7.4	-12.1	-19.5
Other services	-101.3	-8.7	-110.0	-139.7	-66.3	-206.0	-38.4	-57.6	-96.0
Trades/Construction/Transportation	42.8	-70.1	-27.3	35.0	-82.1	-47.1	-7.8	-12.0	-19.8
Production	299.2	-255.2	44.0	249.1	-307.0	-57.9	-50.1	-51.8	-101.9

Note: Counterfactual changes represent the changes in employment level had there been no change in Chinese import penetration. Following Acemoglu *et al.* (2016) and Murray (2017), the quantity is computed based on both statistically significant and insignificant coefficients from our stacked models. Note that each row represents a different specification: row (1); row (2); and row (3). An implied effect is computed (separately) using 2SLS estimates from the corresponding row specification. Thus, implied effects on individual groups do *not* sum exactly to the quantities based on row (1) specification. Predictions for 1991-2011 is equal to the sum of the predictions for the two sub-periods. The unit of analysis is 4-digit NOC occupations.

Note that Chinese import competition rose significantly from the early 2000s. During this period, Chinese import competition accounted for a loss of 89.8 thousand jobs in low-skilled occupations. In this period, low-skilled employment declined by 333.6 thousand. This means that 26.9 per cent of the decline in low-skilled jobs in manufacturing was due to the Chinese import competition. This compares to 18.1 per cent for the high-skilled and 2.0 per cent for the mid-skilled.

Next, we examine the employment effect by skill type. Over the 1991-2011 period, production occupations had the largest net loss due to the China shock (101.9 thousand). The ratio of implied employment effect to the actual change in their employment reaches 176.0 per cent over the 1991-2011 period. They are closely followed by occupations in other services: a loss of 96.0 thousand due to Chinese import competition. For other service, the loss accounts for 46.6 per cent of the total decline in its employment over 1991-2011.[35] Among the skill types with a statistically significant marginal effect, technical/paraprofessional had the smallest negative employment effect. [36] The employment in that skill group fell by 19.5 thousand due to trade with China over the two decades. However, the employment in that skill group actually increased over the period. Hence, had there been no Chinese import penetration, we would have seen an increase of 50.0 thousand instead of 30.5 thousand.

Over the 2001-2011 period, jobs in other services had the largest net loss due to the China shock (57.6 thousand). This accounts for 86.9 per cent of the total decline in their employment over the period. Occupations in production had a comparable job loss (51.8 thousand) but relative to the actual decline in their employment, the role of Chinese import penetration appears to be smaller than it does for other services. We had an actual decline of 307.0 thousand jobs in these occupations implying that a trade-induced loss accounts for 16.9 per cent of the actual decline. For occupations in technical and paraprofessional, Chinese import penetration led to a loss of 12.0 thousand jobs accounting for 59.9 per cent of the total decline observed during the 2001-2011 period.

The key message from our results is that the job loss in manufacturing due to Chinese import competition was not equally distributed across skill groups. It appears that the negative effect on the manufacturing employment is driven by particular skill groups within manufacturing. In the skill level dimension, low-skilled occupations had the largest decline in their employment due to imports from China over the 2001-2011 period. They explain nearly 80 per cent of the total decline in the manufacturing employment.

In the skill-type dimension, occupations in production, other services, and technical/paraprofessional account for most of the job loss occurred in manufacturing. Additionally, the importance of Chinese import penetration in explaining the observed decline in their employment is found to vary across the three skill groups. Production occupations experienced a substantial decline in their employment in the absolute level. Nevertheless, job

[35] Note that service occupations had a quite large decline in their employment during the 1991-2001 period leaving the proportion explained by Chinese import penetration relatively small among the skill types during the full-span of 1991-2011.

[36] We avoid to discuss the rest of the groups since the marginal impact on their employment is not statistically significantly different from zero.

loss was *proportionally* larger for other services and technical/paraprofessional as the trade-induced job loss accounts for a larger share in the total decline in their employment.[37]

Our estimates also have important implications for the "employment polarization" often observed in advanced economies. For example, Autor and Dorn (2013) find that technological progress led to "employment polarization" in the United States such that low-skilled labour moved from goods-producing (involving routine-tasks) to low-skilled services while high-skilled labour remained where they are. Hence, we observe a strong U-shape employment growth in skill level leaving the mid-skilled labour with relatively low employment growth. In this section, we find that trade did not play a role in inducing "employment polarization" in Canada since it was only the low-skilled group that experienced a significant trade-induced job loss.

We end this section with two caveats worth noting. First, the estimates presented in Table 11 are based on the estimated marginal effect over the 1991-2011 period. This means that we impose the same marginal effect on employment growth in both the 1991-2001 and 2001-2011 sub-periods. However, we know from Table 8 - 10 that the marginal effect of Chinese import competition is estimated to be different across the two sub-periods. Relevant groups are low-skilled occupations and occupations in the four skill types with statistically significant coefficients based on the 2001-2011 period. During the 1991-2001 period, employment growth in these groups were not affected by Chinese import penetration (if we exclude few influential observations in low-skilled as discussed earlier). However, these skill groups experienced a notable marginal employment effect of Chinese import competition during the 2001-2011 period. Hence, we acknowledge that the total direct effect on the employment of the those groups over the two decades may be smaller than our estimates reported in Table 11. However, this does not affect our conclusion that during 2001-2011 since the estimated effects are quite similar to those based on the stacked model (1991-2011).

Another caveat is that total employment effect in row (1) in Table 11 is not necessarily equal to the sum of the employment effect across the three skill levels in row (2) or across the six skill types in row (3). The reason is that in row (1), we impose the same marginal effect of trade on all occupations regardless of skill levels or skill types while in row (2) or row (3), we allow the marginal effect to differ across skills based on the estimated coefficients in column (1) in Table 9 and Table 10, respectively. Hence, the sum of implied employment effects reported in each row would not necessarily be the same (see Equation 8). For example, the *total* implied employment effect based on row (2) specification is -82.1 thousand for 1991-2001 and -99.1 thousand for 2001-2011. Based on row (3) specification, the *total* effect is -92.2 thousand for 1991-2011 and -114.9 thousand for 2001-2011. These estimates are smaller than the estimates reported in row (1). Hence, we conclude that -92.2 thousand and -82.1 thousand to be the lower and upper bound of our estimate for the job loss during the 1991-2001 period; and -114.9 thousand and -113.5 thousand for the job loss during the 2001-2011 period.

[37] One might argue that some of the decline in low-skill or production occupations is driven simply by a reclassification of jobs to a higher skill level or to other skill type as the classification system changes over time. However, we find that the national occupation classification system is relatively consistent over time especially between the NOC 2001 (used for 2001 data) and NOC 2006 (used for 2011 data). The occupation classification systems used for the period 2001-2011 are almost identical to each other in terms of classification of skill types and skill levels.

VI. Empirical Analysis 2: Indirect Effect Operating within Local Labour Markets

A. Model

It is important to realize that an analysis based on the manufacturing industries would miss some important spillover effects on industries beyond manufacturing. As discussed in Section II, a trade-induced reduction in manufacturing employment may lead to an increase in employment in another industry as labour is reallocated. At the same time, a trade shock may reduce the incomes of displaced workers. This may lead to a decline in demand for output produced in other industries and hence, a decline in employment in those industries as well.

In this section, we are interested in assessing the net effect of the China shock on employment for each occupation group, taking into account possible spillovers to unaffected industries. Following Autor *et al.* (2013) as a general framework, we estimate how the employment of each occupation group in manufacturing and non-manufacturing sectors responded to the import shock over time *within* local labour markets.[38] It will shed some light on how resilient a given occupation group had been in the face of rising Chinese import competition within local labour markets.[39]

We treat local labour markets as subeconomies subject to differential trade exposure according to initial patterns of employment across different occupations. Then, we exploit variations in local employment rate and locality's trade exposure *across* the local labour markets in Canada to estimate the marginal employment effect of import competition. Here, the sample is no longer restricted to the occupations in the manufacturing industries. We first present our baseline specification to measure employment rate response at the local level:

$$\Delta E_{l,\tau}^{j} = \alpha_\tau + \beta \Delta IE_{l,\tau}^{L} + \gamma X_{l,\tau} + \epsilon_{l,\tau} \qquad (9)$$

where $\Delta E_{l,\tau}$ is the annual percentage-point change in the employment rate (*i.e.* the ratio of total employment to the working-age population, defined as the population aged 15 or over) in sector j (manufacturing or non-manufacturing) in locality l over time period τ.[40] $\Delta IE_{l,\tau}^{L}$ is the annual percentage-point change in locality l's exposure to Chinese import over τ. $X_{l,\tau}$ is a vector of locality-specific control variables which we will specify later.

[38] Our definition of locality is the census metropolitan area or census agglomeration (CMA/CA).

[39] Note that our framework can capture but cannot explicitly show the effect of individual *worker* being re-employed in different skill group from the group in which he or she was previously employed. A worker-level panel structure in our data would be necessary for such study.

[40] We use a cross-tabulation of 494 four-digit NOC occupations and 300 four-digit NAICS industries (303 industries for 2011) for each of 122 CMAs/CAs as well as working-age population in each CMAs/CAs from the censuses. The cross-tabulations referred here are the ones created after we carry the concordance between SIC-NAICS and SOC-NOC in our census files.

To estimate the marginal effect by skill group, we estimate the following equations:

$$\Delta E^{j}_{s,l,\tau} = \alpha_{s,\tau} + \beta_1 \Delta IE^{L}_{l,\tau} \cdot \mathbb{I}\{s = high\ skilled\} + \cdots + \beta_3 \Delta IE^{L}_{l,\tau} \cdot \mathbb{I}\{s = low\ skilled\} + \gamma X_{s,l,\tau} + \varepsilon_{s,k,\tau} \quad (10)$$

$$\Delta E^{j}_{p,l,\tau} = \alpha_{s,\tau} + \beta_1 \Delta IE^{L}_{l,\tau} \cdot \mathbb{I}\{p = management\} + \cdots + \beta_6 \Delta IE^{L}_{l,\tau} \cdot \mathbb{I}\{p = production\} + \gamma X_{p,l,\tau} + \varepsilon_{p,k,\tau} \quad (11)$$

where j represents industry (manufacturing or non-manufacturing); s and p represent skill level and skill type of a given occupation, respectively. X includes fixed effects for six regions (the Atlantic region, Quebec, Ontario, the Prairie region, British Columbia, and the Northern region) and the initial share of a locality's employment that is in manufacturing.

Local labour markets differ in their trade exposure due to variation in the importance of different occupations (in manufacturing sectors) for local employment. The variation in $\Delta IE^{L}_{l,\tau}$ across local labour markets stems entirely from variation in local occupational employment structure at the start of period τ. Specifically, we construct $\Delta IE^{L}_{l,\tau}$ as the following:

$$\Delta IE^{L}_{l,\tau} = \sum_{k=1}^{K} \frac{L_{l,k,\tau}}{L_{l,\tau}} \Delta OIP_{k,\tau} \quad (12)$$

where $L_{l,k,\tau}$ is the number of employed workers in occupation k in manufacturing sectors in locality l at the start of τ and $L_{l,\tau}$ is the number of employed workers in locality l at the start of τ.[41] The instrument for $\Delta IE^{L}_{l,\tau}$ is obtained by replacing $\Delta OIP_{k,\tau}$ with $\Delta OIPE_{k,\tau}$ in Equation (4).

If the degree of mobility response of working-age population is small to an adverse trade shock, then a trade-induced decline in manufacturing employment should yield a corresponding rise in either non-manufacturing employment, unemployment, labour force exit, or some combination of the three. By estimating equation (9), (10), and (11) separately for manufacturing and non-manufacturing, we pay particular attention to how much of the change in non-manufacturing employment is induced by the China shock.[42] This will represent the combination of labour reallocation and negative demand effect of Chinese import penetration operating within a local labour market. In other words, we assess the relative importance of the two effects.

Together with the degree of change in manufacturing employment due to the same shock, we can then assess the degree of resiliency of each occupation group. For example, if a given skill group had a decline in its employment in manufacturing but had a comparable increase in the employment in non-manufacturing, we can say that the labour reallocation to that skill group

[41] We also constructed the $\Delta IE^{L}_{l,\tau}$ as the employment-weighted average of our *industry-level* import competition measure following Murray (2017). Statistical properties of the two variables are very similar and our general results in this section is not altered when we adopt the one from Murray (2017).
[42] We assume that no industry in non-manufacturing industries faced a direct exposure to Chinese import penetration. This is a plausible assumption since the manufacturing share of total imports from China is 98.4 per cent on average over the 1992-2015 period.

in unaffected sectors was successful mitigating the aggregate job loss in response to a trade shock.[43] On the other hand, if there was no corresponding increase (or even a reduction) in employment in other sectors, this implies that negative demand effects presumably inhibit labour reallocation to that group in unaffected sectors to some extent. Some portion of the displaced workers would either stay unemployed or exit the labour force. Note, however, that the above interpretation requires the assumption that local labour markets are not well-integrated such that an initial local impact does not rapidly diffuse across regions.[44]

Similarly, using our estimated coefficient $(\hat{\beta})$, we compute the implied employment effect as follows. Let $\widetilde{\Delta IE_{l\,t}}$ denote the portion of the change in import penetration to locality l over time period t that is attributable to the Chinese export supply shocks:

$$\Delta L_t^{cf} = \sum_l^L \Delta L_{l,t}^{cf}$$

$$= \sum_l^L POP_{l,t} \hat{\beta} \widetilde{\Delta IE_{l\,t}} \cdot 0.01 \qquad (13)$$

where $POP_{l,t}$ is the working-age population in locality l at the end of period t. We measure $\widetilde{\Delta IE_{l\,t}}$ by discounting the observed change in local trade exposure by the R-squared from our first-stage regression. We multiply the quantity by $POP_{l,t}$ and 0.01 since $\hat{\beta}\widetilde{\Delta IE_{l\,t}}$ represent a percentage-point change in employment rate over period t.

The implied employment effect estimated by Equation (13) capture not only the direct impact of Chinese but also the net effect of inter-industry labour reallocation and demand spillover effects operating *within* local labour markets. Again, it will not capture the effects operating at a broader level (at the provincial or national levels).

B. Summary Statistics

Summary statistics for the variables are reported in Table 12. The rising Chinese import competition after 2001 is evident; the mean annual change in Chinese import penetration ratio is 0.05 percentage points over the 1991-2001 period and 0.10 percentage points over the 2001-2011 period. It also shows the turnaround in employment growth after 2001 we discussed in the earlier

[43] Note that the reallocation to this skill group can occur from not only the same skill group but also from other skill groups in manufacturing.

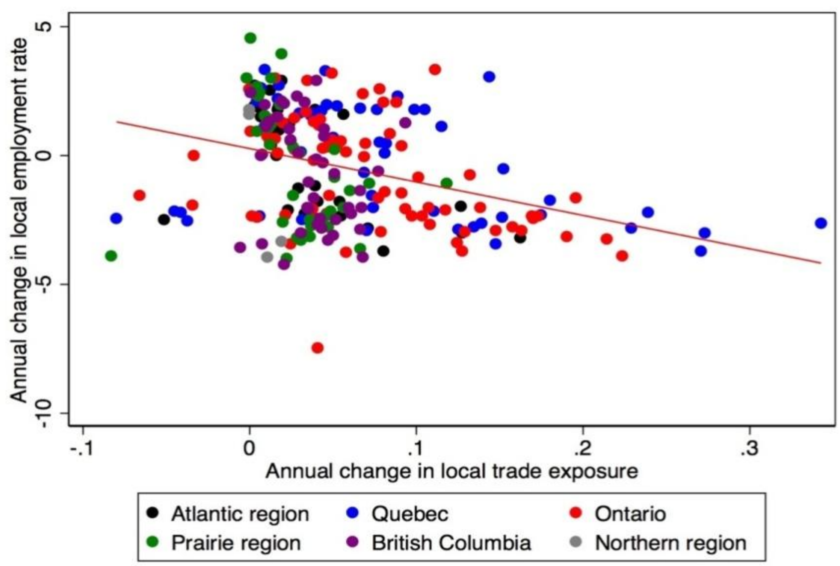
[44] We ran a crude regression in which we regressed annual growth of local working-age population (population aged 15 or over) on annual change in local's trade exposure to China controlling for regional difference in time trend as well as initial manufacture share of the local employment. We find no statistically significant response of local working-age population growth to an increase in trade exposure (based on 2SLS). Hence, the mechanism described in the text is valid for most of the labour markets across Canada on average. However, there could be some local labour markets for which across-localities reallocation is important. For example, depending on the performance of gas and oil sectors, there could be a large degree of labour reallocation between British Columbia and Alberta.

section; across all industries, the annual change in the employment rate averaged 0.06 percentage points over the 1991-2001 period and -0.20 percentage points over the 2001-2011 period.

The breakdown of employment rate changes by skill levels reveals that this turnaround was largely driven by low-skilled occupations. During the 2001-2011 period, the mean annual employment rate change was -0.31 percentage points for low-skilled occupations, down from the mean change of 0.03 percentage points over the earlier period. In contrast, the mean changes in employment rate for high- and mid-skilled occupations were -0.10 and -0.20 respectively during the 2001-2011 period, down from 0.10 and 0.03 percentage points respectively over the 1991-2001 period. By skill types, the turnaround was largely driven by occupations in other services. Their employment rate had the mean annual change of -0.23 percentage points over the 2001-2011 period, down from -0.03 over the earlier decade. Occupations in the other skill types experienced a smaller degree of decrease in their mean employment rate changes between the two sub-periods.

Although not shown in Table 12, we also find that a greater increase in local trade exposure is associated with a lower growth in the local employment rate and vice versa. Chart 6 displays a scatter plot for the two variables across 122 CMAs/CAs in our sample over the full 1991-2011 span. A negative relationship between the two variables is evident. Also, the localities with large annual percentage-point changes in trade exposure tend to be in Quebec and Ontario. This pattern reflects the relative concentration of manufacturing sectors in the two provinces.[45]

Chart 6: Annual change in local employment rate and annual change in local trade exposure, 1991-2011, Canada's CMAs/CAs, percentage point



Source:Author's calculation based on the online trade data base maintained by Innovation, Science, and Economic Development Canada and the 1991 and 2001 censuses and 2001 National Household Survey

[45] We omit detailed discussion on trends in local employment rates and local import penetration ratios. Refer to Murray (2017) .

Table 12: Summary Statistics on Changes in Employment Rates and in Chinese Import Penetration across Local Labour Markets, All Industries, 1991-2011, % point

	1991-2011			1991-2001		2001-2011	
	Mean	S.D.	Median	Mean	SD	Mean	SD
Annual change in Chinese Import Penetration	0.08	0.05	0.07	0.05	0.03	0.10	0.05
Instrument for annual change in Chinese Import Penetration	0.07	0.06	0.06	0.03	0.02	0.11	0.06
Annual change in Employment Rate							
(1) All occupations	-0.07	0.23	-0.06	0.06	0.19	-0.20	0.20
(2) By Skill Level							
High-skilled	0.00	0.18	-0.02	0.11	0.14	-0.10	0.14
Mid-skilled	-0.08	0.21	-0.09	0.03	0.17	-0.20	0.18
Low-skilled	-0.14	0.28	-0.13	0.03	0.22	-0.31	0.21
(3) By Skill Type							
Management	-0.03	-0.02	0.09	0.03	0.06	-0.09	0.08
Professional	0.02	-0.01	0.08	0.05	0.08	-0.01	0.07
Technical/Paraprofessional	0.02	0.10	0.01	0.09	0.08	-0.05	0.07
Other services	-0.13	0.25	-0.09	-0.03	0.22	-0.23	0.24
Trades/Construction/Transportation	-0.05	0.11	-0.05	0.01	0.09	-0.10	0.09
Production	-0.05	0.13	-0.06	0.03	0.12	-0.13	0.10

Note: The annual change in Chinese import exposure is the employment-weighted mean (within the locality) of the occupation-level import exposure penetration ratio. The instrument is computed similarly but using imports to the eight advanced economies as described in the main text. The employment rates by locality are measured as 100 x the locality's total employment in each skill group divided by the locality's population aged fifteen and over. The variables in the table are the annual percentage-point differences over the time periods specified. The samples are 122 CMAs/CAs. Observations are weighted by the locality's working-age population in 1991

C. Results

1. Regression results

First, we report the results from estimating Equation (9), our baseline specification. Focusing on the 2SLS estimate in column (1) in Table 13, a 1-percentage-point increase in annual change in locality's trade exposure reduces the annual change in local employment rate (all industries) by 0.43 percentage points. Within manufacturing, the employment rate is reduced by 3.01 percentage-points in response to a 1-percentage-point increase in annual change in locality's exposure to import. Such decline is somewhat mitigated by a rise in employment rate in non-manufacturing. The employment rate in non-manufacturing increases by 2.15 percentage points in response to a 1-percentage-point increase in locality trade exposure to China. This suggests that the labour reallocation could be quite effective within most of the 122 CMAs/CAs.

Table 13: Effect of Import Penetration on Employment in Canadian Local Labour Markets, All Occupations, All Industries, 1991-2011 stacked model: 2SLS Estimates

	Employment Rate (all occupations)		
	All industries	Manufacturing	Non-manufacturing
CMA/CA import exposure	-0.43 (0.52)	-3.01*** (0.56)	2.15** (0.94)
Obs.	488	244	244
First-stage F statistics	898.80	878.07	878.07

Note: The number of observation is 488 (122 CMA/CA's x two sectors x two time periods). The dependent variable is the annual percentage-point change in the employment rate within a CMA/CA over the 1991-2001 and 2001-2011 periods. We include period and region dummies (the Atlantic region, Quebec, Ontario, the Prairie region, British Columbia, and the Northern region) as well as the initial share of a locality's employment that is in manufacturing. Standard errors in parentheses are clustered on 122 CMAs/CAs.

Table 14 reports the results from estimating Equation (11) - by skill level. Here, we estimate the marginal impact of an import shock on the change in local employment rate of each skill group in affected and unaffected sectors (*i.e.* manufacturing and non-manufacturing) respectively. According to column (1), there is no statistically significant relationship between local trade exposure and employment rates in high- and mid-skilled occupations in *all i*ndustries. In contrast, the employment rate of low-skilled occupations in all industries decreases by 0.59 percentage points per year in response to a 1-percentage-point annual increase in local trade exposure. The estimated coefficient is highly statistically significant. This implies that local demand effects prohibit a complete labour reallocation to low-skilled occupations in unaffected sectors within local labour markets.

The breakdown by the two industries supports the above implication. Column (2) reports the estimates for manufacturing. As expected, all skill levels are negatively affected by trade shocks in terms of their annual change in employment rate. Here, low-skilled occupations have the largest marginal effect among the three skill groups. A 1-percentage-point increase in local trade exposure reduces the low-skilled employment rate by 1.89 percentage points.

In column (3), we find that all skill levels in non-manufacturing were able to receive labour inflow in response to a rise in Chinese import penetration.[46] However, they do so in a varying degree. Although high- and mid-skilled occupations experience reduction in their employment rate in manufacturing, they seem successful in achieving an equivalent degree of rise in employment rate in non-manufacturing.[47] For low-skilled occupations, negative demand effects presumably prevent them from achieving enough rise in the employment rate in non-manufacturing so that we see a statistically significant negative coefficient for them in column (1). Although it is not shown in our results, this also implies that we should observe an equivalent rise either in their unemployment rate or the share of low-skilled population not in the labour force.

Next, we present the results from estimating Equation (12) in which we assess the employment effect by skill type. Based on column (1) in Table 15, we find that a 1-percentage-point increase in annual local trade exposure reduces the change employment rate in production occupations by -0.66 percentage points per year in *all* industries. The coefficient is highly statistically significant. Interestingly, we find a positive relationship between local trade exposure and employment rate for technical/paraprofessional.[48] For other skill types, we find no statistically significant effect of trade on their employment rate.

Column (2) reports the estimate for each skill type in manufacturing sector. Here, we observe that all skill types except for professional are negatively affected by a trade shock. Most notable is production occupations. They experience a decline of 1.47 percentage points per year in response to a 1-percentage-point rise in import penetration. Column (3) shows that production occupations have essentially no equivalent rise in employment rate in non-manufacturing sector while other skill types do. This implies that the labour reallocation to production occupations in unaffected sectors was completely inhibited by negative demand effects.

[46] Based on the observation that all the coefficient in column (3) are positive, one can infer that none of the three skill levels faced strong negative local demand effects such that they completely offset the positive effect of labour reallocation.

[47] Note that the coefficient for each skill group in non-manufacturing reflects the reallocation from not only the same skill group but also the other skill groups in manufacturing. For example, a positive response of the employment rate in mid-skill group in non-manufacturing could be driven by the employment being reallocated from low-, mid-, and high-skilled in manufacturing. The same logic applied to the analysis by skill type.

[48] A decline in the employment rate in those occupations for manufacturing is more than offset by an increase in non-manufacturing resulting in a positive marginal effect at the aggregate level (column 1). This indicates that a trade shock might have induced previously unemployed workers to be re-employed in those occupations in non-manufacturing or induced workers in those occupations to exit the labour force. In order to examine a more complete mechanism, we would need data for labour force, unemployment rate, and out-of-labour-force by skill type so that we assess the responses of four mutually exclusive categories (those three categories plus the employment rate) with respect to a trade shock.

In summary, at the aggregate level, the labour reallocation from manufacturing to non-manufacturing in response to a rise in import exposure was successful within local labour markets. This is consistent with the findings in Murray (2017). However, the breakdown by skill group reveals that not all occupations had a complete labour reallocation from affected sectors. The reallocation to low-skilled in unaffected sectors (non-manufacturing) was partly inhibited by local demand effects as they did not see an equivalent rise in the employment rate in non-manufacturing in response to a rise in import exposure. By skill type, we find that the reallocation to production occupations in unaffected sectors appears to be completely inhibited by demand effects operating within local labour markets.

Table 14: Effect of Import Penetration on Canadian Local Labour Markets, By Skill Level, 1991-2011: 2SLS Estimates

	Employment Rate (all industries)	Manufacturing Employment Rate	Non-Manufacturing Employment Rate
	(1)	(2)	(3)
CMA/CA import exposure x {High-skilled}	0.09	-0.33***	0.51**
	(0.12)	(0.07)	(0.24)
CMA/CA import exposure x {Mid-skilled}	0.07	-0.78***	0.93**
	(0.22)	(0.20)	(0.40)
CMA/CA import exposure x {Low-skilled}	-0.59***	-1.89***	0.72*
	(0.23)	(0.33)	(0.37)
Obs.	1,464	732	732
First-stage F statistics	1919.45	1877.93	1877.93

Note: For Column (1), the number of observation is 1,464 (122 CMA/CA's x two industries x three types of occupations x two time periods). For Column (2), (3), and (4), N=732 (122 CMA/CA's x three types of occupations x two time periods).The dependent variable is the annual percentage-point change in the employment rate within a CMA/CA over the 1991-2001 and 2001-2011 periods. In columns (2) and (3), the dependent variable is the annual percentage-point change in the ratio of sectoral employment to the total working-age population within a CMA/CA over the 1991-2001 and 2001-2011 periods and for high-, mid-, and low-skilled occupations in each sector. In all specification, we include period, region dummies, and the locality's initial manufacturing employment share interacted with skill dummies. Standard errors in parentheses are clustered on 122 CMAs/CAs.

* p<0.10

** p <0.05

*** p<0.01

Table 15: Effect of Import Penetration on Canadian Local Labour Markets, By Skill Type, 1991-2011: 2SLS Estimates

	Employment Rate (all industries)	Manufacturing Employment Rate	Non-Manufacturing Employment Rate
	(1)	(2)	(3)
CMA/CA import exposure x {Management}	-0.01	-0.24***	0.21*
	(0.06)	(0.04)	(0.13)
CMA/CA import exposure x {Professional}	0.08	-0.02	0.19
	(0.08)	(0.03)	(0.15)
CMA/CA import exposure x {Technical/Paraprofessional}	0.15*	-0.24***	0.54***
	(0.08)	(0.07)	(0.17)
CMA/CA import exposure x {Other Services}	0.08	-0.59***	0.75*
	(0.20)	(0.10)	(0.40)
CMA/CA import exposure x {Trades/Construction/Transportation}	-0.07	-0.46***	0.32*
	(0.10)	(0.10)	(0.18)
CMA/CA import exposure x {Production}	-0.66***	-1.47***	0.14
	(0.15)	(0.31)	(0.10)
Obs.	2,928	1,464	1,464
First-stage F statistics	1920.12	1879.27	1879.27

Note: For (1), the number of observation is 2,928(122 CMA/CA's x two industries x six types of occupations x two time periods). For (2), (3), and (4), N=1,464 (122 CMA/CA's x six types of occupations x two time periods). The dependent variable is the annual percentage-point change in the employment rate within a CMA/CA over the 1991-2001 and 2001-2011 periods. In columns (2) and (3), the dependent variable is the annual percentage-point change in the ratio of sectoral employment to the total working-age population within a CMA/CA over the 1991-2001 and 2001-2011 periods and for occupation in the six skill groups in each sector. In all specification, we include period, region dummies, and the locality's initial manufacturing employment share interacted with skill dummies. Standard errors in parentheses are clustered on 122 CMAs/CAs.

* p<0.10

** p <0.05

*** p<0.01

Table 16: Implied Employment Changes Induced by Changes in Chinese Import Penetration, thousand, All Industries, Canada, thousand

Skill Group(s)	Counterfactual Δ in employment level			Actual Δ in employment level			Implied Employment Effect		
	1991-2001	2001-2011	1991-2011	1991-2001	2001-2011	1991-2011	1991-2001	2001-2011	1991-2011
(1) All occupations	**1,851.80**	**2,119.10**	**3,970.90**	**1,782.20**	**1,948.50**	**3,730.70**	**-69.6**	**-170.6**	**-240.2**
(2) By Skill Level									
High-skilled	756.9	767.2	1524.1	771.4	802.8	1574.2	14.5	35.6	50.1
Mid-skilled	416.9	776.2	1193.1	428.9	805.7	1234.6	12.0	29.5	41.5
Low-skilled	678.0	575.7	1253.7	581.9	340.0	921.9	-96.1	-235.7	-331.8
(3) By Skill Type									
Management	258.4	162.9	421.3	256.5	158.2	414.7	-1.9	-4.7	-6.6
Professional	385.3	578.9	964.2	371.9	611.8	983.7	-13.4	32.9	19.5
Technical/Paraprofessional	462.4	451.4	913.8	487.5	512.9	1000.4	25.1	61.5	86.6
Other services	391.0	689.3	1080.3	404.3	722.0	1126.3	13.3	32.7	46.0
Trades/Construction/Transportation	160.2	326.2	486.4	148.9	298.6	447.5	-11.3	-27.6	-38.9
Production	221.3	-89.7	131.6	113.1	-355.0	-241.9	-108.2	-265.3	-373.5

Note: Counterfactual changes represent the changes in employment level if there had been no change in Chinese import penetration. Following Acemoglu *et al.* (2016) and Murray (2017), the quantities in row (1) - row (3) is computed based on both statistically significant and insignificant coefficients from the corresponding stacked models. Predictions for 1991-2011 is equal to the sum of the predictions for the two sub-periods.

2. Implied employment effects.

In this section, we summarize the implied employment effects computed based on the estimated coefficients analyzed in the previous section. Specifically, we assess the implied employment effect by skill level and skill type based on Equation (13). They are reported in Table 16.

Starting with the aggregate implied employment effect in row (1) in Table 16, we find that rising Chinese import competition reduced the employment by 240.2 thousand in *all* industries in Canada during the 1991-2011 period.[49] This total job loss is the result of losses of 69.6 thousand over the 1991-2001 period and 170.6 thousand over the 2001-2011 period. This implies that if the rise in Chinese import competition after 2001 had not occurred, the total employment across CMAs/CAs in Canada would have increased by 8.8 per cent more than it actually did over the 2001-2011 period, assuming that all other factors are held constant.

As we show in Table 13, the labour reallocation to non-manufacturing was effective in mitigating the decline in the employment rate in manufacturing. Row (1) in Table 17 shows the breakdown by sector. Consistent with the results shown in Table 13, the job loss occurred in manufacturing is largely offset by the job gain in non-manufacturing, indicating that the labour reallocation was quite successful.

In row (2) and row (3), we report the estimated job losses broken down by skill level and skill type respectively based on the estimated coefficients in column (1) in Table 14 for the three skill levels and in Table 15 for the six skill types.

Again, most of the Chinese import penetration occurred over the 2001-2011 period. During that period, low-skilled occupations suffered a job loss of 235.7 thousand across all industries in Canada due to Chinese import penetration. In other words, if Chinese import penetration had been shut down during the 2001-2011 period, low-skilled jobs across CMAs/CAs would have grew by 69.3 per cent more than it did in reality. We do not find any trade-induced job loss in high- and mid-skilled occupations.

Row (2) in Table 17 reports the breakdown by sector for low-skilled group. As indicated by the regression result in Table 14, a trade-induced job loss for low-skilled occupations in manufacturing is not fully offset by a rise in non-manufacturing. During the period 2001-2011, the total effect (direct + labour reallocation + demand effects) of rising Chinese import penetration led to a loss of 379.1 thousand jobs in manufacturing. We observe that the loss is not fully offset by a rise in non-manufacturing (a gain of 143.4 thousand). As a result, we see a job loss of 235.7 thousand in all industries. Nevertheless, this still implies that labour reallocation effect plays a role in mitigating the negative employment effect of trade on low-skilled occupations at the aggregate level. Had there been no reallocation, the total job loss for low-skilled occupations would have been 37.8 per cent greater during the 2001-2011 period.

[49] The quantity is computed based on the estimated coefficient reported in column (2) in Table 13.

As we emphasize in Section II, skill level and skill type are two different dimensions of a given occupation. Therefore, analyzing the differential employment effect by skill type would also have value-added. In row (3), we see that production occupations lost 265.3 thousand jobs in total over the period in which Chinese import penetration took off. We estimate that had there been no trade shock from China, there would have been only 89.7 thousand job loss in production occupation in all industries across CMAs/CAs in Canada, instead of 355.0 thousand loss.[50]

Table 17: Implied Employment Changes Induced by Changes in Chinese Import Penetration, selected skill groups, Canada, thousand

Skill Group(s)	Implied Employment Effect (direct+labour reallocation+demand effects) (1) 1991-2001	(2) 2001-2011	(3) 1991-2011
(1) All occupations	**-69.6**	**-170.6**	**-240.2**
Manufacturing	-245.4	-601.6	-847.0
Non-manufacturing	175.8	431.0	606.8
(2) Low-skilled	**-96.1**	**-235.7**	**-331.8**
Manufacturing	-154.6	-379.1	-533.7
Non-manufacturing	58.5	143.4	201.9
(3) Production	**-108.2**	**-265.3**	**-373.5**
Manufacturing	-119.6	-293.3	-412.9
Non-manufacturing	11.4	28.0	39.4

Note: Counterfactual changes represent the changes in employment level if there had been no change in Chinese import penetration. Following Acemoglu *et al.* (2016) and Murray (2017), the quantities in row (1) - row (3) is computed based on both statistically significant and insignificant coefficients from the corresponding stacked models. Predictions for 1991-2011 is equal to the sum of the predictions for the two sub-periods.

Again, Table 17 reports the breakdown of the employment effect in production occupations by sector. The regression results in Table 15 indicates that the labour reallocation to production occupations was completely inhibited by demand effects operating within local labour markets. Row (3) in Table 17 shows that a job loss in manufacturing is not at all offset by a rise in the employment in non-manufacturing. During the 2001-2011 period, production occupations had a job loss of 293.3 thousand in manufacturing due to rising import penetration. Non-manufacturing sectors did not see any meaningful rise in the employment for production occupations during this period. Note that the coefficient for the employment rate in non-manufacturing production is not statistically different from zero. Therefore, the small job gains in non-manufacturing reported in Row (3) should be treated as zeros.

The reallocation to production jobs within local labour markets could be unsuccessful if there is a relatively small number of production jobs outside manufacturing. Moreover, most of the production jobs outside manufacturing are in primary industries such as agriculture, forestry, mining, oil and gas extraction. However, the reallocation to these sectors usually requires a

[50] Additionally, we see a job loss of 27.6 thousand in trades/construction/transportation. A potential explanation for this loss is that the decline in manufacturing may have led to a decline in the demand for services produced by those in trades/construction/transportation. And this negative demand effect might have limited the reallocation of workers in trades/construction/transportation from manufacturing to non-manufacturing.

migration to other provinces as these sectors tend to be in a particular region. If displaced production workers migrated to other provinces to be employed in those sectors, this is not captured in our framework. Therefore, the reallocation to production within local labour markets might appear to be unsuccessful.

Table 18-1: Regional share in the total manufacturing employment by skill type, 2001, per cent

	Total	Management	Professional	Technical Paraprofessional	Other services	Trades/ Construction/ Transportation	Production
Atlantic region	2.5	2.7	2.2	2.2	2.8	2.9	2.3
Quebec	**26.4**	**24.4**	**28.3**	**28.2**	**29.6**	**24.2**	**26.1**
Ontario	**51.3**	**52.3**	**52.1**	**51.6**	**46.6**	**49.9**	**53.7**
Prairie region	11.0	10.7	10.1	10.2	11.9	13.4	9.7
British Columbia	8.7	10.0	7.2	7.8	9.2	9.5	8.2
Northern region	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 18-2: Manufacturing share in the total regional/provincial employment, by skill type, 2001, per cent

	Total	Management	Professional	Technical Paraprofessional	Other services	Trades/ Construction/ Transportation	Production
Atlantic region	7.1	6.4	0.8	5.9	3.0	13.1	47.3
Quebec	**16.0**	**13.4**	**2.4**	**14.4**	**7.5**	**23.4**	**76.3**
Ontario	**15.4**	**12.4**	**2.4**	**13.8**	**6.0**	**23.2**	**70.7**
Prairie region	9.1	7.7	1.3	7.5	4.0	14.9	46.6
British Columbia	8.6	8.1	1.1	6.8	3.7	14.5	48.6
Northern region	1.2	0.9	0.0	0.9	0.2	3.8	13.7

To further examine the above explanation, one should focus on Ontario and Quebec. First, note that Ontario and Quebec account for about 65 per cent of the total employment in Canada; 63 per cent of the total non-manufacturing employment; and 77 per cent of the total manufacturing employment. Table 18-1 shows the regional/provincial share of the total employment in manufacturing by skill type. Ontario and Quebec, not surprisingly, accounted for nearly 80 per cent of the employment across all skill types in 2001. Therefore, the estimated marginal effects of rising import penetration reported in Table 13-15 are largely driven by those two provinces. Of the total implied employment effect in Canada during the 1991-2011 period, 79.3 per cent is attributed to the two provinces (see Appendix Table A3 and A3-1).

Table 18-2 report the manufacturing share in the employment by skill type and by province. Within those two provinces, manufacturing accounts for about 71 per cent to 76 per cent of the total production employment in 2001.[51] This is in contrast with the other provinces and regions where manufacturing accounts for 13 per cent to 48 per cent of the provincial/regional production employment. Hence, displaced manufacturing workers in these two provinces are less likely to get production jobs in unaffected sectors (*i.e.* non-manufacturing) within local labour markets relative to other provinces since most of the production jobs were in manufacturing.

[51] This is due to the fact that many automobile manufacturers were located in ON and QC.

Displaced workers can migrate to the other provinces to be re-employed but this is *not* captured in our framework. This is more likely to be the case for the displaced manufacturing workers looking for production jobs in Ontario and Quebec since the two provinces relied heavily on manufacturing sectors with large shares in total production employment (*e.g.* auto and auto parts sectors). Across-localities labour reallocation could have been successful for production occupations. Hence, we may be missing a considerable amount of across-localities reallocation.

In summary, we find that within-locality labour reallocation was somewhat successful at the aggregate level. However, there are variations in the degree of labour reallocation across different skill groups. We find that low-skilled occupations across CMAs/CAs received a significant negative employment effect from Chinese import competition but the effect was only partially mitigated by labour reallocation. In contrast, the labour reallocation to production occupations in non-manufacturing appears to be fully offset by local demand effects. The negative employment effects we find earlier on technical/paraprofessional and other services in manufacturing disappear at the local level due to the positive labour reallocation effect. The key message we would like to present is that the job loss due to Chinese import competition was not equally distributed across workers with different skills due in part to a varying degree of labour reallocation.

VII. Conclusion

This report estimates the impact of the Chinese import shock on Canadian labour markets over the period 1991-2011. By constructing a measure of occupation-specific trade exposure, we focus on differential employment effect across distinct occupational groups both within manufacturing in Canada and the broader industrial sectors within CMAs/CAs. An instrumental variable strategy is employed to deal with potential endogeneity of Canada trade exposure. This way, we capture the causal impact of Chinese import penetration on Canadian employment.

Using four-digit occupations in National Occupation Classification (NOC) as the unit of analysis, we find that the direct effect of rising Chinese import competition in Canada was the largest for low-skilled and production occupations over the full 1991-2011 span. Rising Chinese import penetration accounted for 166.2 thousand jobs in low-skilled occupations (or 76.9 per cent of the total decline in the low-skilled employment in manufacturing). Production occupations exhibited a loss of 101.9 thousand due to rising Chinese import penetration. Had there been no China shock (with other factors held constant), then we would have seen an increase of 44.0 thousand (instead of a decline of 57.9 thousand) in the production employment in manufacturing. Occupations in other services also had a large job loss - 96.0 thousand accounting for 46.6 per cent of the actual decline in the employment for that group.

Over the period in which Chinese import penetration rose significantly (*i.e.* 2001-2011), we estimate that a trade-induced job loss amounts to 113.5 thousand jobs in manufacturing. Within manufacturing, rising Chinese import penetration had particularly large negative employment effects on:

- Low-skilled occupations - a loss of 89.8 thousand low-skilled jobs (or 26.9 per cent of the total decline in low-skilled jobs)

- Occupations in other services – a loss of 57.6 thousand (86.9 per cent of the total decline in other services).

- Occupations in technical/paraprofessional - a loss of 19.5 thousand (59.9 per cent of the total decline in technical/paraprofessional)

- Occupations in production – a loss of 51.8 thousand (16.9 per cent of the total decline in production)

By exploiting variations in local employment rates and local trade exposure across 122 CMAs/CAs in Canada, we also assess the effects of labour reallocation and demand effects operating within localities. We find that the labour reallocation is proved important in offsetting the negative direct effects but the degree of reallocation within local labour markets varies across skills. The labour reallocation to unaffected sectors was less successful for low-skilled occupation when analyzed by skill level and for production occupations when analyzed by skill type.

Our results indicate that trade did not play a role in "employment polarization" in Canada. For example, the United States experienced a strong U-shaped employment growth in skill level. Autor and Dorn (2013) argue that among the other factors, non-neutral technological progress might have led to such polarization as low-skilled workers reallocate their labour supply from goods (involving routine tasks) to services while high-skilled workers remain where they were leaving employment growth for mid-skilled relative low. This was not the case when we analyze the employment effect of trade exposure.

Our report has focused on a distributional effect of rising Chinese imports to Canada: differential employment effects across different skill levels and skill types. Policymakers should also pay attention to potential benefits from trade as much as we do to distribution concerns of trade. Costs should be set against benefits in a balanced and principled manner so that one can understand the full picture on trade. Lastly, we want to emphasize that rising Chinese import competition is only one factor contributing to the broad trend in the contracting manufacturing employment. Hence, other factors should be given an equal weight when one analyzes the trend.

We conclude our report by suggesting some ideas for future research directions. First, previous studies show that China does not invent technologies and high-tech products themselves. Instead, the country establishes quite efficient workshops for manufacturing other countries' innovations. Most of the value-added is done not in China but elsewhere such as the United States. Take a famous example of Apple. In 2010, China contributed only 1.8 per cent of the value of an Apple iPhone and 2 per cent in iPad. This implies that China accounted for $10 and $8 per unit, which sold in the United State for $549 and $499, respectively (Kraemer *et al*., 2011). This observation is not limited to Apple. Across all types of exports, China contributed just over half of the total value. In exports of electronics and IT, Chinese domestic value-added drops to only 15 per cent of the total values (Branstetter and Lardy, 2008; Man *et al.*, 2013, Koopman and Wang, 2008). Since Canada may be contributing some value-added in exported goods from China, it may be misleading to argue that Chinese rising exports to Canada had a negative impact on employment. Further research in this regard is warranted.

Secondly, the effect of the Chinese import penetration may go beyond an effect on employment. For example, it would be useful to assess the effect of the China shock on wages by skill group. Wage effects at the industry-level might be quite different from the effects found at the occupation-level as shown in Ebenstein *et al*. (2015).

Another important factor is innovation. Recently, Autor *et al*. (2017) find that rising import competition from China induced a fall in firm-level and technology class-level patent production in United States. They also find that firms tend to scale back their global R&D spending in response to the China shock. On the other hand, Bloom . (2016) find that, in Europe, greater import competition from China is associated with higher firm patenting and expanding investment in information technology. Estimating the relationship between the two variables for Canada would be interesting.

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VIII. Appendix: Additional Tables and Charts

Table A1: Total Shipments, Total Domestic Absorption, and Import Penetration, Manufacturing (NAICS 31-33), Canada, 1992-2015

	Domestic Absorption (Millions of CAD)			Import Penetration (%)	
	Total Sales	Net Exports	Total Domestic Absorption	All Countries	China
1992	280,518	-6,194	286,712	45.7	0.8
1993	303,943	-2,870	306,813	49.3	1.0
1994	346,941	-3,419	350,360	52.1	1.1
1995	389,779	8,597	381,182	53.1	1.2
1996	400,085	12,424	387,661	53.2	1.2
1997	426,519	-7,347	433,866	56.2	1.4
1998	441,153	-14,524	455,677	59.4	1.6
1999	510,550	-5,934	516,483	56.7	1.7
2000	561,301	-1,877	563,178	57.0	2.0
2001	543,272	-140	543,412	56.4	2.3
2002	559,903	-8,200	568,103	55.2	2.8
2003	563,634	-12,306	575,940	51.8	3.2
2004	582,563	-4,489	587,052	53.5	4.1
2005	599,206	-15,873	615,079	53.8	4.7
2006	605,527	-27,891	633,418	54.3	5.4
2007	597,673	-32,593	630,266	55.6	6.0
2008	591,970	-58,989	650,959	55.5	6.5
2009	488,731	-76,011	564,741	55.1	7.0
2010	529,275	-81,389	610,664	55.8	7.2
2011	568,282	-93,440	661,722	56.3	7.2
2012	585,336	-100,191	685,526	56.8	7.3
2013	587,645	-110,701	698,347	57.9	7.5
2014	618,593	-121,799	740,393	59.4	7.9
2015	608,323	-122,064	730,387	64.5	8.9
Growth Rates:	Per cent per year			Percentage-point change	
1992-2015	3.4	-13.8	4.1	18.8	8.1
1992-2000	9.1	13.9	8.8	11.3	1.1
2000-2008	0.7	-53.9	1.8	-1.6	4.5
2008-2015	0.4	-10.9	1.7	9.1	2.4
2001-2011	0.5	-91.7	2.0	0.0	4.9

Note: Total domestic absorption = Total shipments - net exports. Import penetration ratio = 100 x Imports/Domestic absorption.
Source: Table 3 in Murray (2017)

Table A2: Occupation group classification, skill level and skill type

(1) Skill Type	(2) Stats Can/HRSDC re-classification	(3) 2-digit NOC	(4) Skill Level
Management	Management	00 Senior management occupations	Skill level A
		01-05 Specialized middle management occupations	Skill level A
		06 Middle management occupations in retail and wholesale trade and customer services	Skill level A
		07-09 Middle management occupations in trades, transportation, production and utilities	Skill level A
Professional	Professional	11 Professional occupations in business and finance	Skill level A
		21 Professional occupations in natural and applied sciences	Skill level A
		30 Professional occupations in nursing	Skill level A
		31 Professional occupations in health (except nursing)	Skill level A
		40 Professional occupations in education services	Skill level A
		41 Professional occupations in law and social, community and government services	Skill level A
		51 Professional occupations in art and culture	Skill level A
Technical and paraprofessional	Technical and paraprofessional	22 Technical occupations related to natural and applied sciences	Skill level B
		32 Technical occupations in health	Skill level B
		42 Paraprofessional occupations in legal, social, community and education services	Skill level B
		43 Occupations in front-line public protection services	Skill level B
		52 Technical occupations in art, culture, recreation and sport	Skill level B
Other services	Administration and administrative support	12 Administrative and financial supervisors and administrative occupations	Skill level B
		13 Finance, insurance and related business administrative occupations	Skill level B
		14 Office support occupations 15 Distribution, tracking and scheduling co-ordination occupations	Skill level C
	Sales	62 Retail sales supervisors and specialized sales occupations	Skill level B
		64 Sales representatives and salespersons - wholesale and retail trade	Skill level C
		66 Sales support occupations	Skill level D
	Personal and	63 Service supervisors and specialized service occupations	Skill level B
		65 Service representatives and other customer and personal services occupations	Skill level C
		67 Service support and other service	Skill level D

	customer information services	occupations, n.e.c.	
		34 Assisting occupations in support of health services	Skill level C
		44 Care providers and educational, legal and public protection support occupations	Skill level C
Trades, construction, and transportation	Industrial, construction and equipment operation trades	72 Industrial, electrical and construction trades	Skill level B
		73 Maintenance and equipment operation trades	Skill level B
	Workers and labourers in transport and construction	74 Other installers, repairers and servicers and material handlers	Skill level C
		75 Transport and heavy equipment operation and related maintenance occupations	Skill level C
		76 Trades helpers, construction labourers and related occupations	Skill level D
Production	Natural resources, agriculture and related production occupations	82 Supervisors and technical occupations in natural resources, agricultural and related production	Skill level B
		84 Workers in natural resources, agriculture and related production	Skill level C
		86 Harvesting, landscaping and natural resources labourers	Skill level D
	Occupations in manufacturing and utilities	92 Processing, manufacturing and utilities supervisors and central control operators	Skill level B
		94 Processing and manufacturing machine operators and related production workers	Skill level C
		95 Assemblers in manufacturing	Skill level C
		96 Labourers in processing, manufacturing and utilities	Skill level D

Note: We choose to display 2-digit occupations due to the space limit. In this report, we re-classify individual 4-digit occupations belonging to each of the 2-digit occupations according to column (1) and column (4). In column (1), we aggregate the ten skill types in column (2) to have six types.
Source: Column (2)-(4) are based on a variant of NOC available at Statistics Canada website. http://www.statcan.gc.ca/eng/subjects/standard/noc/2011/index

Table A3: Implied employment effect of rising Chinese import penetration to regional labour markets, by region/province, thousand, all industries, 1991-2011

	Canada	**Ontario**	Rest of Canada	Atlantic region	Quebec	Prairie region	British Columbia	Northern region
1991-2001	-69.5	**-33.3**	-36.2	-1.2	-22.8	-5.5	-6.7	0.0
2001-2011	-170.6	**-83.5**	-87.1	-3.6	-50.8	-17.3	-15.3	0.0
1991-2011	-240.1	**-116.8**	-123.3	-4.8	-73.6	-22.8	-22.0	0.0

Note: Implied employment effect include not only the direct effect of rising Chinese import penetration but also indirect effects (within-locality labour reallocation and local demand effects).

Table A3-1: Regional share in total implied employment effect in Canada, per cent, all industries, 1991-2011

	Atlantic region	Quebec	**Ontario**	Prairie region	British Columbia	Northern region
1991-2001	1.7	32.8	**47.9**	7.9	9.6	0.0
2001-2011	2.1	29.8	**48.9**	10.1	9.0	1.0
1991-2011	2.0	30.7	**48.6**	9.5	9.2	2.0

Note: Implied employment effect include not only the direct effect of rising Chinese import penetration but also indirect effects (within-locality labour reallocation and local demand effects).