August 2018

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

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Prepared for Global Affairs Canada

CSLS Research Report 2018-3

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

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. A trade-induced job loss in manufacturing is estimated by gender. We estimate that a trade-induced job loss amounted to 56.8 thousand for males and 36.1 thousand for females over the 2001-2011 period. However, females had a larger loss in relative terms since they experienced a much smaller decline in their total manufacturing employment over this period. We also find that the labour reallocation in response to a trade shock is important in offsetting the negative employment effect. However, the reallocation was less successful for females.

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

Table of Contents

Abstract i
- Executive Summary iv

List of Tables vii

List of Charts ix

I. Introduction 1

II. Conceptual Framework 4
- A. Decomposing the Effects of Import Shocks 4
- B. Defining Occupational Groups 6
  - 1. Skill-level 6
  - 2. Skill-type 7

III. Employment and Occupation-specific Import Penetration in Canada 7
- A. Employment patterns by gender 7
  - 1. Employment patterns across skill levels 8
  - 2. Employment patterns across skill types 9
- C. Occupation-specific trade exposure 11

IV. Empirical Strategy and Data sources. 14
- A. Measure of occupation-specific import exposure 14
- B. Identification strategy 15
- C. Data Sources 17

V. Empirical Analysis 1: Occupation-Level Direct Effect 18
- A. Model 18
- B. Summary Statistics 19
- C. Results 22
  - 1. Regression results 22
  - 2. Implied employment effects 30

VI. Empirical Analysis 2: Indirect Effects Operating within Local Labour Markets 37
- A. Model 37
- B. Summary Statistics 40
- C. Results 43
  - 1. Regression results 43
  - 2. Implied employment effects 50

VII. Conclusion....54
References....55
Appendix: Additional Tables and Charts....57

Rising Import Competition in Canada and its Employment Effect by Gender: 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. We assess potential gender differences in the employment effect of an import shock within each skill level and skill type.

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 (not the same as industrial categorization as it is not the type of economic activity carried out by an establishment). 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 occupational 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, during the period in which Chinese import penetration rose significantly (*i.e*. 2001-2011), a trade-induced job loss in manufacturing amounted to 36.1 thousand for females and 56.8 thousand for males. Females suffered a larger job loss in relative terms. Rising Chinese import penetration accounts for 21.3 per cent of the total decline in female employment in manufacturing (169.3 thousand). For males, China accounts for 16.8 per cent of their total manufacturing employment (337.5 thousand).

When analyzed by skill level, we find that a trade-induced job loss at the aggregate level is largely driven by low-skilled occupations. We find no statistical evidence that high- and mid-skilled were negatively affected by China for both genders. However, we find evidence of trade-induced job loss for low-skilled occupations. Importantly, gender-difference in the trade-induced job loss was evident here. The trade-induced job loss for low-skilled occupations was equally distributed between male and female although the female share in the total low-skilled employment is much smaller in manufacturing. Low-skilled occupations had a loss of 42.4 thousand for females and a loss of 42.9 thousand for males. The loss accounts for 31.9 per cent of the total decline in low-skilled jobs of women (132.9 thousand) and 21.3 per cent of the total decline in low-skilled jobs of men (201.1 thousand). Therefore, in relative terms, females had a larger job loss than males did.

We also analyze the impact by skill type. During the 2001-2011 period, rising Chinese import competition had statistically significant effects on the employment of production occupations for both gender. Again, females suffered as many job losses as males did despite a much smaller female share in the total production employment in manufacturing.

- Production - a loss of 32.3 thousand jobs for females and 32.7 thousand for males (28.7 per cent of the total decline in jobs of women in production and 16.8 per cent of the total decline in jobs of men in production)

We find statistical evidence that females also experienced a substantial job loss in the following skill types while we found no evidence for males:

- Technical/paraprofessional - a loss of 3.6 thousand for females (78.3 per cent of the total decline)

- Other services - a loss of 15.4 thousand jobs for females (35.2 per cent of the total decline)

In summary, despite a smaller female share in the total manufacturing employment across skill groups, females had a job loss comparable to the loss for males. We find that this phenomenon is due to the following two factors: 1. a greater sensitivity of female employment to rising import penetration; 2. a larger increase in import penetration for females due to the concentration of female employment in highly exposed sectors.

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 effect is important in offsetting the negative direct effects but the degree of reallocation within local labour markets varies across gender in some cases.

For females workers, the labour reallocation to production and trades/construction/transportation occupations in unaffected sectors appears to be fully inhibited by the negative local demand effect. However, the labour reallocation to these occupations in unaffected sectors was quite successful for males, mitigating the job loss occurred in affected sectors (*i.e.* manufacturing). As a result, the total job loss in these two groups was much larger for females in both absolute and relative terms.

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

List of Tables

Table 1: Employment share in total employment by skill level, Manufacturing, Male, 1991-2011, Canada 8
Table 2: Employment share in total employment by skill level, Manufacturing, Feale, 1991-2011, Canada 9
Table 3: Employment share in total employment by skill type, Manufacturing, Male, 1991-2011, Canada 10
Table 4: Employment share in total employment by skill type, Manufacturing, Female, 1991-2011, Canada 10
Table 5: 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, Male, Manufacturing, 2001-2011 12
Table 6: 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, Feale, Manufacturing, 2001-2011 13
Table 7: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, Manufacturing Industries, Canada 21
Table 8: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries, Male, Canada: OLS and 2SLS Estimates 24
Table 8-1: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries, Female, Canada: OLS and 2SLS Estimates 25
Table 9: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries by Skill-Level, Male, Canada: 2SLS Estimates 26
Table 9-1: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries by Skill-Level, Female, Canada: OLS and 2SLS Estimates 27
Table 10: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries by Skill-Type, Male, Canada: 2SLS Estimates 28
Table 10-1: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries by Skill-Type, Female, Canada: 2SLS Estimates 29
Table 11: Implied Employment Changes Induced by Changes in Chinese Import Penetration, thousand, by Skill level and Skill type, Manufacturing sectors, Male Canada 34
Table 11-1: Implied Employment Changes Induced by Changes in Chinese Import Penetration, thousand, by Skill level and Skill type, Manufacturing sectors, Female Canada 35
Table 12: 2001 Employment level (thousand), share in three-digit NAICS manufacturing sectors, annual % pt change in import penetration at three-digit NAICS industry level over 2001-2011, male and female, Canada 36
Table 13: Summary Statistics on Changes in Employment Rates and in Chinese Import Penetration across Local Labour Markets, Male, All Industries, 1991-2011, % point 41
Table 13-1: Summary Statistics on Changes in Employment Rates and in Chinese Import Penetration across Local Labour Markets, Female, All Industries, 1991-2011, % point 42

Table 14: Effect of Import Penetration on Employment in Canadian Local Labour Markets, All Occupations, All Industries, 1991-2011 stacked model: 2SLS Estimates....................................43
Table 15: Effect of Import Penetration on Canadian Local Labour Markets, By Skill Level, Male, 1991-2011, stacked model: 2SLS Estimates 46
Table 15-1: Effect of Import Penetration on Canadian Local Labour Markets, By Skill Level, Female, 1991-2011, stacked model: 2SLS Estimates 47
Table 16: Effect of Import Penetration on Canadian Local Labour Markets, By Skill Type, Male, 1991-2011, stacked model: 2SLS Estimates 48
Table 16-1: Effect of Import Penetration on Canadian Local Labour Markets, By Skill Type, Female, 1991-2011, stacked model: 2SLS Estimates 49
Table 17: Implied Employment Changes Induced by Changes in Chinese Import Penetration, thousand, Male, All Industries, Canada 52
Table 17-1: Implied Employment Changes Induced by Changes in Chinese Import Penetration, thousand, Female, All Industries, Canada 53

List of Appendix Tables

Table A1: Occupation group classification, skill level and skill type 57
Table A2: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, by Skill-Level, Male, Manufacturing Industries, 1991-2011 by sub-period, Canada 59
Table A2-1: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, by Skill-Level, Female, Manufacturing Industries, 1991-2011 by sub-period, Canada 60
Table A3: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, by Skill-Type, Male, Manufacturing Industries, 1991-2011 by sub-period, Canada 61
Table A3-1: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, by Skill-Type, Female, Manufacturing Industries, 1991-2011 by sub-period, Canada 62

Rising Import Competition in Canada and its Employment Effects by Gender: Evidence from the 'China Shock'

List of Charts

Chart 1: Import penetration ratio for Canada from China and Manufacturing Share of Total Employment, 1992-2015 2
Chart 2: Occupation-specific import exposure to China: Other advanced economies vs. Canada, 1991-2001 and 2001-2011 16

List of Appendix Charts

Chart A1: Annualized employment growth and annual change in import penetration ratio, 3-digit occupations, Male, Manufacturing, Canada, 2001-2011 63
Chart A2: Annualized employment growth and annual change in import penetration ratio, 3-digit occupations, Female, Manufacturing, Canada, 2001-2011 63

Rising Import Competition in Canada and its Employment Effects by Gender: 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 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. Kim (2018a) find that the distributional effect of rising Chinese import penetration is evident in both skill level and skill type dimensions. He finds that rising Chinese import penetration hurt a particular skill group disproportionately more in manufacturing. In this report, we study whether the distribution effect is also evidence in the gender dimension.

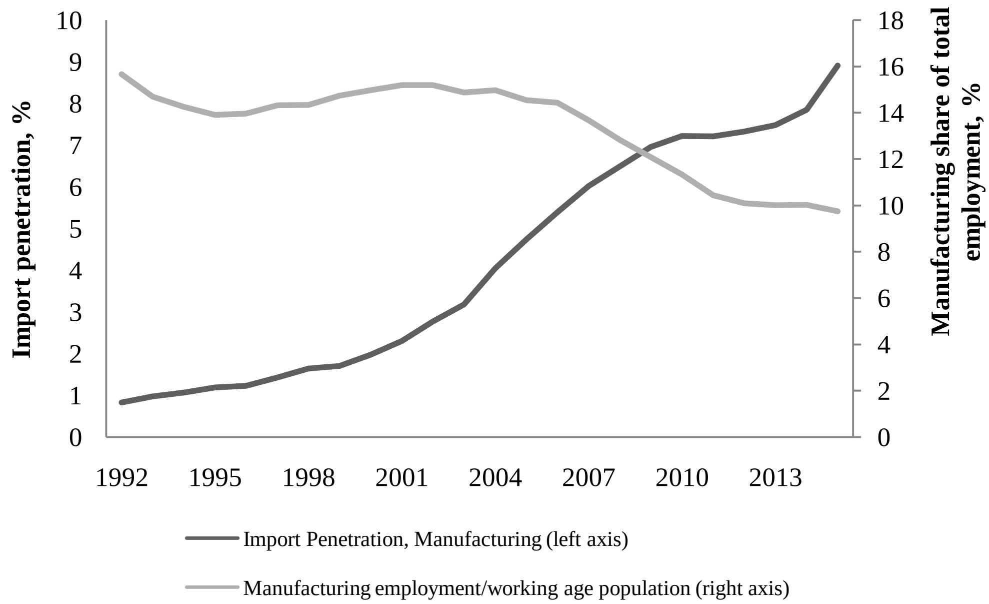
We analyze differential employment effects by gender in two distinct dimensions of individual occupation's characteristics: skill type and skill level. Skill level is associated with the amount of education or training required to perform the main duties of an occupation while skill type is the type 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,

[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, June 1-3, 2018. Email: daniel.kim@csls.ca.

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

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. 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 not easily employable in other sectors prolonging unemployment spell for affected workers. For example, Kim (2018a) finds that the labour reallocation was less successful in low-skilled occupations when analyzed by skill level and in production occupations when analyzed by skill type. In this report, we examine whether there is a significant asymmetry in the degree of labour reallocation between men and women within each skill level and type. 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.[3] We first estimate the direct effect of Chinese import penetration on employment for male and female 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.

Our main finding is that, during the period in which Chinese import penetration rose significantly (*i.e*. 2001-2011), a trade-induced job loss amounted to 36.1 thousand for females and 56.8 thousand for males. Note that females experienced a much smaller decline in their manufacturing employment than males did during this period. This implies that females suffered a larger job loss in relative terms. Rising Chinese import penetration accounts for 21.3 per cent of the total decline in female employment in manufacturing. For males, China accounts for 16.8 per cent of their total manufacturing employment.

When analyzed by skill level, we find that a trade-induced job loss at the aggregate level is largely driven by low-skilled occupations. We find no statistical evidence that high- and mid-skilled were negatively affected by China for both genders. However, we find evidence of trade-induced job loss for low-skilled occupations. Importantly, gender-difference in the trade-induced job loss was evident here. The trade-induced job loss was equally distributed between male and female despite the fact that the female share is much smaller in the total low-skilled employment in manufacturing. Low-skilled occupations had a loss of 42.4 thousand for females and a loss of 42.9 thousand for males. The loss accounts for 31.9 per cent of the total decline in low-skilled jobs of women and 21.3 per cent of the total decline in low-skilled jobs of men. Hence, in relative terms, females had a larger job loss than males did.

We also analyze the impact of Chinese import penetration in skill type dimension. During the 2001-2011 period, rising Chinese import competition had statistically significant effects on the employment of production occupations for both genders but females suffered a larger job loss than males in relative terms. A trade-induced job loss for production occupations is estimated to be 32.3 thousand and 32.7 thousand for females and males respectively. Again, this is surprising since the female share in the total production employment in manufacturing is much smaller. In relative terms, Chinese import penetration can explain 28.7 per cent of the total decline in jobs of females in production and 16.8 per cent of the total decline in jobs of males in production.

[3] 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.

We find statistical evidence that females also experienced a job loss in the following skill types: Technical/paraprofessional - a loss of 3.6 thousand (78.3 per cent of the total decline); Other services - a loss of 15.4 thousand jobs (35.2 per cent of the total decline) . We found no statistical evidence that males in these occupations were affected by rising Chinese import penetration.

We also find that the degree of labour reallocation within local labour markets varies across the two genders. For females, the reallocation to production and trades/construction/transportation occupations in unaffected sectors appears to be fully inhibited by negative local demand effects. However, the labour reallocation to these occupations in unaffected sectors was quite successful for males, mitigating the job loss occurred in affected sectors (*i.e.* manufacturing). As a result, the total job loss in these two groups was much larger for females in both absolute and relative terms.

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 the employment structure in manufacturing 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 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.[4] We decompose the total employment effect in a local labour market as follows:

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.

[4] 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.

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.[5]

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 A1 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. 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.[6]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).

[5] 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.

[6] 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.

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.[7] 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.

III. Employment and Occupation-specific Import Penetration in Canada

A. Employment patterns by gender

In this section, we discuss the employment structure of Canadian manufacturing. We describe how employment is distributed across skill levels and skill types. We discuss the employment distribution both within each gender and across the two genders. It is well known that men account for a majority of manufacturing employment. However, it would be informative to examine the breakdown of the employment by skill to identify the skill groups in which female employment is relatively more important as well as any within-gender characteristics in the employment structure across different skill groups.

[7] 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..

1. Employment patterns across skill levels

Table 1 and 2 report the share of employment by skill level. For both genders, low-skilled occupations account for the largest share in manufacturing. For males, roughly half of the total manufacturing employment is attributed to low-skilled occupations. For females, low-skilled occupations account for more than half of their manufacturing employment (62 per cent on average).

During the period in which Chinese import penetration rose substantially (*i.e.* 2001-2011), both high- and mid-skilled share of the total employment increased for each gender. In other words, low-skilled share declined. For males, the share of low-skilled occupations in their total manufacturing employment declined from 48.8 per cent to 45.5 per cent over this period. Females experienced a larger decline: from 64.9 per cent to 59.3 per cent. This is in contrast to the previous decade (1991-2001) when low-skilled share increased while both high- and mid-skilled occupations declined slightly in their employment share.

The redistribution of employment from low-skilled to higher-skilled occupations could be the result of many factors. Most notable is the skill-biased technological change which tends to increase the demand for higher skills while decreasing the demand for low skills. However, it could also be the result of increasing penetration of Chinese low-tech manufactured goods. In the following empirical analysis, we quantify the role of Chinese import penetration in explaining the redistribution of employment.

Table 1: Employment share in total employment by skill level, Manufacturing, Male, 1991-2011, Canada

Panel A: Employment / Total male employment (%)

	High-skilled	Mid-skilled	Low-skilled
1991	16.6	35.7	47.7
2001	15.5	35.6	48.8
2011	17.3	37.2	45.5

Panel B: Employment / Aggregate (male+female) employment (%)

	Total	High-skilled	Mid-skilled	Low-skilled
1991	71.1	77.8	75.3	63.5
2001	71.0	78.6	77.9	64.8
2011	72.4	76.9	78.4	66.8

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

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

Panel A: Employment / Total female employment (%)

	High-skilled	Mid-skilled	Low-skilled
1991	10.8	26.7	62.5
2001	10.4	24.8	64.9
2011	13.8	26.9	59.3

Panel B: Employment / Aggregate (male+female) employment (%)

	Total	High-skilled	Mid-skilled	Low-skilled
1991	28.9	22.2	24.7	36.5
2001	29.0	21.4	22.1	35.2
2011	27.6	23.1	21.6	33.2

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

Panel B in Table 1 and 2 presents the share of each gender in the aggregate manufacturing employment by skill level. First, the manufacturing employment is dominated by males. They account for over 70 per cent of the total manufacturing employment. The male share of the total manufacturing employment in Canada is higher for all three skill levels. Among the three skill levels, the female share is the largest in low-skilled occupations. The female share in low-skilled occupations stands at roughly 35 per cent, compared to 22 to 24 per cent share in high- and mid-skilled occupations.

It is interesting to note that the gender distribution of the manufacturing employment is not static across time. During the 2001-2011 period, the female share in the aggregate employment in high-skilled occupations increased while the female share in the aggregate low- and mid-skilled occupations decreased.

2. Employment patterns across skill types

The gender difference in the employment structure is more evident in the skill type dimension (see Panel A in Table 3 and 4). A majority of the female employment in manufacturing is in other services and in production while males have the employment that is relatively more dispersed across the six skill types. It is interesting to observe that, for both genders, the share of production occupations in their manufacturing employment declined over the 2001- 2011 period while the share of the remaining five skill types increased.

Panel B in Table 3 and 4 reports the gender share of the aggregate manufacturing employment in Canada. Not surprisingly, over 90 per cent of the total manufacturing employment in trades/construction/transportation is explained by males. Such pattern remained quite stable over the 1991-2011 period. A similar pattern is also observed for occupations in technical/paraprofessional.

There are two skill groups in which females were becoming more important in terms of employment. Roughly 80 per cent of the total management employment is accounted for by males. However, the female share in management had increased over the 1991-2011 period. Over the 1991-2011 period, the female share had increased by 5.1 percentage points: 17.2 per cent to 22.3 per cent. The manufacturing employment in professional is somewhat equally distributed between male and female relative to the other skill types. Nevertheless, the female share in the total professional employment had increased by 5.7 percentage points during the 1991-2011 period.

Table 3: Employment share in total employment by skill type, Manufacturing, Male, 1991-2011, Canada

	Panel A: Employment / Total male employment (%)					
	Management	Professional	Technical & Paraprofessional	Other services	Trades & Construction & Transportation	Production
1991	11.3	2.5	9.0	16.3	28.3	32.6
2001	9.8	1.3	10.7	10.3	27.2	40.6
2011	10.4	1.7	12.6	11.4	28.6	35.3
	Panel B: Employment / Aggregate (male+female) employment (%)					
	Management	Professional	Technical & Paraprofessional	Other services	Trades & Construction & Transportation	Production
1991	82.8	53.7	77.2	44.6	95.7	68.3
2001	79.9	49.5	77.1	44.6	94.2	67.7
2011	77.7	48.0	77.0	47.1	94.6	70.1

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

Table 4: Employment share in total employment by skill type, Manufacturing, Female, 1991-2011, Canada

	Panel A: Employment / Total female employment (%)					
	Management	Professional	Technical & Paraprofessional	Other services	Trades & Construction & Transportation	Production
1991	5.4	4.9	6.1	46.3	2.9	34.4
2001	6.1	3.4	7.8	31.4	4.1	47.3
2011	7.8	4.8	9.9	33.7	4.3	39.6
	Panel B: Employment / Aggregate (male+female) employment (%)					
	Management	Professional	Technical & Paraprofessional	Other services	Trades & Construction & Transportation	Production
1991	17.2	46.3	22.8	55.4	4.3	31.7
2001	20.1	50.5	22.9	55.5	5.8	32.3
2011	22.3	52.0	23.0	52.9	5.4	29.9

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

In contrast, the female share in production employment declined over the 2001-2011 period, the period associated with a large increase in Chinese import penetration. Other services is the only skill type in which females account for more than half of the aggregate manufacturing employment. Again, the female share in these occupations declined over the 2001-2011 period.

The pattern in the changing female shares across the four skill types is somewhat consistent with the pattern observed across the three skill levels. We find that in manufacturing, the female shares in mid- and low-skilled occupations declined while their share increased in high-skilled occupations. Note that management and professional tend to be in high-skilled group while production and other services tend to be in either mid- or low-skilled groups. To summarize, although the change is not substantial, we observe that females were becoming more important in management and high-skilled professional jobs but less so in mid- and low-skilled services and production jobs.

B. Occupation-specific trade exposure

Based on equation (2) in Section IV, we compute import exposure for 140 three-digit NOC occupations for each gender in the manufacturing industry in Canada. Table 5 and 6 present the occupations with the ten largest and ten smallest changes in Chinese import exposure over the 2001-2011 periods along with the employment growth for each occupation.

Males and females appear to have a similar pattern in occupation-specific import exposure. Seven of the ten most exposed occupations for females are also found in the ten most exposed occupations for males. There are less overlapped occupations in the ten smallest but they tend to be in a similar occupational group. For example, both genders have occupations unique to primary industry such forestry and mining, oil, and gas.

More importantly, for both genders, the occupations with large annual increases in the import penetration ratio tend to have their employment concentrated in highly exposed sectors in manufacturing. For example, the occupation that experienced the largest increase in import penetration for both genders was *Managers in communication (except broadcasting).* Note that more than half of their total manufacturing employment was in *Communications equipment manufacturing* (NAICS 3342) for both genders. Among the manufacturing sectors, it experienced the largest increase in import penetration (7.23 percentage-point increase per year) over the period 2001-2011. Another example is *Machine operators and related workers in fabric, fur and leather products manufacturing*. Their employment tended to in *Clothing knitting mills* (NAICS 3151) in 2001. The sector experienced a 5.22 percentage-point increase per year over the 2001-2011 period.

It is interesting to note that, for the ten largest occupations, females tend to experience larger annual increases in import penetration ratio. Moreover, the annual employment growth for those occupations tend to be lower for females. As we show in the following empirical analysis, this pattern is observed not only in the ten most exposed occupations but also in most of the occupations at 4-digit level. Females are subject to a greater degree of import exposure to China. We show in the following section that this is due to the fact that female manufacturing employment is concentrated in highly exposed sectors.

Table 5: 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, Male, Manufacturing, 2001-2011

Ten largest	Δ in Import Penetration Ratio (% pt)	Employment growth (%)
A31 Managers in communication (except broadcasting)	4.41	-11.77
C07 Computer and Information Systems Professionals	2.29	-0.61
H51 Upholsterers, tailors, shoe repairers, jewellers and related occupations	2.10	-6.14
J16 Machine operators and related workers in fabric, fur and leather products manufacturing	2.07	-9.53
G98 Other elemental service occupations	2.06	-17.32
C18 Technical occupations in computer and information systems	1.98	-1.43
G81 Childcare and home support workers	1.91	12.04
C14 Technical Occupations in Electronics and Electrical Engineering	1.73	-3.82
H12 Carpenters and Cabinemakers	1.66	-2.03
A12 Managers in Engineering, Architecture, Science, and Information Systems	1.62	-0.67
Ten smallest		
G96 Food Counter Attendants, Kitchen Helpers and Related Occupations	0.19	8.91
I12 Supervisors, Mining, Oil and Gas	0.19	-1.44
G71 Occupations in Travel and Accommodation	0.16	-5.71
G73 Other Occupations in Travel, Accommodation, Amusement and Recreation	0.12	19.46
I11 Supervisors, Logging and Forestry	0.11	-10.49
I15 Logging Machinery Operators	0.10	-11.15
G94 Butchers and Bakers	0.09	-0.42
I17 Fishing Vessel Masters and Skippers and Fishermen	0.06	27.85
D03 Assisting Occupations in Support of Health Services	0.05	15.16
E02 Psychologists, Social Workers, Counsellors, Clergy and Probation Officers	0.01	11.53

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: D04 (Therapy and Assessment Professionals) has an annualized percentage point change in OIP of 0.00 as we have zero male employment in 2001 and 2011 for the occupation. Hence, we excluded it in this table.

For both genders, we observe the occupations in the bottom ten exhibit only a negligible annual increase in their import exposure to China. Most of them are not 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. *Police Officers and Firefighters Police Officers and Firefighters*; 4. *Other Occupations in Travel, Accommodation, Amusement and Recreation.*

Interestingly, for both male and female, there are occupations included in the bottom ten in mining, oil, and gas extraction: *Mine service workers and operators in oil and gas drilling*; *Supervisors, Mining, Oil and Gas*; and *Underground Miners, Oil and Gas Drillers and Related Workers Underground Miners, Oil and Gas Drillers and Related Workers*. These occupations tend to have a large employment share in *Petroleum and coal product manufacturing* (NAICS

3241). This sector was one of only few manufacturing sectors that faced a declining import penetration ratio during the 2001-2011 period.

To examine a correlation between the two variables among all 140 three-digit occupations, we plot employment growth against changes in import penetration ratio. Appendix Chart A1 and A2 depicts a scatter plot between annualized employment growth and the annual change in import penetration ratio over the 2001-2011 period for male and female respectively. We observe that occupations with lower growth rates (or higher rates of decline) in their employment tend to experience larger increases in Chinese import competition and vice versa.

Table 6: 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, Female, Manufacturing, 2001-2011

Ten largest	Δ in Import Penetration Ratio (% pt)	Employment growth (%)
A31 Managers in communication (except broadcasting)	4.36	-12.32
H21 Electrical Trades and Telecommunication Occupations	2.61	-8.28
C14 Technical Occupations in Electronics and Electrical Engineering	2.43	-4.01
J16 Machine operators and related workers in fabric, fur and leather products manufacturing	2.22	-11.99
H51 Upholsterers, Tailors, Shoe Repairers, Jewellers and Related Occupations	2.12	-9.40
H43 Other Mechanics	2.11	-4.47
G98 Other elemental service occupations	2.11	-18.70
C05 Architects, Urban Planners and Land Surveyors	2.10	0.61
C07 Computer and Information Systems Professionals	2.03	-3.71
H12 Carpenters and Cabinemakers	1.84	-1.87
Ten smallest		
G71 Occupations in Travel and Accommodation	0.15	0.00
C17 Transportation Officers and Controllers	0.15	-2.88
A33 Managers in Public Administration Managers in Public Administration	0.14	0.00
D04 Therapy and Assessment Professionals	0.11	13.87
D03 Pharmacists, Dietitians and Nutritionists	0.11	8.47
I14 Mine Service Workers and Operators in Oil and Gas Drilling	0.09	4.70
G94 Butchers and Bakers	0.07	1.89
I13 Underground Miners, Oil and Gas Drillers and Related Workers Underground Miners, Oil and Gas Drillers and Related Workers	0.02	2.88
G61 Police Officers and Firefighters Police Officers and Firefighters	0.00	4.05
G73 Other Occupations in Travel, Accommodation, Amusement and Recreation	0.00	12.53

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:

$$\Delta IP_{j,\tau} \equiv \frac{\Delta M_{j,\tau}^{cc}}{Y_{j,92}+M_{j,92}-E_{j,92}} \qquad (1)$$

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.[8] Hence, $Y_{j,92} + M_{j,92} - E_{j,92}$ represents the domestic absorption in sector j in the initial period. $\Delta M_{manu,\tau}^{cc} = \sum_{j=1}^{J} \Delta M_{j,\tau}^{cc}$ and $\Delta M_{j,\tau}^{cc}$ is the change in import from China in subsector j over τ.[9]

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:

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

[8] 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.

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

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.[10]

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.[11]

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.[12]

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

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.

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

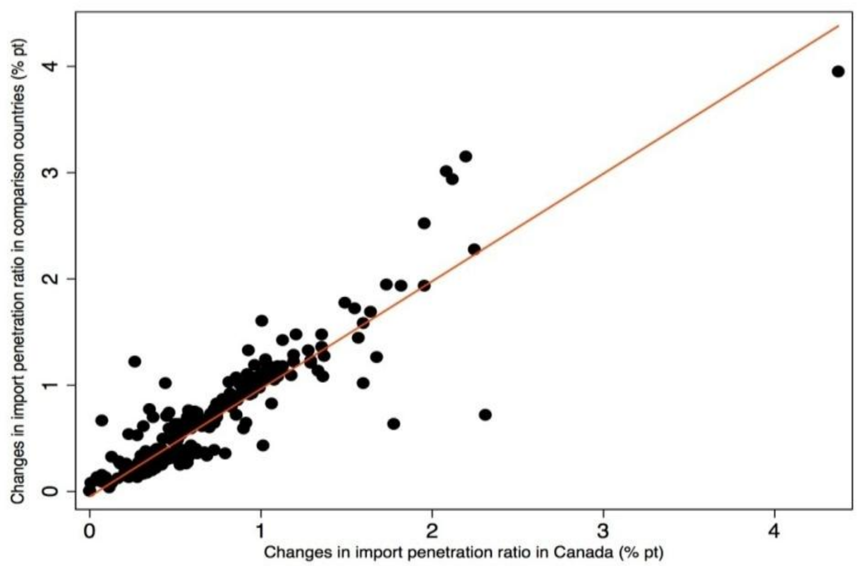
The motivation for our identification strategy is that the eight advanced economies would have been exposed to China in a similar way in that Chinese import growth was driven by supply shocks in the country. Then, the key identifying assumptions are: 1. product demand shocks are

[10] 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.
[11] Variation may not be significant at a broader level (skill-type and skill-level). However, at the 4-digit occupation level, variation is substantial**.**
[12] 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.

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.[13] 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.[14] 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.

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.

[13] 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.

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

[14] 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.

A. 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).[15]

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.

[15] 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.

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.[16] Thus, we take a more parsimonious approach by taking into account only the difference in the occupational distribution of employment across CMAs/CAs and across the two genders (*i.e.* we carry out concordance for each CMA/CA and for each male and female). This should not distort our analysis greatly because a major Chinese import penetration occurred only after the 2000s.[17]

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.

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

where $\Delta L_{k,\tau}$ is 100 times the log change (annualized) in employment level in 4-digit occupation k over τ.[18] $\Delta OIP_{k,\tau}$ 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.[19]

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

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

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.

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[16] 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).

[17] 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.

[18] 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.

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

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 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:

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

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

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 7 reports summary statistics for the three key variables used in the estimation of equation (5). First, the rising growth of Chinese import competition after 2001 is evident. The mean annual increase in import penetration is higher for the 2001-2011 period than the mean increase observed in the 1991-2001 period. The turnaround in the employment growth in manufacturing after 2001 is also shown. The mean employment growth turns negative for both genders for the latter half of the full 1991-2011 period.

According to the data, females experienced a larger increase in Chinese import exposure and a larger decline in employment in manufacturing during the 2001-2011 period. Notice that females have a larger mean increase in the annual change in import penetration. For the stacked 1991-2011 sample, the mean for females is 0.63 percentage-point, compared to 0.48 percentage-point observed for males. This is also true in each of the two sub-periods. Note also that, during the 2001-2011 period, females experienced a larger mean decline in their employment in manufacturing. The mean rate of decline in female employment is -3.41 percentage-points, compared to the mean of -2.99 percentage-points for males. Note that the median rate of decline in employment is also larger for females.

Appendix Table A2 and A2-1 report the summary statistics by skill-level. During the 2001-2011 period, females experience a larger mean increase in Chinese import penetration in all skill levels but particularly in mid- and low-skilled. Females also have a larger mean rate of decline in employment in mid- and low-skilled occupations than males do during this period. For example, female low-skilled occupations had a mean rate of decline of 4.25 percentage points in their employment. For males, the mean rate of decline for low-skilled employment is 3.52 percentage-points. However, note that the median rates of decline in the employment are similar for males and females implying that females had some occupations with particularly large rates of decline in employment during this period.

Appendix Table A3 and A3-1 report the summary statistics for the variables by skill type. First, females have a larger mean annual increase in Chinese import penetration for all the skill types except for professional over the 2001-2011 period. Most notable is trades/construction/transportation. Even though the female share in its total employment is very small, they have a mean annual increase of 0.81 percentage-point, compared to 0.33 percentage-point for males. Interestingly, Chinese import penetration ratio declined on average for professional occupations. Both genders experienced a decline in Chinese import penetration in this skill group on average with females having a larger mean decline.

Mean annual changes in import penetration and *mean* employment growth do not appear to be closely (negatively) correlated. Except for production occupations, males tend to have a smaller mean employment growth than females during the 2001-2011 period despite the fact that they tend to have a slightly smaller mean increase in import penetration ratio annually. However, we show in the previous section that the two variables are negatively correlated across *individual* occupations (see Appendix Chart A1 and A2).

Table 7: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, Manufacturing Industries, Canada

	1991-2011 stacked		Sub-periods		
			1991-2001	**2001-2011**	**1991-2011**
			Male		
	Mean	Median	Mean/Median	Mean/Median	Mean/Median
AnnualΔ in Chinese Import Penetration (% pt)	0.48	0.38	0.35 / 0.31	0.61 / 0.63	0.52 / 0.48
Instrument for Chinese Import Penetration (% pt)	0.43	0.26	0.23 / 0.19	0.63 / 0.60	0.48 / 0.42
100 x Annual log change in Employment (%)	-1.98	-1.70	-0.97 / 0.58	-2.99 / -2.46	-3.78 / -2.35
			Female		
	Mean	Median	Mean/Median	Mean/Median	Mean/Median
Annual Δ in Chinese Import Penetration (% pt)	0.63	0.55	0.45 / 0.41	0.80 / 0.80	0.67 / 0.62
Instrument for Chinese Import Penetration (% pt)	0.58	0.38	0.32 / 0.26	0.84 / 0.78	0.65 / 0.57
100 x Annual log change in Employment (%)	-1.22	-0.48	0.92 / 2.34	-3.41 / -2.63	-2.21 / -0.47

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 employmentis 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 by gender in Canadian manufacturing industries. Here, we estimate Equation (5), (6), and (7) but on split samples (male and female). Table 8 and Table 8-1 report our estimates for the total direct effect on manufacturing employment for males and females respectively (Equation 5). Column (1) in both tables only includes time dummies for the two sub-periods. We observe that females experienced a larger mean rate of annual decline in their manufacturing employment than males did.

Column (2) estimate the equation by OLS but we find no statistically significant employment effect of rising Chinese import penetration. 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.

Our 2SLS estimates from the stacked models (column 3) suggest that there is statistically significant effect of rising import penetration on manufacturing employment for both male and female. Nevertheless, there was essentially no difference in the sensitivity of employment growth to trade between male and female workers over the 1991-2011 period (-0.95 for male and -0.96 for female). Focusing on the two sub-periods does not change the story. Both genders exhibit a very similar degree of marginal effect of trade on their employment growth.

Table 9 and Table 9-1 report 2SLS estimates of the marginal effect by skill level. We find that for both genders, only low-skilled occupations are negatively affected by rising Chinese import penetration in Canadian manufacturing. The estimates from the stacked model suggest that female low-skilled occupations faced a slightly larger marginal effect of rising import penetration on their employment. A one-percentage-point increase in import penetration leads to a 1.57 percentage-point decline in annual employment for males and 1.75 percentage-point for females. The estimates based on the 2001-2011 period also suggest that the marginal effect of Chinese import competition on low-skilled employment growth is slightly larger for females but the difference is very small.[20]

[20] With the total sample (male+female), we find that rising Chinese import penetration leads to a higher employment growth for low-skilled occupations during the *1991-2001* period (see Kim, 2018a). Column (2) in Table 9 indicates that this was driven by male low-skilled workers. As pointed out in Kim (2018a),such positive relationship is driven by few influential observations in the male sample. A negative but statistically insignificant relationship is found if we exclude them.

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.

In the skill-type dimension, we see a quite different response of employment growth to Chinese imports. First, female production occupations exhibit a greater sensitivity to Chinese import competition. Column (1) in Table 10-1 shows that annual employment growth in female production occupations is reduced by 2.33 percentage points in response to a 1 percentage-point increase in import penetration ratio. This compares to 1.60 percentage-point reduction for male production workers as suggested in column (1) in Table 10.

In Kim (2018a), we find that the negative impact of China on the employment for technical/paraprofessional and other services in the total sample (male+female). Here, it appears that such negative impact found at the aggregate level is mostly driven by female workers in those occupations. Column (1) in Table 10 indicates that male workers in those occupations receive no statistically significant impact from the China shock. Lastly, we find that male employment growth in professional occupations increased in response to a rise in Chinese import penetration (see column 1).[21] However, such effect disappears at the aggregated sample as shown in Kim (2018a).

Column (2) and (3) in Table 10 and 10-1 report the results based on the two sub-periods. For both genders, the results based on the 2001-2011 period are generally consistent with those based on the stacked model. In Kim (2018a), we find that the positive marginal effect on production occupations observed in the total sample (male+female) based on the 1991-2001 sub-period. Note that such positive relationship is driven by males as shown in column (2) of Table 10. Male employment in production exhibits a positive and statistically significant response to a rise in Chinese import penetration while female does not. However, similar to what we find in Kim (2018a), the positive relationship is driven by few influential observations in the male sample. If we exclude them, we find a negative but statistically insignificant relationship.

[21] The negative relationship is driven by some influential outliers (e.g. Registered nurses - D112 in NOC-S 2006). Note that we do not exclude all influential outliers in the regression analysis in this report. Most of the influential outliers exist in the sample period 1991-2001 (except for male professional). Therefore, they do not fundamentally alter our conclusion in this report.

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

	Stacked Differences, 1991-2011			By Sub-periods			
	1991-2001 and 2001-2011			1991-2001		2001-2011	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Annual change in Chinese Import Penetration	-	-0.47 (0.35)	-0.95** (0.45)	1.69 (1.06)	0.90 (1.24)	-0.75* (0.42)	-1.11** (0.55)
1{1991-2001}	-1.31* (0.71)	-1.14 (0.70)	-0.98 (0.71)	-	-	-	-
1{2001-2011}	-3.28*** (0.95)	-3.16*** (0.95)	-3.03*** (0.94)	-	-	-	-
Constant	-	-	-	-1.90*** (0.72)	-1.62** (0.77)	-4.13*** (0.61)	-3.91*** (0.64)
Obs.	829	829	829	437	437	394	394
Estimation Method	OLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
First-stage F Statistic	-	-	170.36	-	71.45	-	310.94

Note: In all specifications, the dependent variable is the average annual growth rate of employment by four-digit occupation 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. Note that, for some occupations, the sum of employment for male and female reported in census tables is not necessarily equal to the total employment reported for those occupations. Hence, for some occupations, employment level is zero for both male and female although it is positive for the total sample. Hence, the number of observation in regressions by gender does not match up with the one reported in the regressions for the total. 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 8-1: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries, Female, Canada: OLS and 2SLS Estimates

	Stacked Differences, 1991-2011			By Sub-periods			
	1991-2001 and 2001-2011			1991-2001		2001-2011	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Annual change in Chinese Import Penetration	-	-0.41 (0.43)	-0.96* (0.57)	2.61** (1.02)	0.59 (1.15)	-0.91* (0.48)	-1.13* (0.63)
1{1991-2001}	0.78 (0.72)	0.96 (0.75)	1.21 (0.76)	-	-	-	
1{2001-2011}	-6.27*** (0.90)	-6.10*** (0.90)	-5.87 *** (0.91)	-	-	-	
Constant	-	-	-	-0.42 (0.89)	0.51 (0.90)	-4.70*** (0.61)	-4.49*** (0.70)
Obs.	754	754	754	410	410	344	344
Estimation Method	OLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
First-stage F Statistic	-	-	884.38	-	68.03	-	297.82

Note: In all specifications, the dependent variable is the average annual growth rate of employment by four-digit occupation 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. Note that, for some occupations, the sum of employment for male and female reported in census tables is not necessarily equal to the total employment reported for those occupations. Hence, for some occupations, employment level is zero for both male and female although it is positive for the total sample. Hence, the number of observation in regressions by gender does not match up with the one reported in the regressions for the total. 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

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

	Stacked Differences, 1991-2011	1991-2001	2001-2011
	(1)`	(2)	(3)
Annual change in Chinese Import Penetration			
High-skilled	0.40	3.29	0.35
	(0.43)	(2.86)	(0.46)
Mid-skilled	-0.26	-0.79	-0.24
	(0.22)	(2.25)	(0.20)
Low-skilled	-1.57*	2.79***	-2.12**
	(0.80)	(1.05)	(0.99)
Obs.	829	437	394
First-stage F Statistic	5746.11	7334.79	7652.72

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. Note that, for some occupations, the sum of employment for male and female reported in census tables is not necessarily equal to the total employment reported for those occupations. Potentially due to measurement errors, for some occupations, employment level is zero for both male and female although it is positive for the total sample. Hence, the number of observation in regressions by gender does not match up with the one reported in the regressions for the total reported in Kim (2018a). For (1), we also control for the period dummy interacted with the dummy for skill levels. For (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 9-1: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries by Skill-Level, Female, Canada: OLS and 2SLS Estimates

	Stacked Differences, 1991-2011	1991-2001	2001-2011
	(1)`	(2)	(3)
Annual change in Chinese Import Penetration			
	0.54	8.85	-0.02
High-skilled	(0.90)	(9.13)	(0.62)
	-0.68	-0.38	-0.71
Mid-skilled	(0.49)	(1.93)	(0.46)
	-1.75*	1.07	-2.38**
Low-skilled	(1.00)	(1.06)	(1.19)
Obs.	759	415	346
First-stage F statistic	1659.65	1293.17	1907.18

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. Note that, for some occupations, the sum of employment for male and female reported in census tables is not necessarily equal to the total employment reported for those occupations. Potentially due to measurement errors, for some occupations, employment level is zero for both male and female although it is positive for the total sample. Hence, the number of observation in regressions by gender does not match up with the one reported in the regressions for the total reported in Kim (2018a). For (1), we also control for the period dummy interacted with the dummy for skill levels. For (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, Male, Canada: 2SLS Estimates

	Stacked Differences, 1991-2011	1991-2001	2001-2011
	(1)`	(2)	(3)
Annual change in Chinese Import Penetration			
Management	-0.67	-1.21	-0.64
	(2.22)	(6.45)	(2.34)
Professional	1.14***	-12.58	1.19***
	(0.30)	(19.21)	(0.28)
Technical and Paraprofessional	-0.32	1.18	-0.43
	(0.36)	(1.45)	(0.40)
Services	-1.92	2.62	-2.46
	(1.93)	(5.07)	(1.95)
Trades, Construction, and Transportation	-0.49	-5.06*	-0.25
	(0.59)	(2.89)	(0.54)
Production	-1.60*	2.53**	-2.19**
	(0.95)	(1.26)	(0.99)
Obs.	829	437	394
First-stage F Statistic	5201.81	21184.10	3844.66

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. Note that, for some occupations, the sum of employment for male and female reported in census tables is not necessarily equal to the total employment reported for those occupations. Potentially due to measurement errors, for some occupations, employment level is zero for both male and female although it is positive for the total sample. Hence, the number of observation in regressions by gender does not match up with the one reported in the regressions for the total reported in Kim (2018a). For (1), we also control for the period dummy interacted with the dummy for skill levels. For (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 10-1: Effect of Chinese Import Penetration on Log Employment in 4-digit occupations in Manufacturing Industries by Skill-Type, Female, Canada: 2SLS Estimates

	Stacked Differences, 1991-2011	2001-2011	1991-2011
	(1)`	(2)	(3)
Annual change in Chinese Import Penetration			
Management	3.48 (3.59)	12.16 (15.58)	2.32 (3.03)
Professional	3.97 (2.75)	63.70 (54.22)	2.51 (2.59)
Technical and Paraprofessional	-1.48*** (0.56)	-0.59 (1.46)	-1.56** (0.65)
Services	-4.71** (2.05)	-0.44 (6.28)	-5.46*** (1.88)
Trades, Construction, and Transportation	0.51 (0.96)	0.70 (1.49)	0.50 (0.98)
Production	-2.33*** (0.88)	1.03 (1.41)	-3.15*** (0.76)
Obs.	759	415	346
First-stage F statistic	1992.5	1428.42	1487.36

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. Note that, for some occupations, the sum of employment for male and female reported in census tables is not necessarily equal to the total employment reported for those occupations. Potentially due to measurement errors, for some occupations, employment level is zero for both male and female although it is positive for the total sample. Hence, the number of observation in regressions by gender does not match up with the one reported in the regressions for the total reported in Kim (2018a). For (1), we also control for the period dummy interacted with the dummy for skill levels. For (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

1. Implied employment effects

Using the estimated coefficient in column (3) in Table 8 and 8-1, 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, 9-1 and Table 10, 10-1.[22]

We provide our estimates of employment effect of the China shock for each gender. Table 11 and Table 11-1 present employment changes induced by Chinese import penetration for males and females, respectively. First, the total employment effect was greater for males than it was for females both during the full 1991-2011 span and the 2001-2011 period. However, note that female share in the total employment is much smaller and the total decline in their employment is smaller than males over this period. This implies that females had a larger job loss in relative terms.

For example, during the 2001-2011period when Chinese import penetration rose substantially, the job loss estimated for females is 36.1 thousand and the loss for males is 56.8 thousand. However, in relative terms, females experienced a larger decline in their employment due to the China shock. For them, 21.3 per cent of the total decline was induced by the shock. For males, the share was 16.8 per cent.

It would be useful to assess the total employment effect broken down into different skill groups. In relative terms, females tend to experience a larger job loss than males but is it true for all skill groups? We first assess the implied employment effect by skill level. Over the full 1991-2011 span, female low-skilled workers had a slightly higher net loss than male workers: a loss of 82.1 thousand for female compared to a loss of 77.0 thousand for male. Also, female had a larger proportional decline compared to male. Of the total decline in low-skilled jobs for female, 79.6 per cent was caused by rising import competition from China. For male, the share was 69.5 per cent.

Similarly, the job loss in female low-skilled occupations was larger in relative terms during the period in which import penetration from China rose significantly. Over 2001-2011, males and females experienced essentially the same level of job loss (42.4 thousand loss for female and 42.9 thousand loss for males). We estimate that had import penetration from China remained unchanged, then female low-skilled jobs would have declined by 90.5 thousand instead of 132.9 thousand. In other words, of the total decline in the low-skilled jobs, 31.9 per cent was induced by Chinese imports. For male, the share was 21.3 per cent.

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

Our estimates suggest a quite large employment effect for female low-skilled occupations despite the fact that low-skilled occupations in manufacturing are predominately held by male.[23] This is due to: 1. greater observed increases in trade exposure for female low-skilled occupations; and 2. a larger estimated marginal effect ($\hat{\beta}$) of import competition on female employment growth in low-skilled occupations.

During the 2001-2011 period, the mean annual increase in import penetration ratio for female low-skilled occupations was 0.82 percentage point, compared to 0.63 percentage point for male low-skilled. Moreover, the estimated marginal employment effect of import competition on female low-skilled employment growth is -1.75 (vs. -1.57 for male low-skilled). These two factors lead to a large implied employment effect for female despite a small female share in the total low-skilled manufacturing employment.[24]

We emphasize again that skill level and skill type are not necessarily correlated (*i.e.* no skill level is found exclusively in a particular skill type and vice versa). They each reflects a distinct characteristics of a given occupation. Analyzing the gender difference in employment effect by skill type would also be informative. In which skill type do we observe a substantial gender difference in the direct employment effect of the rising Chinese import penetration?

Across the skill types, we find that female production workers experienced a similar degree of job loss to male production workers. Focusing on the 2001-2011 period, the net loss for female was 32.3 thousand while that for male was 32.7 thousand. During this period, production jobs for females and males declined by 112.5 thousand and 194.6 thousand respectively. Therefore, females had a larger proportional job loss due to rising import penetration. The job loss accounts for 28.7 per cent of the total decline in female production employment during this period. For males, the share is 16.8 per cent.

Note that occupations in production were mostly held by male in manufacturing.[25] Again, despite this fact, having a higher estimated marginal female employment effect results in a quite large employment effect for them (-2.33 vs. -1.60). In addition, the observed increase in trade exposure for female production occupations was greater than that for the corresponding male occupations. For example, the mean annual increase in import penetration ratio for female production workers was 0.86 percentage point while that for male was 0.62 percentage point during the 2001-2011 period.

Females also had a notable trade-induced job loss in occupations in other services during the 2001-2011 period. We estimate that rising Chinese import penetration led to a loss of 15.4 thousand for other services. This accounts for 35.2 per cent of the total decline in the employment for this skill group. It appears that males also had a comparable job loss in other services but the estimates are based on insignificant coefficients. This is less surprising than the

[23] Of the total low-skilled occupations in manufacturing, 36.6 per cent was held by female in 1991, 33.2 per cent in 2001, and 35.2 per cent in 2011.

[24] One can refer to Equation (8) to examine the role of each factors in determining the implied employment effect. Another factor is the R-squared from our first-stage. However, male and female samples exhibit a very similar R-squared.

[25] Note that, of the total production employment in manufacturing, 31 per cent was held by female on average over the 1991-2011 period.

findings for female production occupations since females accounted for more than half of the total employment in other services in manufacturing. On average, females accounted for 55 per cent of the total employment in other services in manufacturing during the 1991-2011 period.

Lastly, we find statistical evidence that females also experienced a job loss in technical and paraprofessional. Although the job loss is small in the absolute term (a loss of 3.6 thousand), it accounts for 78.3 per cent of the total decline in the female employment for that skill group. In contrast, we find no statistical evidence that Chinese import penetration affected the male employment in this skill group.

In summary, females had a larger loss in relative terms in low-skilled occupations when analyzed by skill level and in production and technical/paraprofessional, and other services when analyzed by skill type. It is interesting to find that we observe comparable job losses found for females in low-skilled and production occupations despite the fact that they accounted for a smaller share of the total manufacturing employment in those skill groups. These patterns reflect: 1.larger increases in trade exposure for female; and 2. larger marginal effects of import penetration from China on female employment across skill levels and skill types.

One explanation for the above pattern can be found in Table 12. The table reports the employment structure of three-digit manufacturing sectors across male and female. In 2001, female accounted for 29.0 per cent of the total manufacturing employment in Canada (male accounted for 71.0 per cent). However, female tended to have high shares in sectors with relatively large annual increases in import penetration ratio over the 2001-2011.[26] Most notable is the female share in *Textile Product Mill* (NAICS 314), *Clothing Manufacturing* (NAICS 315), *Leather and Allied Product Manufacturing* (NAICS 316), and *Miscellaneous Manufacturing* (NAICS 339).These sectors experienced quite large increases in import penetration over the 2001-2011 period. For example, *Clothing Manufacturing* (NAICS 315) had an annual increase of 2.6 percentage points in their import exposure over the 2001-2011. In this sector, female accounted for 75.0 per cent of the sectoral employment in 2001.

Autor and Dorn (2013) find that technological progress led to "employment polarization" in the United States such that low-skilled labour moved from goods (involving routine-tasks) to 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 Kim (2018a), we find that trade did not play a role in "employment polarization" in Canada since it was only the low-skilled group that experienced a significant trade-induced job loss. In this report, we find that such result is true for both genders.

We end this section with two caveats worth noting. First, the estimates presented in Table 11 and 11-1 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 Tables 8 to 10 that the marginal effect of Chinese import competition is estimated to be different across the two sub-periods for both male and female. During the 1991-2001 period, for both genders, we find no statistical evidence that

[26] We find that this pattern is quite stable over the three census years we consider. General patterns in employment structures and changes in import penetration ratio at the three-digit industry level are very stable over time.

employment growth in most of the skill groups were affected by Chinese import penetration (if we exclude few influential observations as discussed earlier). However, some skill groups experienced a very large 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 two groups over the two decades may be smaller than our estimates reported in Table 11 and 11-1. However, this does not affect our conclusion that during 2001-2011.

Another caveat is that total employment effect in row (1) in Table 11 and 11-1 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 9-1 for skill level and Table 10 and 10-1 for skill type respectively. Hence, the sum of implied employment effects reported in each row would not necessarily be the same (see Equation 8).

Table 11: Implied Employment Changes Induced by Changes in Chinese Import Penetration, thousand, by Skill level and Skill type, Manufacturing sectors, Male 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	**194.7**	**-280.7**	**-86.0**	**154.6**	**-337.5**	**-182.9**	**-40.1**	**-56.8**	**-96.9**
(2) By Skill Level									
High-skilled	6.3	-39.6	-33.3	9.9	-33.0	-23.1	3.6	6.6	10.2
Mid-skilled	57.9	-99.0	-41.1	54.4	-103.4	-49.0	-3.5	-4.4	-7.9
Low-skilled	124.3	-158.2	-33.8	90.2	-201.1	-110.8	-34.1	-42.9	-77.0
(3) By Skill Type									
Management	-0.6	-21.8	-22.4	-4.1	-27.5	-31.6	-3.5	-5.7	-9.2
Professional	-13.5	-1.6	-15.0	-12.8	-0.6	-13.3	0.7	1.0	1.7
Technical/Paraprofessional	41.5	-11.8	29.7	39.1	-15.9	23.2	-2.4	-4.1	-6.5
Other services	-52.2	-8.2	-60.4	-61.3	-22.7	-84.0	-9.1	-14.5	-23.6
Trades/Construction/Transportation	31.0	-71.2	-40.2	27.7	-76.2	-48.5	-3.3	-5.0	-8.3
Production	193.5	-161.9	31.6	165.8	-194.6	-28.8	-27.7	-32.7	-60.4

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 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 the 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.

Table 11-1: Implied Employment Changes Induced by Changes in Chinese Import Penetration, thousand, by Skill level and Skill type, Manufacturing sectors, Female 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	**56.3**	**-133.2**	**-76.9**	**25.4**	**-169.3**	**-143.9**	**-30.9**	**-36.1**	**-67.0**
(2) By Skill Level									
High-skilled	-1.4	-6.5	-8.0	0.2	-3.6	-3.5	1.6	2.9	4.5
Mid-skilled	0.7	-26.4	-25.7	-4.6	-32.7	-37.3	-5.3	-6.3	-11.6
Low-skilled	69.6	-90.5	185.2	29.9	-132.9	-103.1	-39.7	-42.4	-82.1
(3) By Skill Type									
Management	1.8	-9.2	-7.4	5.4	-3.0	2.4	3.6	6.2	9.8
Professional	-10.3	-3.5	-13.8	-7.9	0.6	-7.3	2.4	4.1	6.5
Technical/Paraprofessional	14.6	-1.0	13.6	12.0	-4.6	7.4	-2.6	-3.6	-6.2
Other services	-64.6	-28.4	-93.0	-76.0	-43.8	-119.8	-11.4	-15.4	-26.8
Trades/Construction/Transportation	7.1	-6.8	0.3	7.6	-6.1	1.5	0.5	0.7	1.2
Production	118.5	-80.2	38.3	84.5	-112.5	-28.0	-34.0	-32.3	-66.3

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 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 the 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.

Table 12: 2001 Employment level (thousand), share in three-digit NAICS manufacturing sectors, annual % pt change in import penetration at three-digit NAICS industry level over 2001-2011, male and female, Canada

	Male	Female	Male share (%)	Female share (%)	Annual Δ in import penetration (% pt)
Total manufacturing	1441.3	589.5	71.0	29.0	1.1
311: Food Manufacturing	136.6	90.0	60.3	39.7	0.1
312: Beverage and Tobacco Product Manufacturing	23.5	7.8	75.1	24.9	0.0
313: Textile Mills	15.8	9.9	61.5	38.5	0.0
314: Textile Product Mills	10.5	10.5	50.0	50.0	1.8
315: Clothing Manufacturing	25.2	75.8	25.0	75.0	2.6
316: Leather and Allied Product Manufacturing	4.3	5.7	43.1	56.9	3.0
321: Wood Product Manufacturing Wood Product Manufacturing	124.4	20.5	85.8	14.2	0.4
322: Paper Manufacturing	83.0	17.3	82.8	17.2	0.2
323: Printing and Related Support Activities	57.1	33.6	62.9	37.1	0.2
324: Petroleum and Coal Product Manufacturing Petroleum and Coal Product Manufacturing	11.9	3.0	80.0	20.0	0.0
325: Chemical Manufacturing Chemical Manufacturing	60.6	34.2	63.9	36.1	0.2
326: Plastics and Rubber Products Manufacturing Plastics and Rubber Products Manufacturing	76.5	36.8	67.5	32.5	0.9
327: Non-Metallic Mineral Product Manufacturing	44.0	10.8	80.2	19.8	0.6
331: Primary Metal Manufacturing	81.7	9.9	89.2	10.8	0.7
332: Fabricated Metal Product Manufacturing	141.7	31.6	81.8	18.2	0.9
333: Machinery Manufacturing Machinery Manufacturing	107.4	21.4	83.4	16.6	0.9
334: Computer and Electronic Product Manufacturing	71.9	40.3	64.1	35.9	3.8
335: Electrical Equipment, Appliance and Component Manufacturing Electrical Equipment, Appliance and Component Manufacturing	38.2	18.4	67.4	32.6	1.9
336: Transportation Equipment Manufacturing	204.5	55.1	78.8	21.2	0.3
337: Furniture and Related Product Manufacturing Furniture and Related Product Manufacturing	77.2	25.2	75.4	24.6	2.1
339: Miscellaneous Manufacturing	45.3	31.6	58.9	41.1	2.1

Source: The 2001 census and author's calculation based on the online trade data base maintained by Innovation, Science, and Economic Development Canada.

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.[27] 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.[28]

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:

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

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.[29] $\Delta IE^{L}_{l,\tau}$ 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.

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

[28] 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.

[29] 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.[30] 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.[31] 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

[30] 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).
[31] 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.[32] 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.[33]

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 13 and 13-1 for each gender respectively. First, the rising Chinese import competition after 2001 is evident: the mean annual change in Chinese import penetration ratio over the 1991-2001 period is lower than that over the 2001-2011 period for both genders. It also shows the turnaround in employment growth after

[32] 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.

[33] 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.

2001 we discussed in the earlier section; across all industries, the annual change in the employment rate is positive for both genders over the 1991-2001 period but it become negative over the 2001-2011 period.

During 2001-2011 period, the mean annual increase in local trade exposure is quite similar for males and females. However, the mean decline in local employment rate (all industries) is lower for males during this period. Across the 122 CMAs/CAs, the employment rate declined by 0.29 percentage-point on average for males while it declined by 0.17 percentage-point for females. On average, females appear to have experienced a larger decline in the employment rate for a given rise in local trade exposure during this period.

During the first half of the 1991-2011 period, occupations in all three skill levels had positive mean increase in their employment except for male mid-skilled occupations. During the period when Chinese import penetration rose substantially (*i.e.* 2001-2011), all three skill levels had a decline in their local employment rate on average across the 122 CMAs/CAs. For both genders, the mean decline in the employment rate was the largest for low-skilled occupations and lowest for high-skilled occupations during this period. Across the two genders, we find that males experienced a larger mean decline in the employment rate for all three skill groups during the 2001-2011 period.

A similar pattern is found in the skill type dimension. The local employment rate for most of the skill types rose on average during the 1991-2001 period but fell in the following sub-period. Similarly, males tend to experience a larger mean decline in the employment rates in all skill types except for other services. For occupations in other services, females had a notably larger mean decline. The employment rate of other services fell by 0.33 percentage-point on average for females during the 2001-2011 period. This is almost twice as large as the mean decline experienced by males.

Table 13: Summary Statistics on Changes in Employment Rates and in Chinese Import Penetration across Local Labour Markets, Male, 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	0.08	0.05	0.03	0.11	0.05
Instrument for annual change in Chinese Import Penetration	0.07	0.06	0.05	0.03	0.02	0.11	0.06
Annual change in Employment Rate							
(1) All occupations	-0.13	0.27	-0.11	0.03	0.21	-0.29	0.22
(2) By Skill Level							
High-skilled	0.06	0.22	-0.06	0.08	0.14	-0.21	0.19
Mid-skilled	-0.15	0.26	-0.14	-0.01	0.23	-0.29	0.21
Low-skilled	-0.17	0.30	-0.16	0.02	0.23	-0.37	0.23
(3) By Skill Type							
Management	-0.08	0.12	-0.06	0.00	0.07	-0.15	0.11
Professional	-0.03	0.08	-0.01	0.01	0.06	-0.06	0.08
Technical/Paraprofessional	0.00	0.14	-0.01	0.10	0.09	-0.11	0.10
Other services	-0.11	0.18	-0.10	-0.03	0.15	-0.18	0.18
Trades/Construction/Transportation	-0.10	0.19	-0.10	-0.01	0.17	-0.19	0.16
Production	-0.08	0.19	-0.08	0.02	0.18	-0.18	0.14

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.

Table 13-1: Summary Statistics on Changes in Employment Rates and in Chinese Import Penetration across Local Labour Markets, Female, 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	0.07	0.05	0.07	0.05	0.03	0.09	0.05
Instrument for annual change in Chinese Import Penetration	0.07	0.06	0.06	0.04	0.02	0.11	0.06
Annual change in Employment Rate							
(1) All occupations	-0.06	0.23	-0.04	0.05	0.19	-0.17	0.21
(2) By Skill Level							
High-skilled	0.03	0.17	-0.01	0.13	0.16	-0.06	0.13
Mid-skilled	-0.06	0.17	-0.05	0.03	0.14	-0.14	0.16
Low-skilled	-0.16	0.28	-0.14	0.00	0.24	-0.31	0.24
(3) By Skill Type							
Management	0.00	0.09	0.00	0.05	0.07	-0.05	0.07
Professional	0.05	0.10	0.00	0.07	0.11	0.01	0.08
Technical/Paraprofessional	0.03	0.08	0.00	0.07	0.08	-0.02	0.06
Other services	-0.20	0.34	-0.12	-0.07	0.28	-0.33	0.35
Trades/Construction/Transportation	-0.01	0.02	-0.01	0.01	0.02	-0.02	0.02
Production	-0.04	0.09	-0.03	0.01	0.08	-0.09	0.07

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. Again, we find a negative relationship between changes in local employment rate in manufacturing and changes in local trade exposure for both genders. Our 2SLS estimates indicate that a 1-percentage-point-increase in local trade exposure leads a decline in the local employment rate by 2.73 percentage points for females and 2.11 percentage points for males.

Importantly, the local employment rate in non-manufacturing increases for both genders in response to a rise in local trade exposure to China, thereby mitigating the decline observed in manufacturing. This indicates that there had been successful labour reallocation from manufacturing to non-manufacturing in response to a rise in local trade exposure. In other words, local demand effects appear to be too weak to offset the labour reallocation effect operating within local labour markets. This is the opposite of what Acemoglu *et al.* (2016) find. They find that negative local demand effects appear to fully offset the labour reallocation operating within local labour markets.

Table 14: 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)		
		Female	
	All industries	Manufacturing	Non-manufacturing
CMA/CA import exposure	-0.16 (0.50)	-2.73*** (0.27)	2.42** (0.98)
Obs.	488	244	244
First-stage F statistics	929.82	908.37	908.37
		Male	
	All industries	Manufacturing	Non-manufacturing
CMA/CA import exposure	0.10 (0.50)	-2.11*** (0.67)	2.31** (1.03)
Obs.	488	244	244
First-stage F statistics	727.67	710.89	710.89

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.

Next, we discuss the results by skill level. Column (2) in Table 15 and 15-1 reports the estimates for manufacturing for each gender. 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 for both genders.

Note, however, that female low-skilled occupations exhibit a greater degree of sensitivity to Chinese import competition. For females, a 1-percentage-point China shock to localities reduces the low-skilled employment rate by 2.68 percentage points. This compares to 1.51 percentage-point reduction of male low-skilled employment rate for a 1-percentage-point increase in local trade exposure.

Based on column (3), the reallocation to non-manufacturing sector did occur for all three skill levels in response to a rise in Chinese import penetration for both genders. However, the reallocation occurred at a varying degree across the three skill levels.

Both male and female exhibit an equivalent rise in non-manufacturing employment rate for high- and mid-skilled occupations. This implies that the reallocation to both high and mid-skilled occupations were quite successful within local labour markets. [34] For both genders, however, negative demand effects presumably prevent low-skilled occupations from achieving an equivalent rise in their employment rate in non-manufacturing. The labour reallocation to low-skilled occupations in non-manufacturing appears to be less successful than the reallocation to high- and mid-skilled occupations.

Next, we present the results from estimating Equation (12) in which we assess the employment effect by skill type. Table 16 and Table 16-1 report the results for each gender. Based on column (1) in each table, we find that a 1-percentage-point China shock to localities reduces the change employment rate in male production occupations by 0.40 percentage points per year in *all* industries. For females, the same shock reduces the employment rate of production occupations by 1.03 percentage points. Hence, females exhibit a larger marginal effect of a rise in Chinese import penetration in local labour markets. Additionally, a 1-percentage-point rise in local import exposure reduces the employment rate of trades/construction/transportation by 0.12 percentage points for females. In contrast, the employment rate of the same occupation group increases for males although the increase is not statistically significant.

The breakdown by the two sectors reveals that the labour reallocation to production and trades/construction/transportation jobs in non-manufacturing was somewhat successful for males but not for females. Column (2) in each table shows that for both genders, the employment rate for the two skill types in manufacturing declined in response to a rise in local trade exposure to China. However, in column (3), we find no statistical evidence for females that the employment rates of those two skill types in non-manufacturing rise in response to a trade shock while we do

[34] 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.

for male.[35] One explanation for this pattern is that there is a smaller number of jobs in those skill groups available for female workers outside manufacturing within local labour markets than it is for male workers, potentially prohibiting re-employment in response to an import shock.

Interestingly, we observe that the employment rate in female management occupations in all industries is positively affected by a rise in local's trade exposure. The breakdown by manufacturing and non-manufacturing indicates that such relationship is driven by the marginal effect observed in non-manufacturing. The female employment rate in management for manufacturing is indeed reduced by a rise in local trade exposure. However, it appears that such decline in the employment rate in manufacturing is more than offset by an increase in non-manufacturing. This indicates that a trade shock might have induced previously unemployed workers to be re-employed in management occupations in non-manufacturing or induced workers in those occupations to exit the labour force.[36]

[35] We conjecture that, within local labour markets, we would see a rise in either unemployment rate or the share of female workers not in the labour force for those two skill types in response to the China shock.

[36] 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 as in Autor *et al.* (2013).

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

	Employment Rate (all industries)	Manufacturing Employment Rate	Non-Manufacturing Employment Rate
	(1)`	(2)	(3)
CMA/CA import exposure x{High-skilled}	0.02 (0.10)	-0.42*** (0.10)	0.46** (0.21)
CMA/CA import exposure x {Mid-skilled}	0.09 (0.22)	-0.62** (0.28)	0.81** (0.38)
CMA/CA import exposure x {Low-skilled}	-0.42** (0.21)	-1.51*** (0.39)	0.67* (0.36)
Obs.	1,464	732	732
First-stage F statistics	1644.01	1608.44	1608.44

Note: For (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 (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 15-1: Effect of Import Penetration on Canadian Local Labour Markets, By Skill Level, Female, 1991-2011, stacked model: 2SLS Estimates

	Employment Rate (all industries)	Manufacturing Employment Rate	Non-Manufacturing Employment Rate
	(1)`	(2)	(3)
CMA/CA import exposure x{High-skilled}	0.25	-0.23***	0.72**
	(0.17)	(0.07)	(0.34)
CMA/CA import exposure x {Mid-skilled}	-0.07	-1.06***	0.92**
	(0.24)	(0.14)	(0.46)
CMA/CA import exposure x {Low-skilled}	-0.66*	-2.68***	1.35**
	(0.35)	(0.33)	(0.57)
Obs.	1,464	732	732
First-stage F statistics	1624.35	1589.21	1589.21

Note: For (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 (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 16: Effect of Import Penetration on Canadian Local Labour Markets, By Skill Type, Male, 1991-2011, stacked model: 2SLS Estimates

	Employment Rate (all industries)	Manufacturing Employment Rate	Non-Manufacturing Employment Rate
	(1)`	(2)	(3)
CMA/CA import exposure x {Management}	-0.08 (0.07)	-0.31*** (0.05)	0.14 (0.13)
CMA/CA import exposure x {Professional}	0.03 (0.05)	-0.03* (0.02)	0.09 (0.10)
CMA/CA import exposure x {Technical/Paraprofessional}	0.08 (0.08)	-0.23** (0.10)	0.39** (0.16)
CMA/CA import exposure x {Other Services}	-0.05 (0.12)	-0.33*** (0.08)	0.24 (0.24)
CMA/CA import exposure x {Trades/Construction/Transportation}	0.11 (0.15)	-0.56*** (0.17)	0.78** (0.31)
CMA/CA import exposure x {Production}	-0.40** (0.19)	-1.09*** (0.40)	0.29* (0.16)
Obs.	2,928	1,464	1,464
First-stage F statistics	1644.58	1609.59	1609.59

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 16-1: Effect of Import Penetration on Canadian Local Labour Markets, By Skill Type, Female, 1991-2011, stacked model: 2SLS Estimates

	Employment Rate (all industries)	Manufacturing Employment Rate	Non-Manufacturing Employment Rate
	(1)`	(2)	(3)
CMA/CA import exposure x {Management}	0.30***	-0.11***	0.70***
	(0.09)	(0.03)	(0.18)
CMA/CA import exposure x {Professional}	-0.02	-0.09***	0.04
	(0.12)	(0.03)	(0.23)
CMA/CA import exposure x {Technical/Paraprofessional}	0.13	-0.24***	0.50**
	(0.10)	(0.06)	(0.23)
CMA/CA import exposure x {Other Services}	0.27	-1.09***	1.62**
	(0.38)	(0.14)	(0.74)
CMA/CA import exposure x {Trades/Construction/Transportation}	-0.12 **	-0.22***	-0.02
	(0.05)	(0.05)	(0.06)
CMA/CA import exposure x {Production}	-1.03***	-2.22***	0.15
	(0.15)	(0.27)	(0.14)
Obs.	2,928	1,464	1,464
First-stage F statistics	1624.92	1590.35	1590.35

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.

* $p<0.10$

** $p <0.05$

*** $p<0.01$

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).

The total implied employment effect for each gender is reported in Table 17 and Table 17-1. The total implied effect in all industries across CMAs/CAs is -138.0 thousand for female and -90.5 thousand for male over the full 1991-2011 span. In other words, total employment for male would have increased by 5.4 per cent more over the period had there been no Chinese import shock (given other factors are held constant). For females, the employment would have grown by 6.5 per cent more without the China shock. Of the total implied effect over the full 1991-2011 period, a loss of 65.4 thousand and 96.0 thousand occurred during the 2001-2011 period for males and females respectively. This implies that, over the 2001-2011 period, the total employment would have grown by 7.5 per cent more for males and 9.0 per cent more for females without the China shock. In any case, the net job loss was greater for females in both absolute and relative terms.

How is the aggregate job loss distributed across different skill levels? Let us focus on the period in which Chinese import penetration rose significantly (*i.e.* 2001-2001). During this period, low-skilled occupations for females had a net job loss of 131.1 thousand while male low-skilled occupations had a net loss of 89.4 thousand. To put it in a context, we estimate that female low-skilled employment would have grown by 73.5 per cent more over this period if they had not been hit by local trade shocks. On the other hand, the employment in male low-skilled occupations would have grown by 36.6 per cent more without the shocks.

We estimate that female production occupations experienced a net job loss of 204.5 thousand across all industries in CMAs/CAs in Canada during the 2001-2001 period (see Table 17 and Table 17-1). On the other hand, males had a loss of 84.3 thousand in production jobs. Note that the employment in production declined for both genders over the 2001-2011 period. During this period, production employment declined by 213.8 thousand for males and by 141.8 thousand for females. This implies that China can explain about 39.4 per cent of the total decline in jobs of males in production. For females, trade-induced job loss is greater than the actual decline. Had there been no change in Chinese import penetration, then the production employment would have increased by 63.5 thousand for females in production.

A larger absolute and relative job loss for female production can be partly attributed to unsuccessful labour reallocation for them. Males were able to have somewhat successful reallocation to production occupations in non-manufacturing in response to a rise in local trade exposure. Although the reallocation did not fully offset the job loss in manufacturing, it mitigated the loss to a significant extent.

Females also experienced a job loss of 23.6 thousand in trades/construction/transportation due to China during the 2001-2011 period while males experienced a job gain (but based on a statistically insignificant coefficient). As we show in the previous subsection, this is due to the fact that the labour reallocation to this group in unaffected sectors was completely inhibited by negative demand effects for females. The reallocation to unaffected sectors for males was quite successful.

We found statistical evidence that females also experienced an aggregate job loss in the following skill types: Technical/paraprofessional - a loss of 3.6 thousand (78.3 per cent of the total decline); Other services - a loss of 15.4 thousand jobs (35.2 per cent of the total decline). We found no statistical evidence that males in these groups were affected by rising Chinese import penetration.

In summary, the greater aggregate job loss for females can be attributed to not only larger marginal impacts estimated for them but also the unsuccessful labour reallocation to unaffected sectors. The negative effect on male production employment in manufacturing was partly offset by the job gain in non-manufacturing due to the labour reallocation. However, we find no statistical evidence that this was true for females. For female, the labour reallocation to production occupations in non-manufacturing was completely inhibited by the negative local demand effect. Additionally, our estimates imply that the female reallocation to trades/construction/transportation in non-manufacturing was also completely inhibited by negative demand effects operating within local labour markets. For males, the reallocation to that skill group was quite successful. In contrast, we find no evidence for the gender difference in the degree of labour reallocation in the skill level dimension.

Table 17: Implied Employment Changes Induced by Changes in Chinese Import Penetration, thousand, Male, All Industries, Canada

Occupation Group(s)	Counterfactual Δ in employment level			Actual Δ in employment level			Implied Employment Effect		
	1991-2001	1991-2001	1991-2011	1991-2001	2001-2011	1991-2011	1991-2001	2001-2011	1991-2011
(1) All occupations	**755.1**	**942.4**	**1781.2**	**730.0**	**877.0**	**1690.7**	**-25.1**	**-65.4**	**-90.5**
(2) By Skill Level									
High-skilled	327.6	290.6	621.9	329.1	294.6	627.4	1.5	4.0	5.5
Mid-skilled	156.2	378.4	553.2	163.9	398.5	581.0	7.7	20.1	27.8
Low-skilled	271.3	333.7	522.4	236.9	244.3	398.6	-34.4	-89.4	-123.8
(3) By Skill Type									
Management	92.8	82.8	159.5	86.1	65.4	135.4	-6.7	-17.4	-24.1
Professional	86.5	174.5	266.8	88.9	180.8	275.5	2.4	6.3	8.7
Technical/Paraprofessional	256.0	205.0	477.2	262.7	222.5	501.4	6.7	17.5	24.2
Other services	111.9	341.4	443.8	108.0	331.2	429.7	-3.9	-10.2	-14.1
Trades/Construction/Transportation	111.4	250.7	383.2	120.2	273.5	414.8	8.8	22.8	31.6
Production	96.4	-129.5	-33.1	64.0	-213.8	-149.8	-32.4	-84.3	-116.7

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.

Table 17-1: Implied Employment Changes Induced by Changes in Chinese Import Penetration, thousand, Female, All Industries, Canada

Occupation Group(s)	Counterfactual Δ in employment level			Actual Δ in employment level			Implied Employment Effect		
	1991-2001	1991-2001	1991-2011	1991-2001	2001-2011	1991-2011	1991-2001	2001-2011	1991-2011
(1) All occupations	**1096.9**	**1165.7**	**2262.6**	**1054.9**	**1069.7**	**2124.6**	**-42.0**	**-96.0**	**-138.0**
(2) By Skill Level									
High-skilled	421.5	455.4	876.9	442.8	504.0	946.8	21.3	48.6	69.9
Mid-skilled	272.3	400.8	673.1	266.4	387.3	653.7	-5.9	-13.5	-19.4
Low-skilled	403.0	309.4	712.4	345.7	178.3	524.0	-57.3	-131.1	-188.4
(3) By Skill Type									
Management	144.7	50.3	195.0	170.3	108.9	279.2	25.6	58.6	84.2
Professional	285.8	429.2	715.0	283.7	424.5	708.2	-2.1	-4.7	-6.8
Technical/Paraprofessional	213.7	248.7	462.4	224.9	274.2	499.1	11.2	25.5	36.7
Other services	275.3	346.3	621.7	298.4	399.0	697.5	23.1	52.7	75.8
Trades/Construction/Transportation	38.7	27.6	66.3	28.4	4.0	32.4	-10.3	-23.6	-33.9
Production	138.6	63.5	202.1	49.2	-141.0	-91.8	-89.4	-204.5	-293.9

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.

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 by gender 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.

In this report we estimate that within manufacturing, females lost more jobs than males did in relative terms. Females experienced a trade-induced job loss of 36.1 thousand which accounts for 21.3 per cent of the total decline in female employment in manufacturing during this period. Males experienced a loss of 56.8 thousand jobs which accounts for 16.8 per cent of the total decline in male employment in manufacturing.

We find that gender differences are also evident within skill groups. When analyzed by skill level, we find that a trade-induced job loss was statistically significant for only low-skilled occupations. Although the trade-induced job loss was equally distributed between males and females, females had a proportionally larger loss. Low-skilled occupations had a loss of 42.4 thousand for females and a loss of 42.9 thousand for males. The loss accounts for 31.9 per cent of the total decline in low-skilled jobs of women and 21.3 per cent of the total decline in low-skilled jobs of men.

When analyzed by skill type, we find that rising Chinese import competition had statistically significant effects on the employment in the following skill types:

- Production - a loss of 24.3 thousand jobs for females and 5.8 thousand for males (21.6 per cent of the total decline in jobs of women in production and 3.0 per cent of the total decline in jobs of men in production);

- Technical/paraprofessional - a loss of 6.2 thousand for females (if no trade shock, we would have seen an increase of 1.6 thousand instead of a decline of 6.1 thousand) and 4.1 thousand for males (25.8 per cent of the total job losses of men with these occupations);

- Other services - a loss of 16.5 thousand jobs for females and 2.2 thousand jobs for males (37.7 per cent for women with these occupations, compared to 9.7 percent for men).

Again, females tend to have a proportionally larger job loss than males.

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 effect proved important in offsetting the negative direct effects but the degree of reallocation within local labour markets varies across gender.

We find that for females, the labour reallocation to production and trades/construction/transportation occupations in unaffected sectors appears to be fully inhibited by the negative local demand effect. For males, the negative demand effect on those occupational groups were offset by the labour reallocation to unaffected sectors, therefore mitigating the negative employment effect of rising Chinese import penetration. As a result, the total job loss in these two groups was much larger for females in both absolute and relative terms.

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VIII. Appendix: Additional Tables and Charts

Table A1: 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 customer information services	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 occupations, n.e.c.	Skill level D
		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 5 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 A2: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, by Skill-Level, Male, Manufacturing Industries, 1991-2011 by sub-period, Canada

		1991-2001	
	High-skilled	Mid-skilled	Low-skilled
	Mean/Median	Mean/Median	Mean/Median
Annual Δ in Chinese Import Penetration (% pt)	0.40 / 0.42	0.34 / 0.26	0.34 / 0.30
Instrument for Chinese Import Penetration (% pt)	0.25 / 0.26	0.22 / 0.18	0.23 / 0.16
100 x Annual log change in Employment (%)	-1.77 / 0.23	-0.92 / 1.05	-0.66 / 0.58
		2001-2011	
	High-skilled	Mid-skilled	Low-skilled
	Mean/Median	Mean/Median	Mean/Median
Annual Δ in Chinese Import Penetration (% pt)	0.73 / 0.87	0.56 / 0.59	0.63 / 0.64
Instrument for Chinese Import Penetration (% pt)	0.76 / 0.92	0.59 / 0.55	0.65 / 0.55
100 x Annual log change in Employment (%)	-1.80 / -2.20	-2.63 / -2.41	-3.52 / -3.85
		1991-2011 stacked	
	High-skilled	Mid-skilled	Low-skilled
	Mean/Median	Mean/Median	Mean/Median
Annual Δ in Chinese Import Penetration (% pt)	0.57 / 0.48	0.45 /0.36	0.48 / 0.33
Instrument for Chinese Import Penetration (% pt)	0.51 / 0.30	0.40 / 0.23	0.44 / 0.21
100 x Annual log change in Employment (%)	-1.79 / -1.27	-1.77 / -1.62	-2.08 / -1.83

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 employmentis 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 A2-1: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, by Skill-Level, Female, Manufacturing Industries, 1991-2011 by sub-period, Canada

	1991-2001		
	High-skilled Mean/Median	Mid-skilled Mean/Median	Low-skilled Mean/Median
Annual Δ in Chinese Import Penetration (% pt)	0.51 / 0.49	0.46 / 0.42	0.43 / 0.39
Instrument for Chinese Import Penetration (% pt)	0.36 / 0.33	0.30 / 0.25	0.32 / 0.25
100 x Annual log change in Employment (%)	1.12 / 3.73	1.81 / 3.05	0.46 / 1.42
	2001-2011		
	High-skilled Mean/Median	Mid-skilled Mean/Median	Low-skilled Mean/Median
Annual Δ in Chinese Import Penetration (% pt)	0.79 / 1.20	0.89 / 0.80	0.82 / 0.74
Instrument for Chinese Import Penetration (% pt)	0.85 / 1.24	0.93 / 0.80	0.85 / 0.75
100 x Annual log change in Employment (%)	-1.08 / -1.13	-3.00 / -2.41	-4.25 / -3.84
	1991-2011 stacked		
	High-skilled Mean/Median	Mid-skilled Mean/Median	Low-skilled Mean/Median
Annual Δ in Chinese Import Penetration (% pt)	0.65 / 0.67	0.67 /0.55	0.63 / 0.47
Instrument for Chinese Import Penetration (% pt)	0.61 / 0.52	0.62 / 0.33	0.58 / 0.34
100 x Annual log change in Employment (%)	0.04 / 0.05	-0.56/ -0.39	-1.88 / -0.96

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 employmentis 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 A3: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, by Skill-Type, Male, Manufacturing Industries, 1991-2011 by sub-period, Canada

	1991-2001					
	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)	0.41 / 0.43	0.32 / 0.33	0.53 / 0.39	0.38 /0.35	0.21 / 0.18	0.37 / 0.21
Instrument for Chinese Import Penetration (% pt)	0.26 / 0.27	0.20 / 0.22	0.31 / 0.23	0.27 / 0.21	0.12 / 0.12	0.28 / 0.14
100 x Annual log change in Employment (%)	-2.00 / -1.05	-7.25 / -1.71	1.37 / 2.86	-5.21 / -3.64	-0.18 / 1.91	2.14 / 2.75
	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)	0.85 / 0.91	-0.04 / 0.51	0.91 / 0.88	0.71 / 0.76	0.33 / 0.46	0.62 / 0.41
Instrument for Chinese Import Penetration (% pt)	0.88 / 0.97	-0.03 / 0.55	0.97 / 0.82	0.77 / 0.77	0.30 / 0.42	0.65 / 0.38
100 x Annual log change in Employment (%)	-2.54 / -2.40	-0.13 / -1.32	-1.52 / -1.27	-2.43 / -2.38	-2.36 / -2.41	-4.50 / -4.27
	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)	0.63 / 0.48	0.14 / 0.33	0.72 / 0.56	0.55 / 0.43	0.27 / 0.22	0.48 / 0.28
Instrument for Chinese Import Penetration (% pt)	0.57 / 0.30	0.08 / 0.22	0.64 / 0.39	0.52 / 0.30	0.21 / 0.13	0.45 / 0.19
100 x Annual log change in Employment (%)	-2.27 / -1.48	-3.77 / -1.71	-0.06 / -0.03	-3.83 / -3.64	-1.27 / -1.83	-1.18 / -0.03

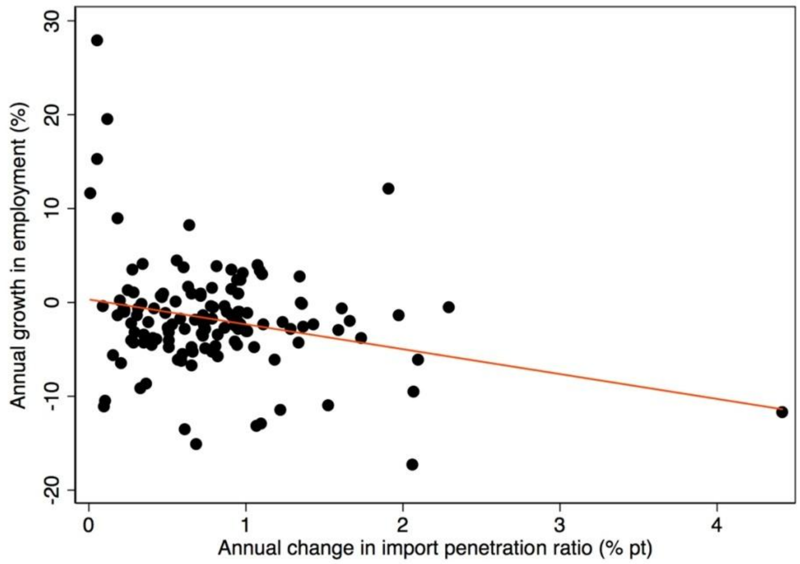
Note: The annual change in Chinese import exposure is 100 x annual change in import penetration for occupation k in a given skill group. The instrument is 100 x annual change in import penetration for occupation k based on the average annual absolute change in imports from China in a set of eight comparator countries over the period indicated. The comparator countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland. Annual growth in employmentis 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 A3-1: Occupation-Level Changes in Employment and Chinese Import Penetration Ratio, by Skill-Type, Female, 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)	0.54 / 0.60	0.35 / 0.39	0.59 / 0.47	0.46 /0.41	0.41 / 0.38	0.43 / 0.32
Instrument for Chinese Import Penetration (% pt)	0.40 / 0.44	0.24 / 0.25	0.37 / 0.32	0.34 / 0.27	0.24 / 0.25	0.32 / 0.17
100 x Annual log change in Employment (%)	1.86 / 3.73	-7.35 / -0.14	4.24 / 5.38	-4.54 / -3.11	3.44 / 3.40	3.38 / 4.29
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)	1.11 / 1.20	-0.53 / 0.63	1.07 / 1.20	0.80 / 0.78	0.81 / 0.83	0.86 / 0.54
Instrument for Chinese Import Penetration (% pt)	1.21 / 1.24	-0.59 / 0.69	1.18 / 1.18	0.88 / 0.78	0.77 / 0.80	0.89 / 0.45
100 x Annual log change in Employment (%)	-1.29 / -1.13	-0.01 / -0.58	-1.34 / -1.20	-3.02 / -2.63	-2.48 / -1.90	-5.62 / -4.93
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)	0.83 / 0.68	-0.09 / 0.39	0.83 / 0.64	0.63 / 0.56	0.61 / 0.55	0.64 / 0.39
Instrument for Chinese Import Penetration (% pt)	0.80 / 0.52	-0.18 / 0.25	0.77 / 0.39	0.61 / 0.48	0.51 / 0.33	0.61 / 0.30
100 x Annual log change in Employment (%)	0.30 / 0.29	-3.88 / -0.58	1.46 / 0.52	-3.78 / -2.63	0.53 / -0.35	-1.09 / 0.10

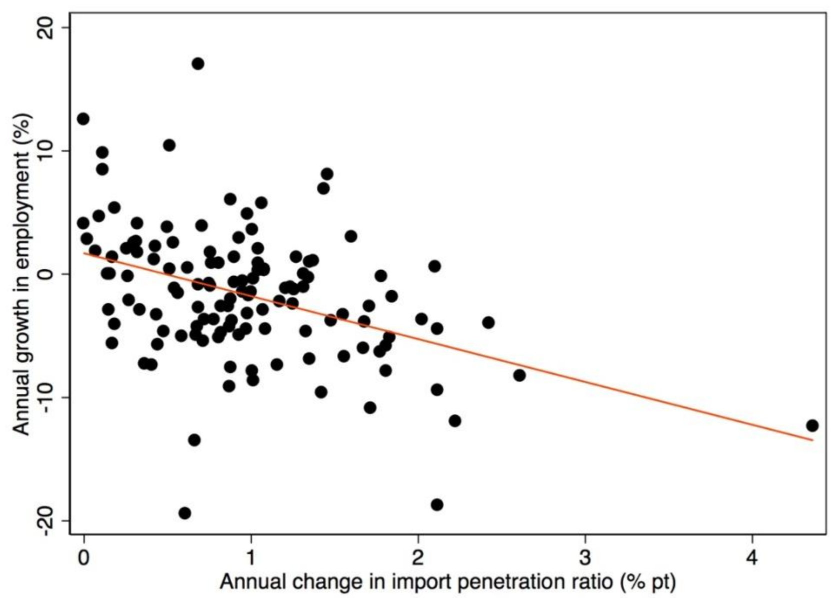
Note: The annual change in Chinese import exposure is 100 x annual change in import penetration for occupation k in a given skill group. The instrument is 100 x annual change in import penetration for occupation k based on the average annual absolute change in imports from China in a set of eight comparator countries over the period indicated. The comparator countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland. Annual growth in employmentis 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.

Chart A1: Annualized employment growth and annual change in import penetration ratio, 3-digit occupations, Male, 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.

Chart A2: Annualized employment growth and annual change in import penetration ratio, 3-digit occupations, Female, 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.