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The Effect of Import Competition on Employment in Canada: Evidence from the 'China Shock'

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Abstract

A common view holds that increasing trade with emerging economies in recent decades has harmed the economic prospects of middle-class workers in Western countries like Canada. In this paper, we provide a quantitative assessment of the impact on Canadian employment of a recent shock to Canada's import supply: the rapid rise of China as a manufacturing export superpower in the late 1990s and early 2000s. Using an instrumental variables strategy, we estimate that total job losses from rising Chinese import competition were on the order of 150 to 170 thousand over the 2001-2011 period. Manufacturing industries account for at least 105 thousand of these job losses. This amounts to 21 per cent of the total decline in manufacturing employment over the 2001-2011 period.

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Executive Summary

The Government of Canada has called for a "progressive trade agenda" for Canada. A common view holds that the liberalization of international trade in recent decades has harmed the economic prospects of middle-class workers in Western countries like Canada. The Government's progressive trade agenda is meant to respond to these concerns – to ensure that trade contributes to broad-based prosperity and that public sentiment does not turn against free and open trade. The objective of this report is to contribute to the development of this agenda by measuring the impact on Canadian employment of a recent shock to Canada's import supply: the rapid rise of China as a manufacturing export superpower in the late 1990s and early 2000s.

The report is structured as follows. Following an introduction in Section I, Section II summarizes recent trends in Canadian trade and employment data. In Section III, three empirical approaches are successively described and their results presented. Section IV concludes.

Trade and Employment in Canada: Recent Trends

- China accounted for 1.7 percent of Canada's imports in 1992, and by 2000 China's share had grown only to 3.2 percent. But by 2015 China had become Canada's second-largest trading partner after the United States, accounting for 12.3 percent of Canada's total imports and 13.8 percent of Canada's manufacturing imports.

- The exposure of Canadian manufacturing to import competition increased over the 1992-2015 period. The import penetration ratio (i.e. the ratio of imports to total domestic absorption) rose by 18.8 percentage points from 45.7 per cent in 1992 to 64.5 per cent in 2015. Of this 18.8 percentage-point increase in import penetration, 8.1 percentage points (or 43 per cent of the total increase) were attributable to rising imports from China.

- Canada's imports from China grew faster than Canada's exports to China both before and after 2000. Canada's bilateral trade deficit with China increased $188 million (or 0.03 per cent of GDP) in 1992 to $45.5 billion (or 2.3 per cent of GDP) in 2015.

- Total employment in Canada increased by 1.5 per cent per year over the 1992-2015 period. The employment rate increased by 3.0 percentage points over the same period. Employment growth has been markedly slower since 2008 relative to before, however, and the employment rate in 2015 was down 1.9 percentage points from 2008.

- Manufacturing employment grew at a robust 2.7 per cent per year over the 1992-2000 period, but then fell at annual rates of 1.9 and 1.7 per cent over the periods 2000-2008 and 2008-2015, respectively. Altogether, Canadian manufacturing shed 533,000 jobs over the 2000-2015 period.

Empirical Approach

The employment impact of rising Chinese import competition is investigated using three sets of estimates: 1) the direct effect of increased import competition on industry-level employment; 2) the indirect effects on industry-level employment arising through input-output linkages; and 3) the combined impact of direct effects, labour reallocation and aggregate demand effects operating within local labour markets. To isolate the impact of rising Chinese exporting capacity (as opposed to increased Canadian import demand), an instrumental variable strategy is applied whereby Chinese import penetration in a set of other advanced economies is used as an instrument for Chinese import penetration in Canada.

Results

The key results of the report are as follows:

- The direct effect of rising Chinese import competition in Canadian manufacturing was a net loss of 105 thousand manufacturing jobs over the 2001-2011 period. This amounts to 21 per cent of the actual observed decline in manufacturing employment over that period (508 thousand jobs).

- By comparison, past research for the United States found that rising Chinese import competition accounted for 10 per cent of U.S. manufacturing employment losses over a similar time period. The difference is due to the fact that Canadian industries experienced a larger increase in Chinese import exposure than American industries did over the 2001-2011 period.

- Data constraints imposed limits on the quality of evidence we could generate in the second step of the analysis. In our view, the results suggest that the employment effect of indirect import exposure through input-output linkages is modest. Relative to the direct effect, accounting for input-output linkages adds about 13 thousand additional job losses over the 2001-2011 period.

- Accounting for labour reallocation and aggregate demand effects within local labour markets yields somewhat larger employment effects; the total decline in employment over the 2001-2011 period attributable to the rise of Chinese import competition is on the order of 150 to 170 thousand jobs. The China shock led to substantial employment losses in the industries most exposed to Chinese import competition (i.e. manufacturing), with these losses partly offset by employment gains in non-exposed non-tradable industries.

This is by no means a comprehensive assessment of the welfare impact of international trade, or of trade with China in particular, on Canadians. Rising Chinese import competition led to a non-negligible reduction in employment in Canada. That cost must be set against the

benefits to Canadian consumers in terms of lower prices and increased product variety, expanded export opportunities for Canadian firms, and the productivity gains associated with enhanced foreign competition. (Not to mention the incredible increase in the living standards of workers in China who not long ago were quite poor.) A progressive trade agenda should seek to take advantage of the gains from trade while helping those who suffer economic dislocation to adjust.

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"[What] is going on is the middle class in western industrial societies … has begun to fear very profoundly that the two great economic transformations of our time—globalization and the technology revolution—may have been good for a narrow elite … but that they haven't been good for most people. …

And you know what? The people who feel that, who have this sort of inchoate anger, who say, 'You know, it's not working for me,' they're not wrong."

Chrystia Freeland, former Minister of International Trade
Montreal, Quebec, June 15, 2016

I. Introduction

The Government of Canada has called for a "progressive trade agenda" for Canada. A common view holds that the liberalization of international trade in recent decades has harmed the economic prospects of middle-class workers in Western countries like Canada. This view was expressed by Chrystia Freeland, then Canada's Minister of International Trade and now Minister of Foreign Affairs, in the quotation that begins this report. The Government's progressive trade agenda is meant to respond to these concerns – to ensure that trade contributes to broad-based prosperity and that public sentiment does not turn against free and open trade. The implications of these principles for trade policy have yet to be made precise.

The development of the progressive trade agenda requires an empirical, quantitative assessment of the impact international trade has had on Canadian labour market outcomes in recent decades. The objective of this report is to contribute to this assessment by measuring the impact on Canadian labour markets of a recent shock to Canada's import supply: the rapid rise of China as a manufacturing export superpower in the late 1990s and early 2000s. China accounted for 1.7 percent of Canada's imports in 1992, and by 2000 China's share had grown only to 3.2 percent. But China's exporting capacity exploded after 2001. By 2015 China had become Canada's second-largest trading partner after the United States, accounting for 12.3 percent of Canada's total imports and 13.8 percent of Canada's manufacturing imports. Over the same period 2000-2015, Canadian manufacturing employment declined by 23.7 percent, amounting to 533,000 lost jobs.

[1] This report was written by CSLS economist Alexander Murray under the supervision of CSLS Executive Director Andrew Sharpe. The Centre for the Study of Living Standards would like to thank Global Affairs Canada for financial support for this research. Earlier versions of the report were presented at the annual meeting of the Canadian Economics Association held at Saint Francis Xavier University Antigonish, Nova Scotia May 31-June 2, 2017 and at the Second OECD Global Forum on Productivity held in Budapest, Hungary June 26-27, 2017. The author would like to thank Phil Leonard and officials at Global Affairs Canada, especially Aaron Sydor for comments. Email: alexander.murray@canada.ca.

Correlation does not imply causation, so more careful analysis is required to assess the impact of Chinese import competition on Canadian employment. Following Acemoglu *et al*. (2016), we use an instrumental variables approach to estimate the causal impact of China's export rise on Canadian employment. Our main finding is that the direct effect of rising Chinese import penetration in Canadian manufacturing was a net loss of 105 thousand manufacturing jobs over the 2001-2011 period. This amounts to 21 per cent of the actual observed decline in manufacturing employment over that period (508 thousand jobs). Data limitations constrain our ability to precisely measure the indirect effects that work via input-output linkages across industries, but our analysis suggests that these indirect import exposure effects add modestly to the total Canadian job losses arising from increased Chinese import competition. Labour reallocation and aggregate demand effects operating within local labour markets prove more important. After accounting for those effects, our main estimates suggest net job losses on the order of 150 to 170 thousand over 2001-2011.

This report's focus on imports from China is not motivated by any special interest in China as such. Rather, the rapidity of China's rise as a global export supplier and the fact that its rise was plausibly driven by factors internal to China mean that China provides a clean 'natural experiment' with which to study the impact of import competition on employment.

This analysis does not constitute a comprehensive assessment of the impact of international trade, or of trade with China in particular, on welfare in Canada. The employment impact of import competition represents one of many implications for Canada of rising trade with China. Other effects include lower prices for Canadian consumers (Francis, 2007; Morel, 2007), higher prices for oil and other primary commodities exported by Canada (Roache, 2012), and hence an improvement in Canada's terms of trade since 2001 (Wilkins, 2016). The opening of the Chinese market also provides new opportunities for Canadian exporters. More broadly, international competition is known to enhance productivity both by reallocating market share from less productive firms to more productive ones and by leading exporters to invest in within-firm productivity improvement (Lileeva, 2008; Baldwin and Yan, 2017a and 2017b). We do not address any of these dimensions of the impact of trade with China in this report.

The narrow scope of our analysis does not diminish the importance of our results from the perspective of economic inclusiveness. Economic inclusiveness requires that all people be able to participate in and benefit from a society's economic activity.[2] Employment is the key means by which most people participate in the economy and partake in the gains from economic growth, so labour market outcomes are a fundamental determinant of the inclusiveness of growth (Sawhill, 2017). Even if rising trade with China has on balance been beneficial for Canada, the loss of employment opportunities in certain sectors may represent a net loss for a segment of workers tied to those sectors. A progressive trade agenda should take those losses into account and seek ways to ameliorate them. The first step in that process is to quantify the losses.

[2] In a recent and influential line of research, the OECD (2014) defines *inclusive growth* as "economic growth that creates opportunity for all segments of the population and distributes the dividends of increased prosperity, both in monetary and non-monetary terms, fairly across society." See Murray (2016) for an application of this notion of inclusiveness in the context of innovation in Canada.

The remainder of the report is structured as follows. In the remainder of this introductory section, we briefly review existing evidence on trade and labour markets. In Section II, we summarize recent trends in Canadian trade and employment data. In Section III, three empirical approaches are successively described and their results presented. Section IV concludes.

Related Literature

There is a large empirical literature on the effects of international trade on labour market outcomes such as employment or the wage distribution. In general, empirical research in the 1980s and 1990s found little evidence that international trade openness was a significant driver of employment outcomes or the wage distribution in advanced economies.[3] More recent research has focused on the effects of increased trade with developing countries, especially China. This research suggests that trade has become a more important factor than past evidence had suggested, and that labour markets are slower to adjust to the dislocations associated with trade shocks than had previously been thought.

Our work fits into a recent line of research by David Autor and coauthors on the labour market impact of the 'China shock,' the rapid increase in China's exports in the 2000s.[4] In these studies, variation in Chinese import exposure across local labour markets in the United States is used to assess the impact of the 'China shock' on employment, wages, and other outcomes. A local labour market's import exposure is an employment-weighted average of industry-level Chinese import penetration measures for industries located in that local labour market. To establish causality, the authors develop an instrumental variable strategy whereby the rise of Chinese imports by other advanced economies is used as an instrument for the rise of Chinese imports by the United States.

The key findings from this set of studies are that the rise of Chinese import competition had large disemployment effects in U.S. regions concentrated in manufacturing industries, and that offsetting employment gains in other industries in these regions have not materialized. On the contrary, the manufacturing employment declines caused by Chinese import competition have been associated with increases in unemployment and labour force nonparticipation within the same local labour markets. The local labour markets more exposed to Chinese import competition also exhibit larger reductions in average wages, concentrated mainly among workers in the bottom 40 per cent of the initial wage distribution (Chetverikov *et al*., 2015). Using longitudinal data on individual workers, Autor *et al*. (2014) find that workers who worked in industries more exposed to Chinese import competition accumulated significantly lower earnings over the 1991-2007 period than otherwise comparable workers who worked in non-exposed industries. The studies find little evidence of migration across local labour markets in response to job loss (Autor *et al*., 2013).

In the study most directly related to ours, Acemoglu *et al*. (2016) estimate that the rise of Chinese import competition led to U.S. job losses of between 2.0 and 2.4 million over the 1999-2011 period. Their method exploits both industry variation and geographic variation in import

[3] See Autor *et al*. (2016) and Harrison *et al*. (2011) for overviews of this research.
[4] See Autor *et al*. (2013a; 2013b; 2014; 2015; and 2016).

exposure, and they use the instrumental variable strategy described above. For our analysis in this report, we adopt the empirical strategy developed by Acemoglu *et al*. The approach is described in detail in Section III below, so we say no more about it here.

This literature has shed new light on the U.S. labour market's ability to adjust to large trade shocks. On the basis of the older empirical evidence, most economists had believed that the labour markets of advanced economies were sufficiently flexible that workers displaced in import-competing industries could easily reallocate to other industries or regions. The recent research by Autor and his coauthors suggests that, at least in the United States, the labour market adjustment to the rise of China has not been so easy.

Of course, the literature on the impact of trade on labour market outcomes extends well beyond the work of Autor and his coauthors. Hakobyan and McLaren (2016) study the effect of NAFTA on U.S. wages using a local labour market approach similar to that of Autor, and they find that NAFTA substantially reduced wages for blue collar workers in localities more exposed to Mexican import competition. Pierce and Schott (2016) find that the accession of China to the World Trade Organization (WTO) in late 2001 led to employment losses in the United States at the industry level, and induced U.S. production plants to adopt less labour-intensive production plans. Helpman (2016) provides a review of research on globalization and wage inequality.

The rise of Chinese manufacturing imports has been accompanied by a corresponding increase in Chinese demand for energy and raw materials. This point is of particular importance to Canada, but it has received little attention in the empirical literature on the labour market impact of China's rise. Once exception is Costa *et al*. (2016), who study the effect of China's growth on outcomes in local labour markets in Brazil. They find that, over the 2000-2010 period, Brazilian localities more exposed to Chinese manufacturing import competition exhibited slower growth of manufacturing wages. Over the same period, however, localities exposed to rising Chinese commodity demand exhibited faster wage growth. Analysis along these lines for Canada should be a priority for future research.

Most of the literature cited above pertains to the United States. On Canada, the recent research literature is thin. An older literature focused on Canada-U.S. trade liberalization.[5] It found that liberalization was followed by employment losses in industries that lost tariff protection, and that these losses were concentrated among production workers (i.e. unskilled labour). Evidence on the impact on wages is mixed. Only a few studies have focused on the labour market implications of the recent increase in Canada's trade with developing economies.[6] To our knowledge, this report represents the first attempt to measure the causal impact of the 'China shock' on Canadian employment using an instrumental variables strategy.

[5] See Gaston and Trefler (1997), Baldwin and Rafiquzzaman (1999), Beaulieu (2000), Lemieux (2005), Trefler (2004), and Townsend (2007).
[6] See Breau and Rigby (2010), Annabi et al. (2013), and Acharya (2015).

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

	All Industries			Manufacturing			Manufacturing Share of Imports	
	China	Total All Countries	China Share (per cent)	China	Total All Countries	China Share (per cent)	China	Total All Countries
1992	2,453	148,018	1.7	2,381	131,142	1.8	97.1	88.6
1993	3,098	169,953	1.8	3,003	151,345	2.0	96.9	89.1
1994	3,856	202,736	1.9	3,732	182,392	2.0	96.8	90.0
1995	4,639	225,553	2.1	4,527	202,379	2.2	97.6	89.7
1996	4,931	232,566	2.1	4,781	206,421	2.3	97.0	88.8
1997	6,341	272,946	2.3	6,211	243,801	2.5	97.9	89.3
1998	7,651	298,386	2.6	7,498	270,876	2.8	98.0	90.8
1999	8,951	320,409	2.8	8,798	292,732	3.0	98.3	91.4
2000	11,294	356,992	3.2	11,130	321,144	3.5	98.5	90.0
2001	12,724	343,111	3.7	12,523	306,308	4.1	98.4	89.3
2002	16,004	348,957	4.6	15,773	313,571	5.0	98.6	89.9
2003	18,583	336,141	5.5	18,314	298,519	6.1	98.6	88.8
2004	24,104	355,886	6.8	23,788	314,050	7.6	98.7	88.2
2005	29,516	380,858	7.7	29,169	330,624	8.8	98.8	86.8
2006	34,508	397,044	8.7	34,178	343,982	9.9	99.0	86.6
2007	38,331	407,301	9.4	37,963	350,185	10.8	99.0	86.0
2008	42,628	433,999	9.8	42,252	360,983	11.7	99.1	83.2
2009	39,661	365,359	10.9	39,287	310,980	12.6	99.1	85.1
2010	44,524	403,701	11.0	44,113	340,931	12.9	99.1	84.5
2011	48,188	446,666	10.8	47,713	372,759	12.8	99.0	83.5
2012	50,723	462,072	11.0	50,250	389,058	12.9	99.1	84.2
2013	52,737	475,661	11.1	52,239	404,078	12.9	99.1	85.0
2014	58,660	512,084	11.5	58,129	439,978	13.2	99.1	85.9
2015	65,650	535,604	12.3	65,077	471,212	13.8	99.1	88.0

Growth Rates:	Percent per year		Percentage-point change	Percent per year		Percentage-point change	Percentage-point change	
1992-2015	15.4	5.8	10.6	15.5	5.7	12.0	2.1	-0.6
1992-2000	21.0	11.6	1.5	21.3	11.8	1.7	1.5	1.4
2000-2008	18.1	2.5	6.7	18.1	1.5	8.2	0.6	-6.8
2008-2015	6.4	3.1	2.4	6.4	3.9	2.1	0.0	4.8
2001-2011	14.2	2.7	7.1	14.3	2.0	8.7	0.6	-5.8

Source: Innovation, Science and Economic Development Canada, Trade Data Online.

II. Trade and Employment in Canada: Recent Trends

In this section, we review recent trends in Canadian trade and employment data. We first discuss trends over the 1992-2015 period at the aggregate level and for the overall manufacturing sector. We then discuss trends at two lower levels of aggregation – the four-digit industry level and the local labour market level – because our econometric analysis will exploit variation at these levels of aggregation. When we discuss trends at the industry level and in local labour markets across Canada, we narrow our focus to the 2001-2011 period. That is the period during which most of the increase in Canada's imports from China occurred, and it is the focus of our main econometric findings later in this report.

A. Aggregate Trends

i. Trade

Table 1 summarizes Canada's imports from China and from all trade partners over the 1992-2015 period.[7] Canada imported goods and services valued at $535.6 billion in 2015 (in current dollars), up 5.8 per cent per year from $148.0 billion in 1992. Canada's imports from China amounted to $65.7 billion, an increase of 15.4 per cent per year from $2.5 billion in 1992. Over the 1992-2015 period, China's share of Canada's total imports increased from 1.7 per cent to 12.3 per cent.

Most of the increase in China's share of Canadian imports occurred after 2000 (Chart 1). Growth of Chinese imports slowed somewhat after 2000; the growth rate declined from 21.0 per cent per year over the 1992-2000 period to 18.1 per cent per year over the 2000-2008 period. But growth of Canada's total imports slowed by much more, so that China's share increased faster after 2000 than before.[8]

[7] The year 1992 is the first year for which detailed industry-level trade data are available for Canada.

[8] China entered the World Trade Organization (WTO) at the end of 2001. See Ostry (2001) for a discussion of that process and some of the legal and administrative challenges it posed. Pierce and Schott (2016) find that the change in the treatment of China under U.S. trade policy following China's WTO accession reduced U.S. manufacturing employment over the 2000s.

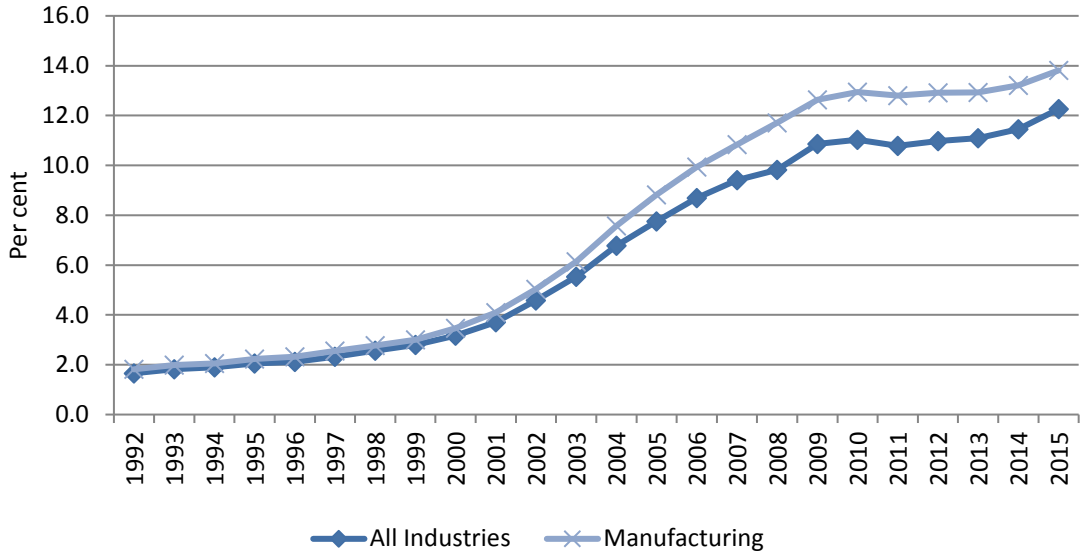
Table 2: Canada's Exports to China and to All Trade Partners, All Industries and Manufacturing, Millions of Current Canadian Dollars, 1992-2015

	All Industries			Manufacturing			Manufacturing Share of Exports	
	China	Total All Countries	China Share (per cent)	China	Total All Countries	China Share (per cent)	China	Total All Countries
1992	2,265	162,828	1.4	853	124,948	0.7	37.6	76.7
1993	1,681	187,515	0.9	1,052	148,475	0.7	62.6	79.2
1994	2,303	225,679	1.0	1,384	178,973	0.8	60.1	79.3
1995	3,465	262,267	1.3	1,748	210,976	0.8	50.4	80.4
1996	3,015	275,819	1.1	1,575	218,845	0.7	52.3	79.3
1997	2,407	298,072	0.8	1,510	236,454	0.6	62.7	79.3
1998	2,497	318,444	0.8	1,306	256,352	0.5	52.3	80.5
1999	2,664	355,420	0.7	1,664	286,798	0.6	62.5	80.7
2000	3,698	413,215	0.9	2,421	319,267	0.8	65.5	77.3
2001	4,264	404,085	1.1	2,906	306,168	0.9	68.2	75.8
2002	4,132	396,381	1.0	3,257	305,371	1.1	78.8	77.0
2003	4,809	381,071	1.3	3,808	286,213	1.3	79.2	75.1
2004	6,770	412,290	1.6	4,821	309,561	1.6	71.2	75.1
2005	7,214	436,351	1.7	4,959	314,751	1.6	68.7	72.1
2006	7,802	440,365	1.8	5,639	316,091	1.8	72.3	71.8
2007	9,512	450,321	2.1	6,774	317,592	2.1	71.2	70.5
2008	10,468	483,488	2.2	6,614	301,994	2.2	63.2	62.5
2009	11,151	359,754	3.1	6,052	234,969	2.6	54.3	65.3
2010	13,232	398,838	3.3	7,980	259,542	3.1	60.3	65.1
2011	16,810	446,688	3.8	9,475	279,319	3.4	56.4	62.5
2012	19,366	455,150	4.3	9,734	288,867	3.4	50.3	63.5
2013	20,492	471,940	4.3	10,587	293,377	3.6	51.7	62.2
2014	19,339	525,019	3.7	10,636	318,179	3.3	55.0	60.6
2015	20,172	523,972	3.8	11,621	349,148	3.3	57.6	66.6

Growth Rates:	Percent per year		Percentage-point change	Percent per year		Percentage-point change	Percentage-point change	
1992-2015	10.0	5.2	2.5	12.0	4.6	2.6	20.0	-10.1
1992-2000	6.3	12.3	-0.5	13.9	12.4	0.1	27.8	0.5
2000-2008	13.9	2.0	1.3	13.4	-0.7	1.4	-2.3	-14.8
2008-2015	9.8	1.2	1.7	8.4	2.1	1.1	-5.6	4.2
2001-2011	14.7	1.0	2.7	12.5	-0.9	2.4	-11.8	-13.2

Source: Innovation, Science and Economic Development Canada, Trade Data Online.

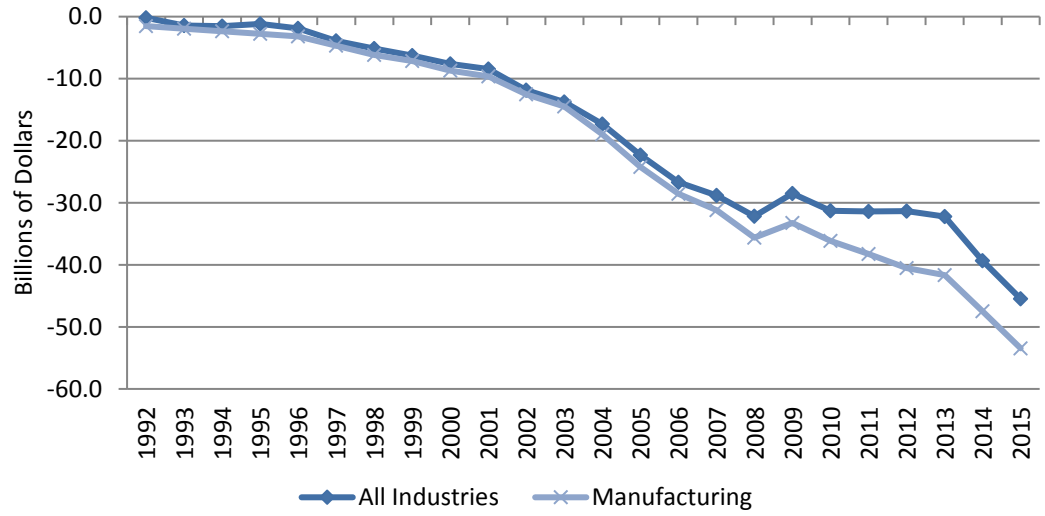
Chart 1: China's Share of Canadian Imports, All Industries and Manufacturing, Per Cent, 1992-2015



Source: Table 1.

Focusing on trade in manufactured goods does not substantially alter these trends. This is no surprise since manufactured goods accounted for 88.0 per cent of Canada's total imports in 2015 and for 87.6 per cent of total imports on average over the 1992-2015 period. Canada's imports from China are dominated by manufactured products to an even greater extent. Manufactured goods accounted for 99.1 per cent of Canada's Chinese imports in 2015 and for 98.4 per cent of Chinese imports on average over the 1992-2015 period.

Chart 2: Canada's Trade Balance with China (Exports less Imports), All Industries and Manufacturing, Billions of Current Canadian Dollars, 1992-2015



Source: Tables 1 and 2.

Table 2 summarizes Canada's exports to China and to all trade partners over the 1992-2015 period. Canada's total exports in 2015 amounted to $524.0 billion, up by 5.2 per cent per year from $162.8 billion in 1992. Canada's exports to China were valued at $20.2 billion in 2015, an increase of 10.0 per cent per year from $2.3 billion in 1992. Over the 1992-2015 period, China's share of Canadian exports increased from 1.4 per cent to 3.8 per cent. This 2.5 percentage-point increase was far smaller than the 10.6 percentage-point increase in China's share of Canadian imports (Table 1).

The entire increase in China's share of Canadian exports occurred after 2000. Indeed, between 1992 and 2000, China's share declined from 1.4 per cent to 0.9 per cent. Growth in Canadian exports to China accelerated after 2000 even as Canada's overall export growth slowed.

It is noteworthy that, following China's entry into the World Trade Organization (WTO) in 2001, growth of Canada's Chinese imports slowed slightly while growth of Canada's exports to China increased. This provides suggestive evidence that the policy changes associated with China's entry into the WTO may have, on the margin, expanded business opportunities for Canadian exporters to China more than for Chinese exporters to Canada. This question warrants further research.

In any case, Canada's imports from China grew faster than Canada's exports to China both before and after 2000. Canada's bilateral trade deficit with China (i.e. imports less exports) increased from $188 million (or 0.03 per cent of GDP) in 1992 to $45.5 billion (or 2.3 per cent of GDP) in 2015 (Chart 2).

The industry composition of Canada's exports, both to China and to all trade partners, is less concentrated in manufacturing than was the case for imports. In 2015, manufactured goods accounted for 66.6 per cent of Canada's total exports and for 57.6 per cent of Canada's exports to China.

One common measure of the exposure of an industry to import competition is the import penetration ratio, the ratio of imports to total domestic absorption in that industry.[9] Table 3 presents measures of domestic absorption and import penetration for Canada's manufacturing sector. The exposure of Canadian manufacturing to import competition increased over the 1992-2015 period. The import penetration ratio rose by 18.8 percentage points from 45.7 per cent in 1992 to 64.5 per cent in 2015. Of this 18.8 percentage-point increase in import penetration, 8.1 percentage points (or 43 per cent of the total increase) were attributable to rising imports from China. Much of the increase in import competition from China relative to other import sources occurred during the 2000-2008 period, which covers the period from the entry of China into the WTO in late 2001 to the slowdown in global trade associated with the global recession of 2008 and 2009. Over that period, import penetration from China increased by 4.5 percentage points while overall import penetration fell by 1.6 percentage points.

[9] Total domestic absorption is equal to total shipments plus imports less exports. The import penetration ratio is a measure of competition for the domestic market in an industry.

Table 3: Total Shipments, Total Domestic Absorption, and Import Penetration, Manufacturing, Canada, 1992-2015

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

Source: CANSIM Table 304-0014 and Innovation, Science and Economic Development Canada, Trade Data Online.
Notes: Total shipments, net exports and total domestic absorption are in millions of current dollars and cover Canada's manufacturing sector (NAICS industries 31-33).
Total domestic absorption = Total shipments - net exports.
Import penetration ratio = 100 x Imports/Absorption.

ii. Employment

Table 4 summarizes trends in Canadian employment, in all industries and in manufacturing, over the 1992-2015 period. Total employment increased by 1.5 per cent per year over the 1992-2015 period. This was slightly faster than the 1.3 per cent annual growth of the working-age population, so that the employment rate increased by 2.9 percentage points over the period. Employment growth has been markedly slower since 2008 relative to before, however, and the employment rate in 2015 was down 2.1 percentage points from 2008.

Within the manufacturing sector, employment declined by 0.3 per cent per year over the 1992-2015 period. There was substantial variation in the trend between sub-periods. Manufacturing employment grew at a robust 2.7 per cent per year over the 1992-2000 period, but then fell at annual rates of 1.9 and 1.7 per cent over the periods 2000-2008 and 2008-2015, respectively. As shown earlier, the 2000-2008 period was a time of rapid growth in Chinese import penetration in Canadian manufacturing.

It is well known that manufacturing employment has been declining as a share of total employment.[10] Over the 1992-2015 period, manufacturing's employment share fell from 14.2 per cent to 9.5 per cent. Of this 4.7 percentage-point decline, 3.9 points (or 82 per cent of the total decline) occurred between 2000 and 2008.

The figures in Table 4 are from the Labour Force Survey, but in our econometric analysis we will use employment estimates derived from census data. Table 5 summarizes the levels and growth rates of employment in the census years 1991, 2001 and 2011 as derived from both the Labour Force Survey (Panel A) and the censuses (Panel B). The two sets of data reveal broadly similar patterns. Total employment growth was similar in the 1991-2001 and 2001-2011 periods, while manufacturing employment growth was positive in the earlier period and turned strongly negative in the latter. The census estimates of employment are consistently somewhat lower than the LFS estimates, especially in manufacturing.

[10] For recent analysis of this trend, see Capeluck (2015a; 2015b) and Calver and Capeluck (2016).

Table 4: Employment Levels and Rates, All Industries and Manufacturing, Canada, 1992-2015

	Population Aged 15+	Employment		Employment Rates		Manufacturing Share of Employment
		All Industries	Manufacturing	All Industries	Manufacturing	
1992	21,820	12,731	1,815	58.3	8.3	14.3
1993	22,093	12,793	1,779	57.9	8.1	13.9
1994	22,368	13,059	1,823	58.4	8.2	14.0
1995	22,660	13,295	1,904	58.7	8.4	14.3
1996	22,960	13,420	1,925	58.5	8.4	14.3
1997	23,247	13,708	2,021	59.0	8.7	14.7
1998	23,516	14,047	2,103	59.7	8.9	15.0
1999	23,782	14,402	2,188	60.6	9.2	15.2
2000	24,090	14,760	2,242	61.3	9.3	15.2
2001	24,419	14,932	2,222	61.1	9.1	14.9
2002	24,769	15,291	2,289	61.7	9.2	15.0
2003	25,080	15,661	2,277	62.4	9.1	14.5
2004	25,408	15,915	2,297	62.6	9.0	14.4
2005	25,755	16,124	2,203	62.6	8.6	13.7
2006	26,116	16,396	2,102	62.8	8.0	12.8
2007	26,462	16,769	2,026	63.4	7.7	12.1
2008	26,824	17,010	1,927	63.4	7.2	11.3
2009	27,203	16,728	1,745	61.5	6.4	10.4
2010	27,574	16,964	1,711	61.5	6.2	10.1
2011	27,913	17,221	1,722	61.7	6.2	10.0
2012	28,283	17,438	1,747	61.7	6.2	10.0
2013	28,647	17,691	1,723	61.8	6.0	9.7
2014	28,981	17,802	1,711	61.4	5.9	9.6
2015	29,280	17,947	1,713	61.3	5.8	9.5

Growth Rates:	Percent per year			Percentage-point change		
1992-2015	1.3	1.5	-0.3	2.9	-2.5	-4.7
1992-2000	1.2	1.9	2.7	2.9	1.0	0.9
2000-2008	1.4	1.8	-1.9	2.1	-2.1	-3.9
2008-2015	1.3	0.8	-1.7	-2.1	-1.3	-1.8
2001-2011	1.3	1.4	-2.5	0.5	-2.9	-4.9

Notes: Population and employment levels are in thousands of persons. Rates are in per cent.
Source: Statistics Canada, Labour Force Survey (CANSIM Table 282-0001).

Table 5: Employment Levels and Rates in Manufacturing and in All Industries, Labour Force Survey and Census, 1991, 2001 and 2011

	Population Aged 15+	Employment		Employment Rates		Manufacturing Share of Employment
		All Industries	Manufacturing	All Industries	Manufacturing	
Panel A: Labour Force Survey						
1991	21,533	12,857	1,890	59.7	8.8	14.7
2001	24,419	14,932	2,222	61.1	9.1	14.9
2011	27,913	17,221	1,722	61.7	6.2	10.0
	Compound Annual Growth (Per Cent)			Annual Percentage-Point Change		
1991-2001	1.27	1.51	1.63	0.14	0.03	0.02
2001-2011	1.35	1.44	-2.52	0.05	-0.29	-0.49
Panel B: Census						
	Population Aged 15+	Employment		Employment Rates		Manufacturing Share of Employment
		All Industries	Manufacturing	All Industries	Manufacturing	
1991	21,604	13,006	1,860	60.2	8.6	14.3
2001	24,282	14,695	2,033	60.5	8.4	12.1
2011	27,869	16,595	1,525	59.5	5.5	11.3
	Compound Annual Growth (Per Cent)			Annual Percentage-Point Change		
1991-2001	1.18	1.23	0.90	0.03	-0.02	-0.22
2001-2011	1.39	1.22	-2.83	-0.10	-0.29	-0.08

Notes: Data in Panel A are from Statistics Canada, CANSIM Table 282-0001. Data in Panel B are calculated from the 1991 and 2001 Censuses and the 2011 National Household Survey. Employment estimates from the Labour Force Survey are annual averages of monthly estimates, while estimates from the Census pertain to a reference week in May or June of the year indicated. Employment and population levels are in thousands of persons. Rates are in per cent.

B. Industry-level Trends

i. Chinese import exposure

At the industry level, we summarize changes in exposure to Chinese import competition using a modified version of the import penetration ratio discussed earlier. For industry j, we measure $\Delta IE_{j,t}$, the change in Chinese import exposure over time period t, as

$$\Delta IE_{j,t} = \frac{\Delta M_{j,t}^{CC}}{Y_{j,92} + M_{j,92} - X_{j,92}} \quad (1)$$

The numerator, $\Delta M_{j,t}^{CC}$, is the change in Canadian imports from China in industry j over time period t. The denominator is domestic absorption in industry j in 1992, the base year of our analysis. Normalizing by initial domestic absorption means that time variation in import

exposure comes only from changes in Chinese imports and is not affected by other factors that may have influenced domestic market size during the period of China's rise. Both the numerator and denominator of (1) are measured in chained 2007 Canadian dollars, deflated by the household consumption expenditure deflator.

We compute this import exposure measure for 85 four-digit NAICS manufacturing industries. Table 6 displays the industries with the five largest and five smallest changes in

Table 6: Changes in the Chinese Import Penetration Ratio for Selected NAICS Manufacturing Industries, 2001-2011

Annual percentage-point change, 2001-2011:	
Five largest:	
NAICS 3341 - Computer and Peripheral Equipment Manufacturing	7.0
NAICS 3169 - Other Leather and Allied Product Manufacturing	6.6
NAICS 3343 - Audio and Video Equipment Manufacturing	5.4
NAICS 3151 - Clothing Knitting Mills	5.2
NAICS 3342 - Communications Equipment Manufacturing	4.9
Five smallest:	
NAICS 3274 - Lime and Gypsum Product Manufacturing	0.0
NAICS 3311 - Iron and Steel Mills and Ferro-Alloy Manufacturing	0.0
NAICS 3131 - Fibre, Yarn and Thread Mills	-0.1
NAICS 3333 - Commercial and Service Industry Machinery Manufacturing	-0.1
NAICS 3132 - Fabric Mills	-0.1
Notes: Figures are the author's calculations based on data in Appendix Tables 1-4. Nominal values were deflated to chained 2007 dollars using the implicit deflator for household consumption expenditure from CANSIM Table 380-0064. The total number of manufacturing industries in the dataset is 85.	

Chinese import exposure over the 2001-2011 period. The top five include three information and communications technology (ICT) manufacturing industries: computer and peripheral equipment; audio and video equipment; and communications equipment. Also included in the top five are two textile manufacturing industries: other leather and allied products; and clothing knitting mills.

No industries exhibited large declines in Chinese import exposure over the period; the five smallest changes were close to zero.

ii. Employment

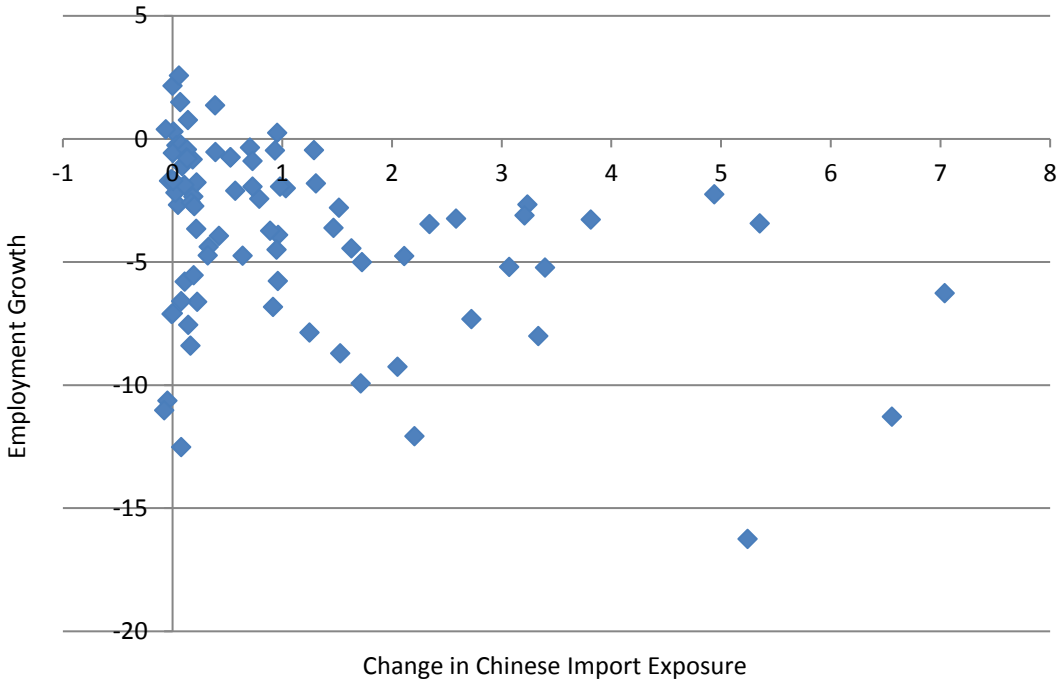
Table 7 shows the manufacturing industries with the five largest and five smallest annual rates of employment growth over the 2001-2011 period, based on census data.The petroleum and coal products manufacturing industry exhibited the fastest employment growth over the period, at 2.6 per cent per year, followed by dairy product manufacturing (2.2 per cent per year).

As the bottom panel of the table reveals, some industries exhibited very large negative employment growth rates over the 2001-2011 period. All five of the manufacturing industries with the largest declines in employment were textile industries. The largest decline was in clothing knitting mills; in that industry, employment growth was -16.2 per cent per year.

Table 7: Employment Growth for Selected NAICS Manufacturing Industries, 2001-2011

Annual per cent change, 2001-2011:	
Five largest:	
NAICS 3241 - Petroleum and Coal Products Manufacturing	2.6
NAICS 3115 - Dairy Product Manufacturing	2.2
NAICS 3273 - Cement and Concrete Product Manufacturing	1.5
NAICS 3331 - Agricultural, Construction and Mining Machinery Manufacturing	1.4
NAICS 3254 - Pharmaceutical and Medicine Manufacturing	0.8
Five smallest:	
NAICS 3132 - Fabric Mills	-11.0
NAICS 3169 - Other Leather and Allied Product Manufacturing	-11.3
NAICS 3152 - Cut and Sew Clothing Manufacturing	-12.1
NAICS 3161 - Leather and Hide Tanning and Finishing	-12.5
NAICS 3151 - Clothing Knitting Mills	-16.2
Notes: Figures are the author's calculations based on data from the 2001 Census and the 2011 National Household Survey. Growth rates are calculated using log differences. The total number of manufacturing industries in the dataset is 85.	

Chart 3: Employment Growth and the Change in Chinese Import Exposure, 4-Digit NAICS Manufacturing Industries, 2001-2011



Comparing Table 7 with Table 6 reveals some overlap between the industries with the largest increases in Chinese import exposure and those with the smallest increases (i.e. the largest declines) in employment. Two industries appear on both lists: other leather and allied product manufacturing and clothing knitting mills.

To provide a more complete picture of the bivariate relationship between employment growth and the change in Chinese import exposure across manufacturing industries, we plot the two variables against one another in Chart 3. A negative correlation is evident. Industries with positive (or only slightly negative) employment growth over the period tended to experience little increase in Chinese import exposure, while industries with large increases in Chinese import exposure tended to exhibit large declines in employment.

While only manufacturing industries are directly exposed to a non-negligible degree of Chinese import competition, our econometric analysis will explore spillover effects of Chinese import competition on employment in non-manufacturing industries. Table 8 displays the industries with the largest and smallest employment growth rates over the 2001-2011 period among all industries, not just manufacturing industries.[11]

[11] This table is based on the input-output industry classification (IOIC). The IOIC is based on NAICS but differs in its treatment of some forms of economic activity, particularly in construction and in the non-profit sector. Our econometric analysis of spillovers to non-manufacturing industries uses input-output data, and that is why we use IOIC industries rather than NAICS industries when we look beyond manufacturing.

Table 8: Employment Growth for Selected IOIC Industries, 2001-2011

Annual per cent change, 2001-2011:	
Five largest:	
IOIC 2111 - Oil and Gas Extraction	5.8
IOIC 2131 - Support Activities for Mining and Oil and Gas Extraction	5.6
IOIC GS21 - Universities	4.3
IOIC 4930 - Warehousing and Storage	4.0
IOIC 611A - Educational Services (Except Universities)	3.7
Five smallest:	
IOIC 3252 - Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments	-6.6
IOIC 3122 - Tobacco Manufacturing	-7.1
IOIC 31A0 - Textile and Textile Product Mills	-8.4
IOIC 3160 - Leather and Allied Product Manufacturing	-9.2
IOIC 3150 - Clothing Manufacturing	-12.2

Notes:
Figures are the author's calculations based on data from the 2001 Census and the 2011 National Household Survey. Employment estimates by four-digit NAICS industry were transformed into estimates by four-digit IOIC industry using a mapping described in Trau (2005). Growth rates are calculated using log differences. The total number of industries in the dataset is 86.

The bottom panel is consistent with Table 7; the industries that exhibited the largest declines in employment over the 2001-2011 period were manufacturing industries, mostly in the clothing and textiles sectors.

The top panel of Table 8 is quite different from that of Table 7, which reflects the fact that none of the industries that exhibited fast employment growth over the 2001-2011 period are manufacturing industries. The two fastest-growing industries are in the oil and gas extraction sector; employment grew by 5.8 per cent per year in oil and gas extraction and by 5.6 per cent per year in support activities for mining and oil and gas extraction. Two of the next three highest employment growth rates were in the education sector: 4.3 per cent per year in universities and 3.7 per cent per year in education services (except universities).

C. Trends within Local Labour Markets

Part of our econometric analysis will exploit variation in Chinese import exposure and employment growth across local labour markets. In related research for the United States, Autor *et al*. (2013a) measure local labour markets as commuting zones, regions defined by strong commuting ties within regions and weak commuting ties across regions. For our purposes, we identify the local labour market concept with the census metropolitan area (CMA) and census agglomeration (CA) as defined by Statistics Canada. This is a suitable choice since Statistics Canada defines the boundaries of CMAs and CAs in part on the basis of commuting flows (Statistics Canada, 2011). Our dataset includes the 129 localities present in all three census years (1991, 2001 and 2011). In 2011, CMAs and CAs contained 82 per cent of Canada's population aged 15 and over.

i. Chinese import exposure

We measure the change in a locality's Chinese import exposure as an employment-weighted average of industry-level exposure changes. Formally, we measure $\Delta IE^{L}_{l,t}$, the change in the Chinese import exposure of locality l over time period t, as

$$\Delta IE^{L}_{l,t} = \sum_{j} \frac{L_{l,j,t}}{L_{l,t}} \Delta IE_{j,t} \qquad (2)$$

where $\Delta IE_{j,t}$ is the change in Chinese import exposure of industry j as defined in equation (1), and $\frac{L_{l,j,t}}{L_{l,t}}$ is the share of industry j in total employment in locality l at the beginning of time period t.

There has been substantial regional variation in changes in Chinese import exposure over the 2001-2011 period (Table 9). The localities that exhibited the largest increases in Chinese import exposure over the period were all located in Quebec or Ontario. Of the ten localities that exhibited the smallest increases in Chinese import exposure, six are located in Western Canada and two in the Atlantic region. This pattern reflects the relative concentration of economic activity in Quebec and Ontario in manufacturing industries, while other regions specialize in commodities industries less exposed to Chinese import competition. No locality experienced a decrease in import exposure over the 2001-2011 period.

ii. Employment

Following Acemoglu *et al*. (2016), we measure employment change within local labour markets using annual percentage-point changes in employment rates rather than per cent annual employment growth rates as in the earlier industry-level analysis. This is to account for local population changes over time as a result of migration between local labour markets (possibly in response to trade shocks).

Regional variation in employment rate changes over the 2001-2011 period is a mirror image of the regional variation in Chinese import exposure changes (Table 10). Among the ten localities with the smallest changes (i.e. the largest declines) in the employment rate, seven are in Quebec or Ontario. Among the ten localities with the largest employment rate increases over the period, there are four Quebec localities but zero from Ontario (the province that contains the most localities by far). Four of the top ten are in Western Canada and two in the Atlantic region.[12]

[12] Readers may be surprised that Cape Breton exhibited the largest employment rate increase of any CMA or CA over the 2001-2011 period. This was driven in part by a large decline in the working-age population of that locality. Between 2001 and 2011, Cape Breton's population aged 15 and over declined by 0.31 per cent per year, from 89,640 to 86,895.

Table 9: Changes in Chinese Import Exposure for Selected Local Labour Markets, 2001-2011

Annual percentage-point change, 2001-2011:	
Ten largest:	
CMA/CA 450 - Granby, Quebec	0.32
CMA/CA 440 - Victoriaville, Quebec	0.32
CMA/CA 454 - Sorel-Tracy, Quebec	0.29
CMA/CA 428 - Saint-Georges, Quebec	0.28
CMA/CA 541 - Kitchener - Cambridge - Waterloo, Ontario	0.27
CMA/CA 553 - Stratford, Ontario	0.27
CMA/CA 512 - Brockville, Ontario	0.26
CMA/CA 550 - Guelph, Ontario	0.25
CMA/CA 465 - Salaberry-de-Valleyfield, Quebec	0.25
CMA/CA 452 - Saint-Hyacinthe, Quebec	0.24
Ten smallest:	
CMA/CA 320 - Fredericton, New Brunswick	0.02
CMA/CA 010 - Grand Falls-Windsor, Newfoundland and Labrador	0.02
CMA/CA 850 - Grande Prairie, Alberta	0.02
CMA/CA 598 - Kenora, Ontario	0.02
CMA/CA 977 - Fort St. John, British Columbia	0.02
CMA/CA 745 - Prince Albert, Saskatchewan	0.02
CMA/CA 411 - Dolbeau-Mistassini, Quebec	0.02
CMA/CA 965 - Terrace, British Columbia	0.01
CMA/CA 845 - Cold Lake, Alberta	0.01
CMA/CA 860 - Wood Buffalo, Alberta	0.01

Notes:
The change in Chinese import exposure by CMA/CA is the employment-weighted average of (national) industry-level changes. At the industry level, the change in Chinese import exposure is equal to 100 times the change in real imports from China between 2001 and 2011, divided by real domestic absorption in that industry in our base year (1992). The employment weights at the CMA/CA level are obtained from the 2001 Census and the 2011 National Household Survey. The total number of CMAs/CAs in the dataset is 129.

Table 10: Changes in Employment Rates for Selected Local Labour Markets, 2001-2011

Annual percentage-point change, 2001-2011:	
Ten largest:	
CMA/CA 225 - Cape Breton, Nova Scotia	0.42
CMA/CA 001 - Saint John's, Newfoundland and Labrador	0.42
CMA/CA 408 - Saguenay, Quebec	0.41
CMA/CA 480 - Val-d'Or, Quebec	0.38
CMA/CA 725 - Saskatoon, Saskatchewan	0.29
CMA/CA 485 - Rouyn-Noranda, Quebec	0.29
CMA/CA 705 - Regina, Saskatchewan	0.25
CMA/CA 421 - Quebec, Quebec	0.25
CMA/CA 915 - Kelowna, British Columbia	0.19
CMA/CA 715 - Moose Jaw, Saskatchewan	0.18
Ten smallest:	
CMA/CA 437 - Cowansville, Quebec	-1.07
CMA/CA 584 - Temiskaming Shores, Ontario	-1.07
CMA/CA 468 - Lachute, Quebec	-1.07
CMA/CA 955 - Prince Rupert, British Columbia	-1.09
CMA/CA 865 - Wetaskiwin, Alberta	-1.11
CMA/CA 546 - Tillsonburg, Ontario	-1.17
CMA/CA 110 - Summerside, Prince Edward Island	-1.17
CMA/CA 528 - Port Hope, Ontario	-1.18
CMA/CA 502 - Hawkesbury, Quebec/Ontario	-1.32
CMA/CA 557 - Leamington, Ontario	-1.32

Notes:
Figures are the author's calculations based on data from the 2001 Census and the 2011 National Household Survey. The total number of CMAs/CAs in the dataset is 129.

Chart 4: Changes in the Employment Rate and in Chinese Import Penetration, CMAs/CAs, 2001-2011

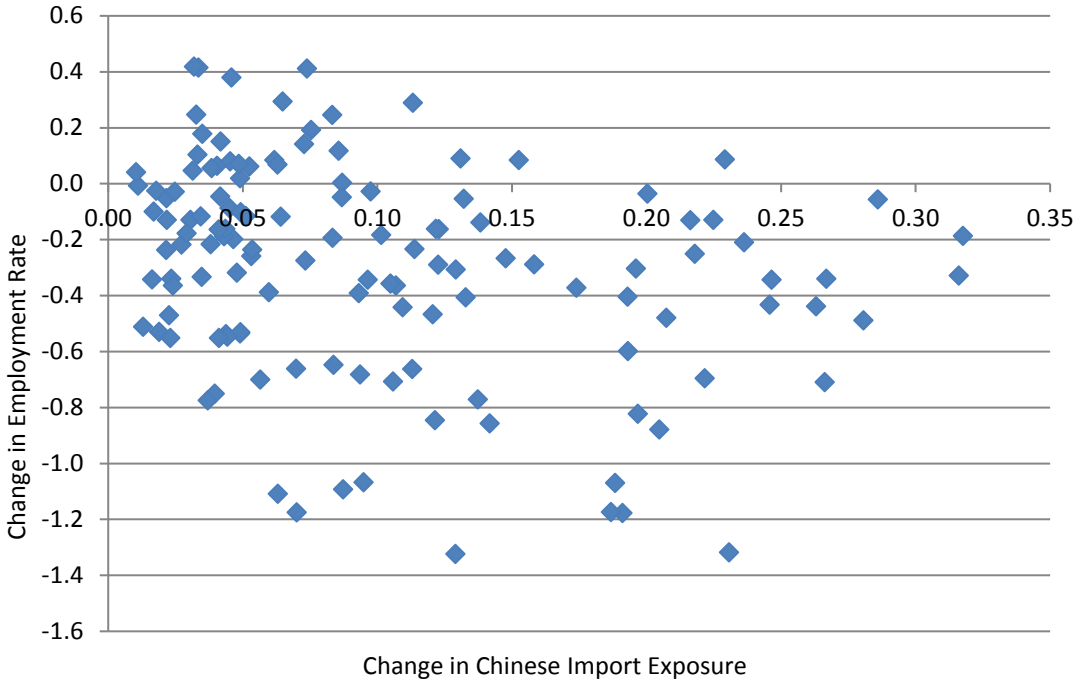


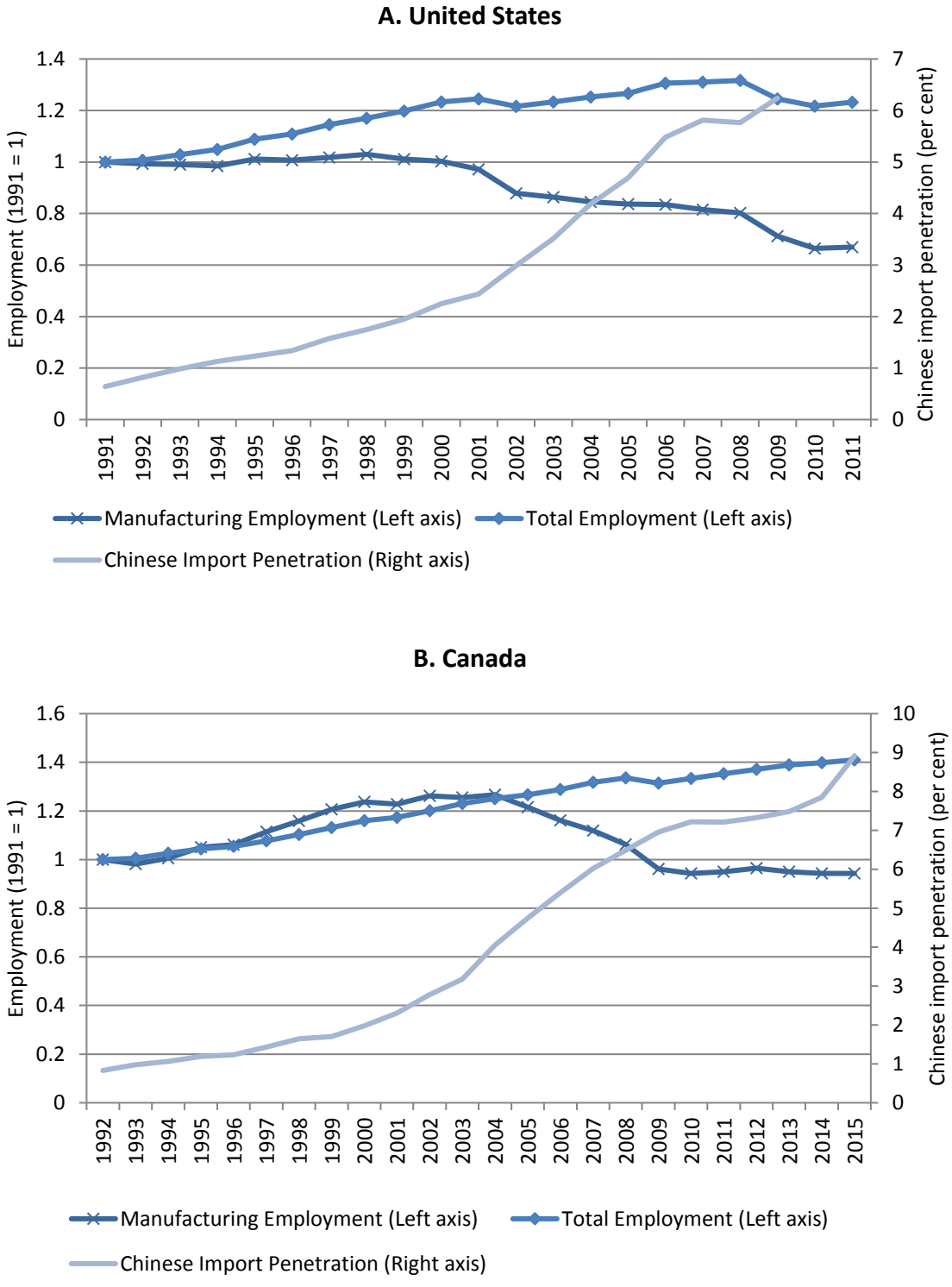
Chart 4 plots the annual change in the employment rate against the annual change in Chinese import exposure for all 129 localities in our dataset. While there is substantial noise in the data, a negative relationship is discernable.[13]

D. Comparison with the United States

The econometric strategy in this report is adapted from the work of Acemoglu *et al*. (2016) on labour market outcomes in the United States. The *prima facie* evidence that motivates the analysis in that paper is the coincident timing of the rise of U.S. imports from China, the decline of U.S. manufacturing employment, and the stagnation of U.S. total employment after the year 2000. Panel A of Chart 5 presents this U.S. evidence. Panel B presents analogous statistics for Canada.

[13] The raw correlation between the two variables is -0.28. A regression of the change in the employment rate against the change in Chinese import exposure and a constant yields a coefficient estimate of -1.38, significant at the one per cent significance level.

Chart 5: Employment and Chinese Import Penetration, United States and Canada



Notes: U.S. data are from Acemoglu *et al*. (2016). Canadian data are from Table 3 and Table 4.

Chart 5 reveals both important similarities and important differences between the two countries. In both countries, the Chinese import penetration ratio was below one per cent in the early 1990s and increased slowly until around 2000, after which year its growth accelerated. Both countries exhibit a downturn in manufacturing employment at about the same time; peak manufacturing employment was in 1998 in the United States and in 2004 in Canada. During the peak-to-peak period 2000-2008, manufacturing employment declined by a cumulative 20.0 per cent in the United States and by 14.1 per cent in Canada. Since 2009, manufacturing employment has stabilized in Canada but has continued to decline in the United States.

One key difference is that manufacturing employment was stagnant over the 1990s in the United States, whereas it grew by a robust 2.7 per cent per year over the 1992-2000 period in Canada. The other difference is the behaviour of total employment. After exhibiting positive growth throughout the 1990s, total employment in the United States stagnated over the 2000s. Acemoglu *et al.* (2016) refer to this as "the great U.S. employment sag of the 2000s."[14] In stark contrast, Canadian total employment continued to grow throughout the 2000s, showing a slight downturn only around the 2008 recession. Evidently, there was no "great Canadian employment sag of the 2000s."

Based on this descriptive evidence, we might expect to find that increased Chinese import competition has reduced Canadian manufacturing employment to some extent, consistent with the Acemoglu *et al*. (2016) results for the United States. On the other hand, we might expect the spillover impact of Chinese manufacturing imports on employment in non-competing Canadian industries (either through input-output linkages or through aggregate demand effects) to be muted relative to the analogous effect in the U.S. context. Acemoglu *et al*. found that the inclusion of input-output spillover effects more than tripled their estimate of job losses relative to the direct effect, and this acted as a major drag on U.S. total employment growth over the 2000s. Our descriptive analysis provides no *prima facie* evidence for such a strong effect of import competition on total employment in Canada (though of course it is possible that such an effect was present over the 2000s and was simply offset by other factors that drove Canada's strong overall employment growth).

Simple descriptive analysis can neither corroborate nor disprove these conjectures. In the next section, we therefore turn to an econometric strategy aimed at identifying the causal impact of rising Chinese import competition on Canadian employment.

III. Effect of Chinese Import Competition on Canadian Employment

Acemoglu *et al*. (2016) develop an econometric method to quantify the impact of Chinese import competition on U.S. employment. The method exploits both industry variation and geographic variation in employment growth and import exposure. An instrumental variables

[14] Acemoglu *et al*. (2016) end their analysis in 2011. U.S. employment grew by a mediocre 0.75 per cent per year over the 2000-2008 period, then fell by 1.27 per cent per year between 2008 and 2011. After 2011, however, U.S. employment growth has improved; it averaged 1.56 per cent per year over the 2011-2015 period. The "employment sag" label applies best to the period 2000-2008, when the U.S. economy was not in recession but employment growth was weak.

approach is used to identify the causal impact of the rapid increase in China's exporting prowess in the 1990s and, especially, the 2000s. The authors' preferred estimates imply that this "China shock" caused net job losses in the range of 2.0 to 2.4 million jobs over the 1999-2011 period in the United States.

We adapt the method of Acemoglu *et al*. (2016) to estimate the impact of the "China shock" on Canadian employment. Three successive sets of estimates are developed: 1) the direct effect of increased import competition on industry-level employment in manufacturing industries; 2) the spillover effects on industry-level employment in manufacturing and non-manufacturing industries arising through input-output linkages; and 3) the combined impact of direct effects, labour reallocation and aggregate demand effects within local labour markets.

This section contains four parts. The first part describes the data sources. The remaining three parts successively present the three sets of estimates described above. In each of these parts, we first lay out the empirical strategy and then present the estimation results.

A. Data

International trade data for Canada are drawn from the Trade Data Online database maintained by Innovation, Science and Economic Development Canada. Trade Data Online provides import and export statistics by detailed NAICS industry. We extracted the nominal values of total imports, total exports, and imports from China for 85 four-digit NAICS manufacturing industries for the 1992-2015 period, the full period for which the data are available.

Construction of the instrumental variable requires data on the Chinese imports of eight other advanced economies by four-digit NAICS industry. To build this dataset, we obtained data on each country's Chinese imports by six-digit HS product code from the UN Comtrade database. We mapped these data into 85 four-digit NAICS manufacturing industries using a procedure based on the crosswalk developed in Pierce and Schott (2012).[15]

The import penetration measures are normalized by the industry's total domestic absorption. Data on total shipments by four-digit NAICS manufacturing industry are drawn from CANSIM Table 304-0014.

We draw measures of employment by four-digit NAICS industry and by industry-by-CMA/CA cell from the 1991 and 2001 censuses and the 2011 National Household Survey.[16] The

[15] There are actually 86 four-digit NAICS manufacturing industries. Our mapping from HS products to NAICS industries mapped no products into NAICS code 3328 (Coating, engraving, cold and heat treating and allied activities). We therefore dropped that industry from the analysis, leaving us with a sample of 85 manufacturing industries. We suspect that our results would not be sensitive to the exclusion of industry 3328; in the Canadian data from Trade Data Online, measured imports in this industry are close to zero (and, for Chinese imports, are missing in several years).

[16] Industry of employment was coded according to the 1980 SIC in the 1991 census. In the 2001 census, both SIC and NAICS codes are available. We used the 2001 census to construct national and locality-specific NAICS-to-SIC crosswalks based on employment shares. We applied these to the 1991 census data to transform SIC-based

census is the only data source sufficiently detailed to allow for our local labour markets analysis.[17]

Information on the input-output structure of the Canadian economy is taken from Statistics Canada's CANSIM Table 381-0009. We use the 1992 input-output table, which provides industries' current-dollar inputs and outputs of 472 commodities. We transform the rectangular industry-by-commodity table into the square industry-by-industry table using the 'industry technology' procedure described in Capeluck (2015b) and Horowitz and Planting (2009).

The input-output accounts use the Input-Output Industry Classification (IOIC), which is based upon but not identical to NAICS. For the part of our analysis that uses input-output information to compute upstream and downstream trade exposure, we collapse our NAICS-based trade and employment growth measures into IOIC-based measures in order to make them commensurable with the input-output data.

In the end, our sample for Step 1 (the estimation of the direct industry-level effect) contains observations for 85 four-digit NAICS manufacturing industries. Our sample for Step 2 (the estimation of the indirect effects that propagate via input-output linkages) contains observations for 86 IOIC industries (42 manufacturing industries and 44 non-manufacturing industries). Our sample for Step 3 (the estimation of direct effects, reallocation effects and aggregate demand effects operating within local labour markets) contains observations for 129 CMAs/CAs; that is, all the CMAs/CAs present in all three census years.

B. Step 1: Industry-level Direct Effect

i. Empirical strategy

The first-step estimate is obtained by running the following regression on industry-level data:

$$\Delta L_{j,t} = \alpha_t + \beta \Delta IE_{j,t} + e_{j,t} \qquad (3)$$

where $\Delta L_{j,t}$ is annual employment growth in manufacturing industry j over time period t and $\Delta IE_{j,t}$ is the change in Chinese import exposure in industry j over time period t, α_t is a period-

employment estimates into NAICS-based employment estimates. This potentially introduces some information from the Canadian economy's 2001 employment structure into our 1991 estimates, but only to the extent that changes in the economy between 1991 and 2001 altered the empirical relationship between SIC categories and NAICS categories. We do not think this is a major concern, and in any event most of our main results are driven by the 2001-2011 period.

[17]The main alternative source of employment statistics would be the Labour Force Survey, but the sample size of that survey does not permit the detailed analysis of employment by CMA/CA and industry that we carry out in this report. Even at the national level, Statistics Canada suppresses estimates of employment for many four-digit NAICS industries. We have nevertheless performed the estimation exercises for steps 1 and 2 of our analysis using LFS-based employment estimates, and the results are broadly consistent with the census-based estimates we report.

specific constant, and $e_{j,t}$ is an error term.[18] The coefficient of interest is β, the marginal impact of import penetration on employment.

Our measure of the change in import exposure$\Delta IE_{j,t}$was defined earlier in equation (1). As a reminder, we repeat it here; it is

$$\Delta IE_{j,t} = \frac{\Delta M_{j,t}^{CC}}{Y_{j,92} + M_{j,92} - X_{j,92}} \tag{4}$$

Here, $\Delta M_{j,t}^{CC}$ denotes the change in Canada's imports from China in industry j over time period t while $Y_{j,92} + M_{j,92} - X_{j,92}$ denotes domestic market absorption in the initial period (in our case, 1992). All nominal values are deflated to chained 2007 Canadian dollars using the PCE deflator, so that the numerator reflects the change in the real value of imports. In equation (4), variation over time within an industry reflects only the change in the real value of imports from China (the numerator), while the domestic market size (the denominator) remains constant at its initial value.[19]

To isolate the impact of rising Chinese exporting capacity (as opposed to other sources of rising imports from China, such as increased Canadian demand), an instrumental variables strategy is applied whereby Chinese import exposure in a set of other advanced economies is used as an instrument for $\Delta IE_{j,t}$. To be precise, we instrument for $\Delta IE_{j,t}$ using

$$\Delta IEO_{j,t} = \frac{\Delta M_{j,t}^{OC}}{Y_{j,92} + M_{j,92} - X_{j,92}} \tag{5}$$

where $\Delta M_{j,t}^{OC}$ is the change in the Chinese imports of eight other advanced economies in industry j over time period t.[20] The total nominal imports of the eight comparison countries are converted

[18] Acemoglu *et al.* (2016) include a vector of industry-level controls in the regression (average wages, pre-1992 employment growth, measures of industry-level technological sophistication and capital intensity, etc.). We include no controls. Due to data constraints, we have substantially fewer observations than Acemoglu *et al*. had for the United States and we want to preserve degrees of freedom. In the U.S. case, Acemoglu *et al*. found that their controls did not affect the main results.

[19] We follow Acemoglu *et al*. (2016) in measuring an industry's exposure to Chinese import competition using an import penetration ratio. This approach captures competition for sales in the domestic Canadian market but ignores the effect of Chinese competition for Canadian sales in third markets. One might question the appropriateness of this approach for a country like Canada, a small open economy that exports a large share of its manufacturing output. How accounting for Chinese competition in Canada's export markets would affect our results is a question we leave for future research. To the extent that our import penetration measure fails as a proxy for total Chinese competition (i.e. inclusive of competition over foreign markets markets), we might expect that our results will understate the impact of China's rise on Canadian employment.

[20] The eight countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland. This is the same set of countries used by Acemoglu *et al.* (2016). They were selected on the basis of data availability in the UN COMTRADE database. We chose not to add the United States to this list. Given the physical proximity and the depth of economic integration between Canada and the United States, as well as the size disparity, we think an instrument based on U.S. data would be unlikely to satisfy the exclusion restriction required for instrumental variables (IV) estimation. For example, import demand shocks in Canada and the United States are probably correlated. See Angrist and Pischke (2009) for an explanation of the technical conditions that justify IV estimation.

from U.S. dollars to Canadian dollars using annual PPPs for personal consumption expenditures from the OECD, then deflated to chained 2007 Canadian dollars using the Canadian PCE deflator.

The key identifying assumption underlying this strategy is that, within industries, the common component of Chinese import growth across advanced economies primarily reflects China's rising exporting capacity (e.g. productivity growth in China's exporting firms). Potential threats to identification include the possibility that import demand shocks are correlated across Canada and the other eight countries or the possibility that adverse Canadian productivity shocks have led buyers both in Canada and in other advanced countries to substitute Chinese goods for Canadian goods. The former would lead us to *underestimate* the impact of the China shock on Canadian employment. We think the latter is unlikely to be a major concern because of Canada's small size relative to the global economy and because China's massive export growth since 2000 appears to be related to technological and policy factors specific to China. Autor *et al.* (2013a) provide further discussion of this point.

We estimate equation (3) by two-stage least squares on a pooled sample of industry-level changes in employment and import exposure over the periods 1991-2001 and 2001-2011.[21] There are 170 observations (85 manufacturing industries for two periods). We measure the changes in employment and import penetration in annualized terms. Observations are weighted by industry employment levels in 1991, so that industries that were initially larger receive greater weight. Standard errors are clustered within 21 three-digit NAICS categories.

Once we have obtained an estimate of the regression coefficient β in equation (3), we can compute an estimate of the direct employment impact of the change in Chinese import competition in Canadian manufacturing industries. Let $\widetilde{\Delta IE_{j,t}}$ denote the portion of the change in Canada's Chinese import exposure in industry j attributable to the Chinese export supply shock. Let $L_{j,t}$ be actual employment in industry j at time t and let $L_{j,t}^{cf}$ be the counterfactual employment level that would have obtained if $\widetilde{\Delta IE_{j,t}}$ had been equal to zero. Then using equation (3), the total direct employment effect of rising Chinese import competition in Canadian manufacturing industries is

$$\begin{aligned} \Delta L_t^{cf} &= \sum_j (L_{j,t} - L_{j,t}^{cf}) \\ &= \sum_j L_{j,t}(1 - e^{-\beta \widetilde{\Delta IE_{j,t}}}) \end{aligned} \tag{6}$$

We measure $\widetilde{\Delta IE_{j,t}}$ as the observed change in Chinese import exposure, $\Delta IE_{j,t}$, multiplied by the partial R-squared from the first-stage regression of $\Delta IE_{j,t}$ on the instrument $\Delta IEO_{j,t}$. In our regression results, that partial R-squared is equal to 0.57.

[21] Data on Chinese imports by industry are available from 1992 onward, so the measure of the change in import competition is defined for the periods 1992-2001 and 2001-2011. We do not view this as problematic since all changes are measured in annualized terms and Chinese imports were small in the early 1990s.

ii. Results

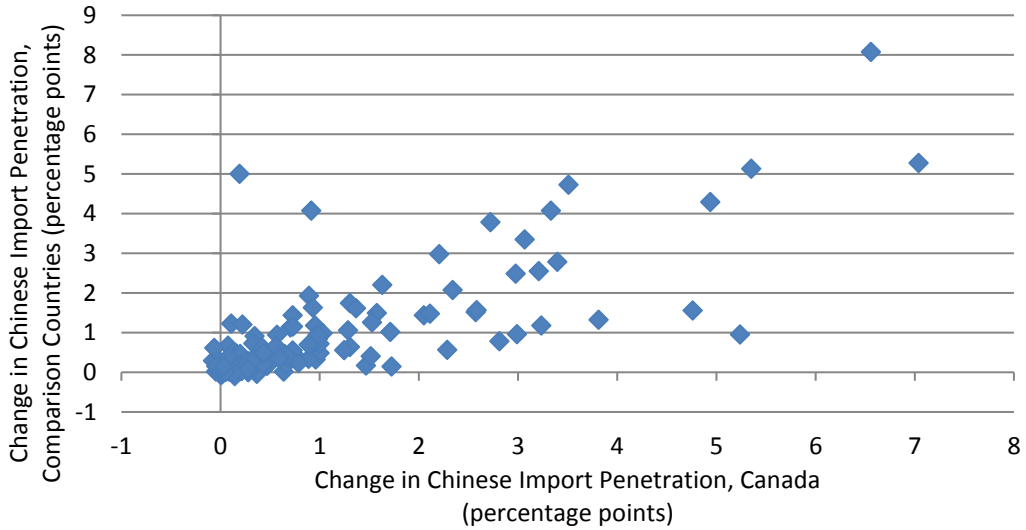
Data summary

Table 11 presents summary statistics for the three key variables used in the estimation of equation (1). The distributions of the Chinese import penetration ratio in Canada and in the comparison countries are quite similar, both over the 1991-2011 period and within the two sub-periods 1991-2001 and 2001-2011. The distribution of import penetration ratio changes is skewed to the right; most industries exhibited small annual increases in import penetration (i.e. below one percentage point per year), while a small subset of the industries showed very large increases. In both Canada and the comparison countries, Chinese import penetration increased faster in the average manufacturing industry after 2001 relative to before.

Chart 6 plots $\Delta IE_{j,t}$ against $\Delta IEO_{j,t}$ by four-digit NAICS manufacturing industry, where the changes are measured over the periods 1991-2001 and 2001-2011. The strong positive relationship between the key variable of interest $\Delta IE_{j,t}$ and its instrument $\Delta IEO_{j,t}$ is evident in the scatter plot. The employment-weighted correlation between the two variables is 0.77.

The dependent variable in equation (3) is annual employment growth by industry. Across four-digit NAICS manufacturing industries, employment growth averaged -1.27 per cent per

Chart 6: Change in Chinese Import Exposure in Canada and in Comparison Countries, Percentage Points per Year, 1991-2001 and 2001-2011



Note: There are 170 points on this chart: 85 changes over the 1991-2001 period and 85 changes over the 2001-2011 period.

Table 11: Summary Statistics on Changes in Employment and in Chinese Import Exposure by 4-Digit NAICS Manufacturing Industry

		1991-2011					1991-2001		2001-2011	
	No. of Obs.	Mean	SD	Median	Min	Max	Mean	SD	Mean	SD
Annual Δ in Chinese import exposure	85	0.67	0.96	0.22	-0.006	5.20	0.38	0.70	0.9	1.31
Instrument for annual Δ in Chinese import exposure	85	0.63	0.90	0.24	0.001	6.59	0.33	0.56	0.87	1.26
Annual growth rate of employment	85	-1.27	2.21	-0.75	-7.69	2.50	0.91	2.38	-3.44	3.45

Notes:
The annual change in Chinese import exposure is 100 x the average annual absolute change in Canadian imports from China over the period indicated, divided by the total Canadian market volume (i.e. total shipments plus imports less exports) in that industry in 1992.
The instrument is 100 x the average annual absolute change in imports from China in a set of eight comparator countries over the period indicated, divided by 9.8 x the total Canadian market volume (i.e. total shipments plus imports less exports) in that industry in 1992. (9.8 is the ratio of the eight countries' combined GDP to that of Canada in 1992 at PPP.) The comparator countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain and Switzerland.
The trade values for the instrument were converted from US dollars to Canadian dollars using OECD annual PCE-based PPPs. Then all trade values (for Canada and the comparator countries) and market absorption measures were deflated to 2007 chained Canadian dollars using the PCE deflator.
Employment changes are average annual per cent changes based on data from the 1991 and 2011 census and the 2011 National Household Survey.
Observations are weighted by industry-level employment in 1991.

year over the 1991-2011 period. The reversal of manufacturing employment growth in the 2000s is evident here; average employment growth was 0.91 per cent per year over the 1991-2001 period, then fell to -3.44 per cent per year over 2001-2011 period.[22]

Estimation results

We estimate several regressions based on equation (3). The results are presented in Table 12. Columns (1) and (2) provide a baseline for the analysis. Column (1) excludes the Chinese import exposure variable; the coefficients on the time indicators reflect the mean growth rates of employment over the two periods, as displayed in Table 11. In column (2), the Chinese import exposure variable is added but the instrumental variable is not used. The coefficient estimate on Chinese import exposure is negative; a larger increase in Chinese import penetration is associated with lower employment growth in an industry. The estimate is statistically significant, though only at the ten per cent significance level.

The negative and significant OLS estimate in column (2) is consistent with the view that rising Chinese import competition has reduced employment growth in Canadian manufacturing industries, but correlation does not establish causation. As noted earlier, we need to isolate the impact of rising Chinese exporting capacity (as opposed to increased Canadian import demand). Thus, we estimate the regression by two-stage least squares (2SLS), using the change in Chinese import exposure in the eight comparison countries as an instrument for the change in Chinese import exposure in Canada.

Column (3) presents the 2SLS estimates. The coefficient estimate on the import penetration variable is -1.36, substantially larger in absolute value than the OLS estimate, and it is statistically significant at the five per cent level. This estimate implies that if the annual change in an industry's exposure to Chinese import competition rises by one percentage point, annual employment growth in that industry is reduced by 1.36 percentage points.

The remaining columns of Table 12 present estimates of the relationship between employment growth and Chinese import exposure for the 1991-2001 and 2001-2011 sub-periods separately. We detect a significant impact of rising import competition on employment growth only in the latter period. These results should be interpreted with caution, since they are based on only 85 observations. Nevertheless, it is reassuring that the 2SLS estimate for 2001-2011 (in column 7) is -1.48, not so different from the main estimate from column (3). These results suggest that our main estimate in column (3) is driven mainly by the 2001-2011 data. We showed earlier that most of the increase in Chinese import penetration in Canadian industries occurred after 2001.

[22] The difference between the manufacturing employment growth rate for 2001-2011 given here and the one reported in Table 5 is attributable to the fact that the observations underlying the summary statistics in Table 11 are weighted by employment levels in 1991.

Table 12: Effect of Import Exposure on Employment in Canadian Manufacturing Industries: OLS and 2SLS Estimates

	Stacked Differences			Separated by Sub-period			
	1991-2001 and 2001-2011			1991-2001	1991-2001	2001-2011	2001-2011
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Annual Δ in Chinese import exposure	--	-0.82* (0.48)	-1.36** (0.68)	-0.01 (0.41)	-0.74 (0.54)	-1.05* (0.58)	-1.48** (0.75)
$\mathbb{1}${1991-2001}	0.91** (0.43)	1.23*** (0.42)	1.43*** (0.47)	--	--	--	--
$\mathbb{1}${2001-2011}	-3.44*** (0.71)	-2.70*** (0.57)	-2.22*** (0.61)	--	--	--	--
Constant	--	--	--	0.92* (0.46)	1.20** (0.48)	-2.49*** (0.61)	-2.10*** (0.64)
Number of Observations	170	170	170	85	85	85	85
Estimation Method	OLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
First-stage F Statistic	--	--	48.0	--	12.8	--	46.9

Notes:
In all specifications, the dependent variable is the average annual growth rate of employment by industry over the specified period. Standard errors are in parentheses. Standard errors are clustered on 21 three-digit industry groups. Observations are weighted by industry employment in 1991.
*** p < .01
** p < .05
* p < .10

Analysis of results

Using the coefficient estimate in column (3) of Table 12 together with equation (6), 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. That estimate is presented in the first row of Table 13. According to our estimates, direct Chinese import competition led to a net loss of 169.5 thousand manufacturing jobs in Canada over the 1991-2011 period. This total includes 64.3 thousand lost jobs over 1991-2001 and 105.2 thousand over 2001-2011.

One way to contextualize these estimates is to compare them with the actual employment changes that occurred over the 1991-2011 period and within the two sub-periods. The first row of Table 14 provides this information. Between 1991 and 2011, manufacturing employment in Canada declined by 334.3 thousand jobs. Over the same period, our estimates imply that rising import competition led to a loss of 169.5 thousand jobs. This means that rising import competition from China accounts for 50.7 per cent of the overall decline in manufacturing employment between 1991 and 2011; if the increase in Chinese import competition had not occurred (and all other factors in the economy somehow remained unchanged), the decline in manufacturing employment over the period would have been 164.8 thousand instead of 334.3 thousand.

The direct effect of rising import exposure reduced manufacturing employment in both sub-periods. Total manufacturing employment nevertheless increased by 173.5 thousand over the 1991-2001 period; absent the employment losses associated with rising Chinese import competition, the gain in manufacturing jobs over the period would have been 237.8 thousand, or 37.1 per cent larger.

Over the 2001-2011 period, by contrast, manufacturing employment declined by 507.8 thousand jobs. Our estimates imply that the direct effect of rising import competition accounted for 105.2 thousand of these job losses, or 20.7 per cent of the total decline.

Further context is provided by comparing our results with the results obtained by Acemoglu *et al.* (2016) for the United States. Those authors found that U.S. manufacturing employment declined by 5.8 million over the 1999-2011 period and that rising Chinese import competition reduced manufacturing employment by 560 thousand over the same period. Thus, the increase in Chinese import competition accounted for 9.7 per cent of the total decline.

At 20.7 per cent, our estimate of the proportional impact of rising Chinese import competition on Canadian manufacturing employment over the 2001-2011 period is twice as large as the Acemoglu *et al*. estimate of 9.7 per cent for the United States over the 1999-2011 period. The main explanation for this difference is that the increase in Chinese import exposure over the period was larger in Canada than in the United States; the mean annual percentage-point increase in Chinese import penetration was 0.90 percentage points in Canadian manufacturing industries (Table 11), compared to 0.50 percentage points in the United States (Table 1 in Acemoglu *et al*., 2016). A secondary part of the explanation is that our estimate of the marginal impact of Chinese import exposure on employment growth in Canada (-1.36, from Table 12) is slightly larger in

Table 13: Implied Employment Changes Induced by Changes in Exposure to Chinese Import Competition

				Implied Employment Effect (x1,000)		
Regression Specification	**Unit of Analysis**	**Description**	**Affected Sector(s)**	1991-2001	2001-2011	1991-2011
Table 12, column 3	Industry (NAICS)	Direct effect of import exposure	Manufacturing	-64.3	-105.2	-169.5
Table 16, column 2	Industry (IOIC)	Direct effect of import exposure	Manufacturing	-72.5	-118.6	-191.1
Table 16, column 5	Industry (IOIC)	Direct and first-order upstream effects of import exposure	Total	-71.5	-131.3	-202.8
--	Industry (IOIC)	Direct and first-order upstream effects of import exposure	Manufacturing	-60.2	-100.9	-161.1
Table 18, column 2	Locality (CMA/CA)	Direct, labour reallocation and local demand effects of import exposure	Total	-59.4	-169.1	-228.6
Table 18, column 4	Locality (CMA/CA)	Direct, labour reallocation and local demand effects of import exposure	Total	-55.7	-153.6	-209.3
			Exposed	-92.6	-255.4	-347.9
			Non-exposed tradable	-18.3	-50.7	-69.0
			Non-exposed non-tradable	55.3	152.4	207.7

Table 14: Actual and Counterfactual Employment Changes, Thousands of Jobs, 1991-2011

		1991-2001		2001-2011		1991-2011	
Description	**Affected Sector(s)**	**Actual Employment Change**	**Counterfactual Employment Change**	**Actual Employment Change**	**Counterfactual Employment Change**	**Actual Employment Change**	**Counterfactual Employment Change**
Direct effect of import exposure	Manufacturing (NAICS)	173.5	237.8	-507.8	-402.6	-334.3	-164.8
Direct effect of import exposure	Manufacturing (IOIC)	173.5	246.0	-507.8	-389.2	-334.3	-143.2
Direct and first-order upstream effects of import exposure	Total	1,689.6	1,761.2	1,899.9	2,031.2	3,589.5	3,792.4
Direct and first-order upstream effects of import exposure	Manufacturing	173.5	233.7	-507.8	-406.9	-334.3	-173.2
Direct, labour reallocation and local demand effects of import exposure by CMA/CA and sector	Total	1,678.6	1,738.0	1,764.2	1,933.3	3,442.8	3,671.3
Direct, labour reallocation and local demand effects of import exposure by CMA/CA and sector	Total	1,678.6	1,734.3	1,764.2	1,917.8	3,442.8	3,652.1
	Exposed	216.7	309.3	-344.3	-88.9	-127.6	220.3
	Non-exposed traded	-12.2	6.1	21.6	72.3	9.4	78.4
	Non-exposed non-traded	1,474.1	1,418.9	2,086.8	1,934.4	3,561.0	3,353.3

magnitude than their estimate for the United States (-1.30, from their Table 2). Via equation (6), these factors contribute to the result that rising Chinese import competition accounts for a larger share of the total manufacturing employment decline in Canada than in the United States.[23]

The key message of our results is that rising import competition from China has had a substantial negative impact on manufacturing employment in Canada. This is especially true after 2001, when China's expansion into global markets for manufactured goods accelerated. Other factors that had buttressed Canadian manufacturing employment in the 1990s ceased to do so in the 2000s; by our estimates, Canada would have lost 402.6 thousand manufacturing jobs after 2001 even without the rise of import competition from China. Moreover, Canada experienced robust employment growth over the 2000s outside of manufacturing. Nevertheless, import competition appears to be a substantial part of the explanation of the decline of Canadian manufacturing employment.

Two caveats are worth noting with respect to the analysis above. First, we assumed that the marginal impact of import competition on employment growth was the same in the 1991-2001 period as in the 2001-2011 period (based on column 3 of Table 12). Columns 5 and 7 of Table 12 suggest that rising import competition negatively affected employment growth only in the 2001-2011 period; the relevant coefficient estimate for the 1991-2001 period (in column 5) was not statistically significantly different from zero. Thus, a more conservative estimate of the net loss of manufacturing jobs over the 1991-2011 period would be around 105.2 thousand, our estimate for the 2001-2011 period.[24]

The second caveat is that the 2001-2011 period encompasses the global recession of 2008-2009 and the beginning of the subsequent recovery. That recession led to a significant disruption of global trade and to substantial employment losses in Canada. In unreported regressions based on employment estimates from the Labour Force Survey, we estimated equation (3) on a pooled sample of changes over the 1991-2001 and 2001-2007 periods (so that our time period excludes the Great Recession and its effects). The coefficient estimate on Chinese import exposure remains statistically significant and negative but is somewhat smaller in magnitude.[25] If we repeat the calculation in equation (6) using those alternative coefficient estimates, we obtain estimated employment effects of -32.2 thousand jobs over the 1991-2001 period and -51.4 thousand over the 2001-2011 period, for a total of 83.6 thousand lost manufacturing jobs. While these numbers are not directly comparable to our main results (since they are based on data from a different source), the possible sensitivity of our regression

[23] Equation (6) reveals a third potential explanation: the estimated share of the increase in Chinese import penetration that is attributable to China's rising exporting capacity (i.e. the partial R-squared from the first-stage of the 2SLS regression). However, our estimate of that share (0.57) is essentially the same as the share used by Acemoglu *et al*. for the United States (0.56).

[24] Note that the coefficient estimates in columns 3 and 7 of Table 12 are quantitatively similar. Recalculating the implied manufacturing employment reduction based on column 7 would therefore yield close to the same number – about 105 thousand – that we obtained by applying the coefficient in column 3 to the 2001-2011 period.

[25] The coefficient estimate is -0.76 and significant at the 5 per cent significance level. As in our main results, estimation by sub-period finds statistical significance only in the second period, 2001-2007. The coefficient estimate for 2001-2007 is -0.70 (significant at the 5 per cent level), similar to the estimate of -0.76 based on stacked changes over 1991-2001 and 2001-2007.

estimates to the choice of the end date (i.e. 2007 or 2011) means that our results should be interpreted with caution.[26]

That being said, it is not obvious that the 2008-2009 recession and its aftermath should be excluded from the analysis. It could be the case that industry-level employment is more sensitive to trade competition during recessions than during booms, so that we would miss an important component of the employment cost of rising import competition if we excluded the recession. This is known to be true of other economic forces that are analytically similar to international trade. Job losses due to the automation of routine tasks, for example, are concentrated in recessions even though the underlying technological progress is not so concentrated (Jaimovich and Siu, 2015). If firms face fixed adjustment costs associated with shutting down, adopting a new technology, or moving production to a new location, it may be optimal for them to wait until a recession before doing so (Foote, 1998).

C. Step 2: Industry-level Indirect Effect via Input-Output Linkages

i. Empirical strategy

Equation (3) captures the direct effect of Chinese import competition on employment within the manufacturing industry facing that competition. Additional employment effects (in both manufacturing and non-manufacturing industries) may arise due to input-output relationships between industries.

A given industry is indirectly exposed to import competition in other industries via 'upstream' and 'downstream' effects:

- **Upstream effect:** an industry's exposure to the import competition faced by the industries that buy its output.

- **Downstream effect:** an industry's exposure to the import competition faced by the industries from which it buys inputs.

For example, an increase in automobile imports would be part of the upstream effect on auto parts manufacturers, since the automobile manufacturing industry is a buyer of the output of the auto parts manufacturing industry. Everything else being equal, if car imports cause a decline in activity in domestic auto manufacturing, demand for domestically-produced auto parts may decline and lead to job losses in the auto parts industry.

On the other hand, an increase in auto parts imports would be part of the downstream effect on automobile manufacturers, since the automobile manufacturing industry buys inputs from the auto parts manufacturing industry. We might expect this effect to be less important than the upstream effect; even if imports lead to a decline in domestic auto parts manufacturing, the automobile manufacturers can presumably replace those lost inputs with the newly available imports.

[26] This issue could also be addressed using data from the 2006 census. We leave this extension for future work.

To estimate these indirect effects, we combine the industry-level import exposure measure $\Delta IE_{j,t}$ with input-output data to construct industry-level measures of upstream and downstream Chinese import exposure. Let $\hat{m}_{i,j}$ be the share of industry i's gross output that is purchased as an input by industry j. Then the first-order upstream exposure of industry i is given by

$$\Delta IE_{i,t}^{U,1} = \sum_{j} \hat{m}_{i,j} \Delta IE_{j,t} \tag{7}$$

Similarly, let $\tilde{m}_{i,j}$ denote industry j's purchases of inputs from industry i as a share of industry j gross output. Then the first-order downstream exposure of industry i is given by

$$\Delta IE_{i,t}^{D,1} = \sum_{j} \tilde{m}_{i,j} \Delta IE_{j,t} \tag{8}$$

So $\Delta IE_{i,t}^{U,1}$ is a weighted average of trade exposure changes faced by industry i's buyers, where the weights are the shares of industry i's output purchased by those buyers. $\Delta IE_{i,t}^{D,1}$is a weighted average of trade exposure changes faced by industry i's suppliers, where the weights are the shares of those suppliers' gross outputs purchased by industry i.

These first-order measures ignore the higher-order upstream and downstream effects emanating from the import exposure faced by an industry's buyers' buyers, its buyers' buyers' buyers, its suppliers' suppliers, and so on. The full upstream and downstream import exposures are given by

$$\Delta IE_{t}^{U} = (I - \hat{M})^{-1} \Delta IE_{t} \tag{9}$$

$$\Delta IE_{t}^{D} = (I - \tilde{M})^{-1} \Delta IE_{t} \tag{10}$$

where ΔIE_t is the vector of direct Chinese import exposure changes for all industries, ΔIE_t^U and ΔIE_t^D the vectors of upstream and downstream effects, I is the identity matrix, and $\hat{M}$ (or $\tilde{M}$) is the matrix with $\hat{m}_{i,j}$ (or $\tilde{m}_{i,j}$) in the i^{th} row and j^{th} column.[27]

To measure the employment impact of upstream and downstream import competition, we replace the change in direct import exposure $\Delta IE_{j,t}$ in equation (3) with the upstream or

[27] We measure direct import penetration only for manufacturing industries, but the upstream and downstream measures are computed for manufacturing and non-manufacturing industries. To make the vectors and matrices in equations (9) and (10) conformable, we add zeros to the direct import exposure vector ΔIE_t in positions that correspond to non-manufacturing industries. Thus, we assume that only manufacturing industries experienced increases in direct import competition from China over our sample period. The data presented in Table 1 earlier suggest that this is not a problematic assumption; almost all of Canada's imports from China are manufacturing imports.

downstream measures computed using (7) and (8) (for first-order effects) or (9) and (10) (for the full effects).[28]

As in Step 1, we employ an instrumental variables strategy to identify the causal impact of rising Chinese export supply on Canadian employment. To construct instruments for ΔIE_t^U and ΔIE_t^D, we simply replace ΔIE_t with ΔIEO_t in (9) and (10), where ΔIEO_t is the vector of Chinese import exposure measures in other advanced economies defined in equation (5).

The only other change relative to Step 1 is that we include period-by-sector dummies in the regression rather than just period dummies. By 'sector' we mean manufacturing or non-manufacturing.

Once the regression coefficients are obtained, the effect on Canadian employment can be obtained using (6) as before with only slight modification.

ii. Results

Data summary

Table 15 presents summary statistics for the key variables used to estimate the indirect effect of import competition on employment through input-output linkages across industries. An important change relative to industry-level direct effect is that we have collapsed four-digit NAICS industries to four-digit IOIC industries, as discussed earlier. This was necessary in order to combine the input-output data with the employment data.

To test the importance of this change, we re-estimate the direct industry-level effect of import competition on employment using the IOIC-based data and compare the results to those we obtained using the NAICS-based data. The first two columns of Table 16 contain those results. It is reassuring that the coefficient estimate in column (2), -1.54, is statistically significant (though only at the ten per cent level) and similar to the main estimate from column (3) of Table 12 (which was -1.36). The implied number of manufacturing jobs lost is given in the second row of Table 13. The total number over the 1991-2011 period is 191.1 thousand, somewhat larger than the NAICS-based estimate of 169.5 thousand but not dramatically different. Thus, the switch from NAICS-based to IOIC-based definitions (and the associated reduction in the number of manufacturing industries from 85 to 42) appear not to have cost us much information.

Estimation results

In Panel B of Table 16, we augment equation (3) with measures of the first-order upstream and downstream import exposure measures defined in equations (7) and (8). It turns

[28] The measures computed using equations (9) and (10) include the direct import competition faced by manufacturing industries as well as the upstream and downstream effects faced by all industries. In some specifications, we subtract the change in direct import exposure from these measures and include the direct, upstream and downstream import exposure measures separately in the regression equation.

Table 15: Summary Statistics on Changes in Employment, in Direct Chinese Import Competition, and in Indirect Upstream and Downstream Chinese Import Competition by 4-Digit IOIC Industry

		1991-2011					1991-2001		2001-2011	
	No. of Obs.	Mean	SD	Median	Min	Max	Mean	SD	Mean	SD
Annual Δ in Chinese import exposure										
Direct	42	0.66	0.83	0.36	-0.01	4.35	0.37	0.58	0.89	1.12
Full Upstream	85	0.08	0.25	0.03	0.00	5.03	0.04	0.10	0.12	0.38
Full Downstream	85	0.33	0.46	0.18	0.00	5.01	0.18	0.24	0.44	0.64
Instrument for annual Δ in Chinese import exposure										
Direct	42	0.61	0.79	0.28	0.01	3.25	0.31	0.46	0.84	1.12
Full Upstream	85	0.08	0.21	0.03	0.00	3.76	0.04	0.09	0.11	0.32
Full Downstream	85	0.32	0.44	0.18	0.00	3.75	0.15	0.19	0.45	0.64
Annual growth rate of employment										
Total	85	0.98	1.66	1.03	-6.39	4.33	1.02	2.00	0.93	2.50
Manufacturing	42	-1.20	2.09	-1.08	-6.39	2.50	0.95	2.28	-3.36	3.13
Non-manufacturing	43	1.33	1.27	1.30	-2.58	4.33	1.04	1.97	1.62	1.50

Notes:
The direct import exposure measure and its instrument are the same as described in the notes for Table 11, except they are computed for IOIC industries rather than NAICS industries. The upstream and downstream measures are computed based on the direct measures as described in the main text. Employment changes are average annual per cent changes based on data from the 1991 and 2011 census and the 2011 National Household Survey.
Observations are weighted by industry-level employment in 1991.

Table 16: Effect of Import Exposure on Employment in Canada Incorporating Input-Output Linkages, 1991-2011

	A. Direct Effects		B. First-Order Input-Output Linkages			C. Full (Higher-Order) Input-Output Linkages)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Direct import exposure	-0.99 (0.64)	-1.54* (0.83)	-1.58 (1.13)	-1.55 (1.15)	--	-1.73* (1.05)	-1.70 (1.08)	--
Upstream import exposure	--	--	0.16 (2.27)	-0.09 (2.56)	--	0.42 (1.06)	0.26 (1.24)	--
Downstream import exposure	--	--	--	0.18 (0.52)	--	--	0.11 (0.33)	--
Combined import exposure (direct + upstream)	--	--	--	--	-1.08* (0.61)	--	--	-0.72 (0.44)
Estimation Method	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
First-stage F statistics	--	53.2	48.4 511.7	82.2 1002.5 789.1	85.3	60.2 570.4	87.7 1023.5 1731.1	132.0

Notes:
In all specifications, the dependent variable is the average annual growth rate of employment by industry over the specified period.
Standard errors are in parentheses. Standard errors are clustered on 21 three-digit industry groups. All specifications include period x sector dummies, where 'sector' is either manufacturing or non-manufacturing. The number of observations is 170, and observations are weighted by industry employment in 1991.
* p < 0.1
** p < .05
*** p < .01

out that when these measures are added to the regression, they do not prove to be statistically significant determinants of employment growth. Moreover, the direct import exposure measure loses its statistical significance (columns 3 and 4).

Similar results obtain when we move to the full higher-order upstream and downstream measures defined in equation (9) and (10). These results are presented in Panel C of Table 16. When the upstream exposure variable is added by itself (column 6), it is not statistically significant. Moreover, it reduces the statistical significance of the direct exposure measure (although the magnitude of the coefficient estimate rises relative to the baseline estimate in column 2). When both the upstream and downstream measures are added, all the import exposure measures lose their statistical significance (column 7).

One plausible explanation of these results is that they arise from a collinearity problem. The upstream and downstream import exposure measures may not have much explanatory power for employment growth over and above the direct import competition effect, but they are highly correlated with the direct measure and with each other. The instruments have high degrees of mutual correlation as well. This, together with the fact that our sample size is quite small, can lead to misleading coefficient estimates that are highly sensitive to small changes in model specification. A larger sample size could help to address this problem, but data limitations prevent us from pursuing that solution.

Instead, we estimate versions of the regression in which we include the sum of the direct and upstream effects as a single regressor.[29] This eliminates the collinearity problem at the cost of imposing the assumption that the marginal impact of indirect upstream import exposure is the same as that of direct import exposure. This is a strong econometric restriction, but it is consistent with the theoretical model in the appendix of Acemoglu *et al*. (2016).

The results are presented in column 5 for the first-order upstream effect and in column 8 for the full upstream effect. The combined direct and first-order upstream Chinese import exposure variable is a statistically significant determinant of employment growth at the ten per cent level; the measure that includes the full upstream effect is not statistically significant.

Analysis of results

Overall, we regard the results in Table 16 as providing little evidence for important spillover effects operating through input-output linkages.

The second row of Table 13 contains the implied employment losses (across all industries) associated with the direct and first-order upstream effects of rising Chinese import exposure over the 1991-2011 period and the two sub-periods (based on column 5 of Table 16). The third row of Table 13 contains the implied employment losses in manufacturing, based on unreported results from a similar regression in which we restricted the sample to manufacturing

[29] Following Acemoglu *et al*. (2016), we do not include the downstream effects. As discussed earlier, theoretical arguments imply that they are less likely to be important.

industries.[30] Taken together, the results suggest that accounting for input-output linkages does not substantially increase the estimated number of job losses. Total losses over the 1991-2011 period from the direct and first-order upstream effects are estimated at 202.8 thousand, of which 131.3 thousand occurred in the 2001-2011 sub-period. These totals are not much larger than the estimated direct effects based on the sample of IOIC industries (row 2 of Table 13).

For the 2001-2011 period, including the first-order upstream spillovers increases the employment effect of rising Chinese import competition by 10.7 per cent (from 118.6 thousand to 131.3 thousand). This input-output multiplier effect is tiny compared to those estimated by Acemoglu *et al*. (2016) for the United States. They found that accounting for input-output linkages magnified the employment losses from rising Chinese import competition by a factor of between 2.8 (if only first-order linkages are accounted for) and 3.5 (if higher-order linkages are accounted for). Our findings indicate that input-output spillovers are much less important as an amplifier of the employment costs of rising Chinese import competition in Canada than they are in the United States. The reasons for this difference are unclear and warrant further research.

D. Step 3: Reallocation and Aggregate Demand Effects within Local Labour Markets

i. Empirical strategy

The approach described in Step 2 should capture employment effects arising from direct import competition and from indirect competition working through inter-industry input-output linkages. There are additional effects that that approach may fail to capture:

- **Labour reallocation:** A trade-induced reduction in employment in one industry may lead to an increase in employment in another industry as labour is reallocated from declining to growing industries.

- **Aggregate demand:** Trade-induced job losses in one industry may reduce the incomes of displaced workers, leading those workers to reduce their consumption expenditures. This reduces the demand for other industries' output, leading to further job losses, further income declines, and so on, in a multiplier effect.

These effects would be difficult to capture at the national level without a structural economic model. We can go some distance toward measuring their net effect by using information on import exposure and employment within local labour markets. As a first pass, we estimate the following equation:

$$\Delta E_{l,t} = \alpha_t + \beta \Delta IE^L_{l,t} + \gamma X_{l,t} + e_{l,t} \qquad (11)$$

Here, $\Delta E_{l,t}$ 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 fifteen years and over) in locality l over time period t; $\Delta IE^L_{l,t}$ is the annual percentage-point change in the

[30] In the regression on the manufacturing sample, the coefficient estimate on the combined direct and first-order upstream import exposure variable is -1.03 and is significant at the ten per cent level.

exposure of locality l to Chinese import competition over time period t; and $X_{l,t}$ is a vector of controls to be specified presently. We measure $\Delta IE^L_{l,t}$ as the employment-weighted average of our industry-level import competition measure from Step 1. It was defined earlier in equation (2); for convenience, we reproduce it here. It is:

$$\Delta IE^L_{l,t} = \sum_j \frac{L_{l,j,t}}{L_{l,t}} \Delta IE_{j,t} \tag{12}$$

where $L_{l,j,t}$ is employment in locality l in industry j at the beginning of time period t and $L_{l,t} \equiv \sum_j L_{l,j,t}$ is total employment in locality l at the beginning of time period t. The instrument for $\Delta IE^L_{l,t}$ is obtained by replacing $\Delta IE_{j,t}$ with $\Delta IEO_{j,t}$ in equation (12).

As discussed earlier, our notion of 'locality' is the census metropolitan area or census agglomeration (CMA/CA) as defined by Statistics Canada.

Once we have obtained an estimate of the coefficient β in equation (11), we can compute the implied decline in Canadian employment as follows. Let $\widetilde{\Delta IE^L_{l,t}}$ denote the part of the change in the import exposure of locality l over time period t that is attributable to the Chinese export productivity shock, and let $\Delta L^{cf}_{l,t}$ be the difference between actual employment in locality l at the *end* of time period t and the counterfactual employment level that would have obtained if $\widetilde{\Delta IE^L_{l,t}}$ had been equal to zero. Then using equation (11), the total employment effect is

$$\begin{aligned} \Delta L^{cf}_t &= \sum_l \Delta L^{cf}_{l,t} \\ &= \sum_l \frac{POP_{l,t}}{100} \beta \widetilde{\Delta IE^L_{l,t}} \end{aligned} \tag{13}$$

where $POP_{l,t}$ is the working-age population of locality l at the end of period t. As in steps 1 and 2, we measure $\widetilde{\Delta IE^L_{l,t}}$ as the actual observed change in Chinese import exposure, $\Delta IE^L_{l,t}$, multiplied by the adjusted R-squared from the first-stage regression (which is 0.57).

The employment effect estimated in (13) should capture the direct impact of Chinese import exposure on employment in local labour markets, plus the net effect of inter-industry labour reallocation and demand spillover effects operating *within* local labour markets. It will not capture the effects of labour reallocation or aggregate demand that operate across localities (i.e. at the provincial, national or global levels). Moreover, our use of CMAs/CAs to define local labour markets means that we are excluding any effects of rising import exposure on workers who do not live in a CMA or a CA.[31]

[31] According to the 2011 National household Survey, 82 per cent of Canadians aged 15 and over lived in a CMA or a CA in 2011.

Following Acemoglu *et al*. (2016), we further explore the impact of Chinese import exposure in local labour markets by separately identifying the employment effects in three broad sectors:

- **Exposed sector:** Industries that experienced large increases in direct Chinese import competition over our period of study;

- **Non-exposed tradable sector:** Industries that produce tradable outputs but that did not experience large increases in direct Chinese import competition over the period;

- **Non-exposed non-tradable sector:** All industries not categorized in the first two categories.

We define the exposed sector as the set of manufacturing industries for which the industry-level Chinese import exposure measure $\Delta IE_{j,t}$ increased by at least two percentage points (cumulatively) over period t. We define the non-exposed tradable sector as the set of all non-service industries in the manufacturing, agriculture, forestry and mining and oil and gas extraction industry groupings, excluding the manufacturing industries already included in the exposed sector. All remaining industries are categorized as non-exposed non-tradable.

With these definitions in hand, we estimate the following equation:

$$\begin{aligned}\Delta E_{k,l,t} = \alpha_{k,t} + \beta_1 \Delta IE^L_{l,t} \mathbb{I}\{exposed\} + \beta_2 \Delta IE^L_{l,t} \mathbb{I}\{non-exposed\ tradable\} \\ + \beta_3 \Delta IE^L_{l,t} \mathbb{I}\{non-exposed\ non-tradable\} + \gamma X_{l,t} + e_{k,l,t}\end{aligned} \quad (14)$$

where $\Delta E_{k,l,t}$ is the change in the employment rate in locality l in sector k over time period t.[32] This specification allows the slope coefficient on Chinese import exposure to vary across the exposed, non-exposed tradable, and non-exposed non-tradable sectors.

Intuitively, rising Chinese import competition should have a substantial negative impact on employment rates in localities' exposed sectors. The effect on employment rates in the other two sectors (especially the non-exposed non-tradable sector) is *a priori* ambiguous because it depends on the net impact of labour reallocation and local aggregate demand effects. If workers displaced from the exposed sector find new jobs in the non-exposed sectors (within the same locality), then we expect the coefficients β_2 and β_3 to be positive. If instead job losses in the exposed sector lead to a decline in aggregate demand (within the locality) that reduces employment in the other two sectors, then we expect those coefficients to be negative.

Given estimates of the regression coefficients in (14), we can compute the total employment effect using (13) with minor modifications.

[32] The 'employment rate in sector k' is total employment in sector k divided by the working-age population of the locality and multiplied by 100. In equation (14), the notation $\mathbb{I}\{k\}$ denotes a dummy variable for sector k.

In terms of controls $X_{l,t}$, all specifications include fixed effects for six regions (the Atlantic region, Quebec, Ontario, the Prairie region, British Columbia, and the Northern region). Following Acemoglu *et al*. (2016), we also control for the share of a locality's employment that is in manufacturing at the beginning of each period. Conditional on the initial manufacturing share of employment, variation across localities in Chinese import exposure arises only from variation in the extent to which localities' manufacturing employment is concentrated in highly exposed manufacturing industries.

ii. Results

Data summary

Summary statistics for the variables are presented in Table 17. The increase in the growth of Chinese import competition after 2001 is evident; the mean annual change in Chinese import exposure is 0.05 percentage points over the 1991-2001 period and 0.13 percentage points over the 2001-2011 period. The summary statistics also display the turnaround in employment growth after 2001; across all industries, the annual change in the employment rate averaged 0.05 percentage points in the 1991-2001 period and -0.16 percentage points over the 2001-2011 period.

The breakdown of employment rate changes by sector reveals that this turnaround was concentrated in the industries that were exposed to large increases in import competition from China. The annual employment rate change in the exposed sector was 0.03 percentage points over the 1991-2001 period and -0.24 percentage points over the 2001-2011 period. In contrast, the employment rate change in the non-exposed non-tradable sector was positive in both sub-periods and, in fact, increased after 2001.

Estimation results

We begin by estimating equation (11). Panel A of Table 18 presents the results. The OLS results reveal that, across localities, increasing Chinese import exposure is negatively associated with employment growth as measured by the change in the employment rate (column 1). The 2SLS results are quite similar to the OLS results. According to our baseline estimate (in column 2), a one percentage-point increase in the annual growth of Chinese import exposure reduces the annual growth of the employment rate by 1.0 percentage point. The regression coefficient is highly statistically significant.

Panel B presents the estimates for equation (14), in which the change in the employment rate is measured by sector and the slope coefficient on the change in Chinese import exposure is allowed to vary across sectors. Again, the OLS and 2SLS results are fairly similar. Focusing on the 2SLS results (column 4), we find that rising Chinese import competition strongly reduces employment rate growth in the exposed sector; a one percentage-point increase in the annual growth of Chinese import exposure reduces the annual change in the employment rate of the exposed sector by 1.78 percentage points.

For the non-exposed non-tradable sector, the coefficient estimate on the change in Chinese import exposure is positive and statistically significant at the five per cent significance

Table 17: Summary Statistics on Changes in Employment Rates and in Chinese Import Exposure across Local Labour Markets, for All Industries and by Sector, 1991-2011

	1991-2011					1991-2001		2001-2011	
	Mean	SD	Median	Min	Max	Mean	SD	Mean	SD
Annual Δ in Chinese import exposure	0.09	0.05	0.09	0.00	0.23	0.05	0.03	0.13	0.06
Instrument for annual Δ in Chinese import exposure	0.09	0.05	0.08	0.00	0.32	0.05	0.03	0.12	0.06
Annual Δ in employment rate									
All industries	-0.06	0.15	-0.10	-1.00	0.52	0.05	0.19	-0.16	0.25
Exposed sector	-0.10	0.07	-0.09	-0.30	0.19	0.03	0.09	-0.24	0.14
Non-exposed tradable sector	-0.02	0.03	-0.01	-0.72	0.12	-0.03	0.07	-0.01	0.05
Non-exposed non-tradable sector	0.06	0.13	0.05	-0.43	0.54	0.03	0.17	0.09	0.19
Initial manufacturing share of employment	--	--	--	--	--	13.8	5.8	13.7	5.7

Notes:
The annual change in Chinese import exposure is the employment-weighted mean (within the locality) of the industry-level import exposure variable described in the notes for Table 11. The instrument is computed similarly. The sectoral employment rates by locality are measured as 100 x the locality's total employment in that sector divided by the locality's population aged fifteen and over; the variables summarized in the table are the annual percentage-point differences in these employment rates over the time periods indicated. The definitions of the three sectors are given in the main text.
The initial manufacturing share of employment is the share of workers employed in four-digit NAICS manufacturing industries in the first year of the period indicated.
The dataset contains 129 localities. Observations are weighted by the locality's working-age population in 1991.

Table 18: Effect of Import Exposure on Employment in Canadian Local Labour Markets, 1991-2011

	A. Total Employment Effect		B. Sectoral Employment Effects	
	(1)	(2)	(3)	(4)
CMA/CA import exposure	-1.05*** (0.28)	-1.00*** (0.27)	--	--
CMA/CA import exposure x {exposed}	--	--	-1.62*** (0.21)	-1.78*** (0.22)
CMA/CA import exposure x {non-exposed tradable}	--	--	-0.19 (0.26)	-0.35 (0.25)
CMA/CA import exposure x {non-exposed non-tradable}	--	--	0.67 (0.56)	1.06** (0.51)
Estimation Method	OLS	2SLS	OLS	2SLS
Number of observations	258	258	774	774
First-stage F statistics	--	792.5	--	1,803.3

Notes:
In columns (1) and (2), 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 (3) and (4), 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 the exposed, non-exposed traded and non-exposed non-traded sectors as defined in the main text.
Standard errors are in parentheses. Standard errors are clustered on 129 CMAs/CAs. Specifications (1) and (2) include period and region dummies; specifications (3) and (4) include period x sector dummies, region dummies, and the locality's initial manufacturing employment share interacted with sector dummies. In all specifications, observations are weighted by CMA/CA working-age population (i.e. population aged 15 and over) in 1991.
* $p < 0.1$
** $p < .05$
*** $p < .01$

level. A one percentage-point increase in the annual growth of Chinese import competition in a locality leads to a 1.06 percentage-point increase in the employment rate in non-exposed non-tradable industries in that locality.

Analysis of results

The fact that the coefficient estimate for the non-exposed non-tradable sector is positive indicates that, within local labour markets, the labour reallocation effect dominates the aggregate demand effect. This result is consistent with the view that many workers displaced from exposed industries in the manufacturing sector are able to find employment in the non-exposed non-tradable sector.

We find no statistically significant impact of Chinese import competition on employment rates in the non-exposed traded sector. Notably, this is the sector that includes the mining and oil and gas extraction industry, the industry in which employment increased the fastest over the 2001-0211 period (Table 8). It may be that the mining and oil and gas industry (which is concentrated in a few geographic locations) has absorbed displaced workers from CMAs/CAs across Canada. Our empirical approach does not capture such cross-locality reallocation effects.

As in steps 1 and 2 of our analysis, we use the regression results to estimate the number of jobs lost as a result of rising import competition from China. The fifth row of Table 13 contains the job losses implied by the regression estimates in column 2 of Table 18. The estimated net loss of jobs as a result of rising Chinese import competition is 228.6 thousand over the 1991-2011 period. This total loss is the result of losses of 59.4 thousand jobs over the 1991-2001 period and 169.1 thousand jobs over the 2001-2011 period. These numbers imply that if the increase in Chinese import competition after 2001 had not occurred (and all other factors in the economy had remained unaffected), total employment across Canada's CMAs and CAs would have increased by 9.6 per cent more than it did in reality over the 2001-2011 period (Table 14).

The bottom section of Table 13 presents the estimated job losses broken down by sector, based on the regression results in column 4 of Table 18. Our estimates imply that the rise of Chinese import competition reduced employment in Canada by 209.3 thousand over the full 1991-2011 period. This total is the result of an employment loss of 347.9 thousand jobs in the exposed sector, partially offset by an increase of 207.7 thousand jobs in the non-exposed non-tradable sector.[33]

Again, most of the effect occurred in the 2001-2011 sub-period. Over that time, rising Chinese import competition reduced employment in the exposed sector by 255.4 thousand. This accounts for 74.2 per cent of the observed employment decline of 344.3 thousand in the exposed sector over the 2001-2011 period (Table 14). The decline of employment in the exposed sector was partially offset by an employment increase of 152.4 thousand in the non-exposed non-tradable sector. Our estimates imply that the reallocation of labour into the non-exposed non-

[33] We follow Acemoglu *et al*. (2016) in including employment effects in the non-exposed tradable sector in our totals even though the coefficient estimates for that sector in Table 18 were not statistically significant. Setting them to zero results in total employment changes close to the estimates from steps 1 and 2.

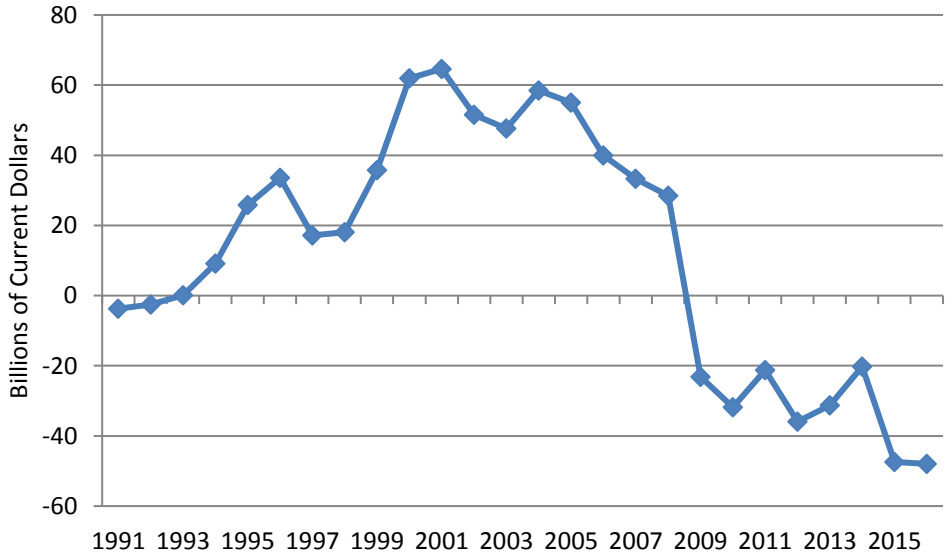
tradable raised the increase in employment in that sector over the 2001-2011 period by 7.9 per cent (from 1,934.4 thousand to 2,086.8 thousand).

In their analysis of U.S. data, Acemoglu *et al*. (2016) did not find statistically significant evidence of employment gains in non-exposed industries to offset declines in the exposed sector. They interpreted this as evidence that strong aggregate demand effects, operating within local labour markets, were limiting employment gains in the non-exposed industries. In contrast, our results for Canada suggest that such demand effects have not completely inhibited the reallocation of labour into the non-exposed sector. That being said, the employment gains we measure in the non-traded non-exposed sector were not sufficient to fully offset the losses in the exposed sector.

A more subtle point is that, under balanced trade, one would expect rising import competition in the exposed sector to result in a reallocation of labour into other traded industries (i.e. the non-exposed tradable sector) rather than into the production of non-tradables. Moreover, local demand spillovers from job losses in the exposed sector − to the extent that they exist − should have a stronger employment-suppressing effect on local production of non-tradables than on the non-exposed tradable sector.

Why, then, do we find large employment gains in the non-exposed non-tradable sector in response to the China shock and no evidence of reallocation into non-exposed tradables? Part of the explanation may be that trade was not balanced over our period of study. In particular, Canada's aggregate trade balance declined substantially over the 2001-2011 period during which most of the employment effects of the China shock occurred; net exports of goods and services declined from 64.6 billion in 2001 to -21.2 billion in 2011 (Chart 7). A declining overall trade

Chart 7: Exports less Imports of Goods and Services, Canada, Billions of Dollars, 1991-2016



Source: Statistics Canada CANSIM Table 380-0064.

balance (driven, in part, by rising imports from China) may have impeded the reallocation of labour into the non-exposed tradable sector, making those workers available to the non-tradable sector.

A second factor, already noted earlier, is that part of the reallocation of labour into the non-exposed tradable sector (in particular, the mining and oil and gas extraction industry) may have occurred across local labour markets rather than within them. To the extent that this is true, our empirical approach will have failed to capture an important component of sectoral labour reallocation in response to the rise of Chinese import competition.[34] Further research on this question is warranted.

IV. Conclusion

This report has assessed the impact on Canadian labour markets of a recent shock to Canada's import supply: the rapid rise of China as a manufacturing export superpower in the late 1990s and early 2000s. An instrumental variables strategy based on the work of Acemoglu *et al*. (2016) was used to capture the causal impact of rising Chinese import competition on Canadian employment.

Our first main finding is that the direct effect of rising Chinese import competition in Canadian manufacturing was a net loss of 105 thousand manufacturing jobs over the 2001-2011 period. This amounts to 20.7 per cent of the actual observed decline in manufacturing employment over that period (508 thousand jobs). Our estimates imply an additional loss of 64 thousand jobs over the 1991-2001 period, for a total loss of 170 thousand manufacturing jobs over the 1991-2011 period.

These estimates are subject to important caveats. In particular, they may overstate the employment costs of trade exposure in the 1991-2001 sub-period (for which we found that the effect of Chinese import growth on employment growth was not statistically significant) and they may inappropriately include some effects of the 2008 recession. However, even our most conservative estimates imply that the increase in Chinese import penetration has accounted for a large share of the actual manufacturing employment decline observed in Canada since 2001.

In a second step, we measured industries' indirect exposure to import competition via input-output linkages with other trade-exposed industries. Data constraints imposed limits on the quality of evidence we could generate in this part of the analysis. In our view, the results suggest that the employment effect of indirect import exposure through input-output linkages is small in Canada.

[34] See Tusz *et al*. (2015) for a recent analysis of interprovincial migration flows in Canada and their implications for aggregate productivity growth. They note that only two provinces − Alberta and British Columbia − had positive net internal migration over the 1987-2014 period. Calculations by Kneebone (2014) suggest that the employment boom in Alberta created 411 thousand jobs over the 1995-2014 period, attracting workers from across Canada and reducing the national unemployment rate in 2014 by 2.2 percentage points.

In a third step, we used data on employment and Chinese import exposure in Canadian local labour markets to assess the role of inter-sectoral labour reallocation and aggregate demand effects operating within local economies. This analysis revealed somewhat larger employment effects; the total decline in employment over the 2001-2011 period attributable to the rise of Chinese import competition is on the order of 150 to 170 thousand jobs. These totals represent the net effect of countervailing sectoral effects. We found that the China shock led to very substantial employment losses in the industries most exposed to Chinese import competition, but that these losses were partly offset by employment gains in non-exposed non-tradable industries.

It must be stated that this is by no means a comprehensive assessment of the welfare impact of international trade, or of trade with China in particular, on Canadians. Rising import competition from China led to a non-negligible reduction in employment in Canada, concentrated mostly in manufacturing. But those costs must be set against the benefits to Canadian consumers in terms of lower prices and increased variety, expanded export opportunities for Canadian firms, and the productivity gains associated with enhanced foreign competition. (Not to mention the incredible increase in the living standards of workers in China who not long ago were quite poor.) A progressive trade agenda should seek to take advantage of the gains from trade while helping those who suffer economic dislocation to adjust.

The analysis in this report could be extended in many directions. We conclude by listing a number of possibilities:

- It would be useful to examine the impact of the 'China shock' on outcomes other than employment. These might include wages, unemployment rates, usage rates of social assistance or unemployment insurance benefits, health outcomes, and interprovincial migration patterns.

- A breakdown of the employment effects by occupational category could provide more detailed insights into the kinds of jobs most affected by Chinese import competition. Similarly, employment effects could be measured according to demographic or socioeconomic characteristics of interest from an inclusiveness perspective (e.g. gender or level of educational attainment).

- The rise of Chinese manufacturing in recent decades contributed to an increase in world commodity prices, and in particular the price of oil. It would be useful to extend our analysis to explicitly account for the effect of this on Canadian employment, given that some Canadian regions are major oil producers.

- Our measures of Chinese import exposure accounted only for competition over the Canadian domestic market. Canada exports a large share of its manufacturing output, so Canadian employment may be affected by Chinese competition over foreign markets. Our analysis could be extended to account for this.

- Acemoglu *et al*. (2016) found that input-output linkages multiplied the employment impact of Chinese import competition dramatically in the United States, while we found that the input-output multiplier was small in Canada. What explains this difference?

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