Are clusters resilient? Evidence from Canadian textile industries*

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Abstract

We investigate whether plants inside and outside geographic clusters differ in their resilience to adverse economic shocks. To this end, we develop a bottom-up procedure to delimit clusters using Canadian geo-coded plant-level data. Focusing on the textile and clothing (T&C) sector and exploiting the series of dramatic changes faced by that sector between 2001 and 2013, we find little evidence that plants in T&C clusters are more resilient than plants outside clusters. Over the whole period, plants inside clusters are neither less likely to die nor more likely to adapt by switching their main line of business. However, in the industries the most exposed to the surge of Chinese imports after 2005, plants inside clusters die and exit less than others in the following two years.

Keywords: Geographic clusters; resilience; textile and clothing industries; multi-fibre arrangement; geo-coded data.
JEL Classifications: R12; F14

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"[...] perhaps the most discerning test of 'true' cluster dynamics is one that assesses the alleged cluster's resilience and robustness over time, in the face of severe shocks and dislocations. How has the region fared under such circumstances? How effectively have its firms and institutions adapted and evolved in response to such pressures for change?"(Wolfe & Gertler 2004, pp. 1085–1086).

1 Introduction

Developed countries have experienced major disturbances over the last two decades. The Great Recession, the 2008 trade collapse, and the surge of China are examples of shocks that have affected many industries in those economies. One political response to these shocks is to put 'resilience' high on the policy agenda. This is echoed by recent speeches of global leaders who urge to "build a more resilient and inclusive global economy."[1]

A widely held view in policy circles is that economic clusters could foster this agenda. As there is an academic consensus that geographic clustering gives rise to productivity gains (see, e.g., Duranton & Puga 2004, Combes & Gobillon 2014), associating clusters with other positive outcomes—such as the 'resilience' of firms, industries, or regions—is tempting. However, the impact of clusters on resilience is theoretically unclear. On the one hand, clusters can make firms more efficient and innovative, improving their ability to adapt and their resilience to shocks. On the other hand, negative disturbances may propagate more easily and, therefore, be amplified by the connectedness of firms within a cluster. So far, we have little empirical evidence to back either possibilty.

To make progress on this topic, we investigate the resilience of plants in Canadian textile and clothing (T&C) clusters between 2001 and 2013, a period during which the sector experienced dramatic changes. Previewing our key results, we find little evidence that clusters are associated with more resilience of plants. Plants in cluster are not more likely to remain active in the T&C sector, and they are as likely as plants outside clusters to adapt by switching their main line of business. We uncover, however, two effects of clusters. First, conditional on switching, plants in clusters are more likely to transition to services, especially in large clusters. Second, there is a short-run 'resilience premium' after 2005 for clustered plants in the most exposed industries. That premium, however, dissipates quickly within two years after the shock.

Evaluating the effect of geographic clustering on the resilience of plants involves two major difficulties. First, one needs an operational definition of clusters. Conceptually defined as *"a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarity"* (Porter 1990, p.16), such clusters are more

[1] The quote is from Christine Lagarde of the IMF. Available at `https://www.imf.org/en/News/Articles/2017/04/07/building-a-more-resilient-and-inclusive-global-economy-a-speech-by-christine-lagarde`, last accessed on February 28, 2018.

difficult to identify in practice as they rarely conform to existing industrial and administrative boundaries. Identifying clusters thus requires meaningful geographic groupings of related activities, and to associate plants with these 'clusters' (see Delgado et al. 2016, Behrens 2016). To delimit the boundaries of the textile and clothing sector, we first use a grouping-algorithm based on several measures of industrial relatedness, including input-output linkages, labor-force similarities, and patent citation flows. Armed with a list of T&C industries, we then use detailed geocoded plant-level data to map the location and evolution of clusters of T&C plants in Canada, using tools from spatial point-pattern analysis. In contrast to standard *global* measures of geographic concentration, our *local* approach allows us to identify several spots of geographic concentration and provides a measure that is specific to the location of each plant.

Second, one needs an operational definition of resilience. As emphasized by Pendall et al. (2010), Martin (2012), or Martin & Sunley (2015), resilience has become a buzzword in policy and academic circles. It may alternatively refer to the ability of a system to recover from, to absorb, or to adapt to a shock. We propose an empirical framework to articulate these concepts and show how they relate to each other. In a nutshell, we consider that a resilient plant is one that remains active in its industry (referred to as '*within* resilience'), or that survives by switching to another industry ('*between* resilience').[2]

Having delimited our geographic T&C clusters and conceptualized resilience, we then compare how plants inside and outside clusters resort to these different adjustment margins. We focus on the 2001–2013 period, when the T&C sector experienced large adverse shocks. As a result of these shocks, the sector lost two-thirds of its employees, half of its plants, while its imports from China surged by about 200%. A careful analysis shows that these shocks had very heterogeneous effects across different sub-industries. Though these large and profound changes entirely reshaped the Canadian T&C sector, we do not find evidence of a higher resilience of establishments in clusters during that period. Controlling for a set of plant-level characteristics—to partially correct for the self-selection of plants into clusters—and both province and industry-year fixed effects, we find that clustered plants were as likely to die as plants located outside clusters. While we do not observe systematic differences in the probability to switch to another industry, we do find that switching patterns are different for plants inside and outside clusters. Plants in clusters were more likely to switch to services, while plants outside clusters were prone to switch to other manufacturing activities. Thus, 'where you cluster' matters for adaptation, at least in the T&C sector. These results are robust to alternative measures of exposition to clusters and several placebo tests. They also hold when using detailed historical information on the location of T&C industries from the 1871 Canadian

[2]We analyze resilience mainly along the *extensive* margin (plant death, exit, or industry switching). We also look at an *intensive* margin of adjustment—plant level employment—but find no significant association with geographic clusters. Unfortunately, our data do not allow us to look at other *intensive-margin* decisions including quality upgrading, productivity changes, or innovation.

Census of Industrial Establishments as instruments to correct for the potential endogeneity of clusters' definition.

While the foregoing analysis does not pay explicit attention to the source and the nature of the economic shocks, we refine it by looking at a large and well-identified shock: the 2005 removal of import quotas in some T&C industries in the wake of the expiry of the Multifibre Arrangement (MFA). The magnitude of this shock—combined with the fact that it affected T&C industries differentially, depending on whether or not the quotas were binding—provides an ideal laboratory for evaluating the interplay between resilience and geographic patterns in the presence of an industry shock. Considering the long-run effect of the end of the MFA, we do not observe any specific behavior of clustered plants following this shock. However, the long-run analysis masks some short-term benefits associated with clusters. Indeed, we find that clustered plants active in industries where quotas were binding died and exited less after the removal of quotas in 2005. This survival premium is, however, short-lived and dissipates within two years after the shock. Finally, we do not find any impact of clusters on the *between* resilience (industry switching), even in the immediate aftermath of the end of the MFA.

Our work contributes to several literatures. First, we contribute to the studies on the resilience of clusters. Theoretically, whether clusters enhance resilience or not is unclear (see Delgado & Porter 2017, for a discussion). Some authors argue that clustering generates economic benefits, thereby enhancing firms' resilience to adverse shocks. However, a competing view is that clusters make firms more vulnerable to such shocks. As clusters mature, so goes the argument, they become a source of inertia by generating behavioral mimetism that makes plants less able to adapt (see, e.g., Pouder & John 1996, Martin & Sunley 2003, p.18). Besides, clusters may host firms that are more exposed to shocks. While firms outside geographic clusters may specialize on niche products and cater to specific local demands, firms in clusters may compete directly on more generic product segments in international markets (Holmes & Stevens 2014). The latter firms may well be more—rather than less—exposed and vulnerable to adverse economic shocks. The scarce empirical literature that examines this question includes Delgado & Porter (2017), who assess the role of clusters for the resilience of regional industries during the Great Recession in the U.S. They find that industries experienced a higher employment growth when located in a region where other *related* industries are represented, suggesting a lower vulnerability and a faster recovery of regional industries active in clusters. Turning to micro-level analysis, Martin et al. (2013) is the only contribution we know of that investigates whether firms in clusters resist better to economic shocks. The authors define resilience as the probability of exporters to stay active in foreign markets after the 2008 trade collapse. They show that exporters located near other exporters or targeted by cluster policies performed better than other firms under business-as-usual, but these cluster advantages vanished during the economic turmoil. We revisit this debate by adopting a novel approach to measure clustering and resilience, and by focusing on a competition shock (the previous studies focused on the great crisis, which might be viewed as a credit or a demand shock).[3]

Our result that plants in cluster are more likely to switch to services (conditional on changing its main line of activity) are also linked to the literature on transition to services. Breinlich et al. (2014), for example, document that UK firms switch to become service providers as a response to increasing international competition.[4] Lastly, we contribute to the growing literature on the firm-level impact of increased competition from low-income countries—including China. Consistent with Mion & Zhu (2013), we do not find a strong impact of Chinese competition on plants' survival.[5]

The rest of the paper is organized as follows. Section 2 explains how we delineate the Canadian textile and clothing sector, and provides some historical context and aggregate facts on the dynamics of this industry. Section 3 shows how we construct and map our geographic clusters. In Section 4, we turn to the econometric analysis and present micro-level evidence on the resilience of textile plants in clusters. Finally, Section 5 concludes.

2 'Textile & Clothing' in Canada: context, definition, and facts

This paper is about industry dynamics, geographic patterns, and trade protection. We first provide some historical context to show how those three components have shaped the Canadian textile landscape in place by the end of the 20th century. We then provide selected aggregate facts on the three components—industry dynamics, geographic patterns, and trade protection—for our study period.

[3]The topic is also somewhat related to the question of the local impact of large plant closures. The existing literature on this topic provides mixed evidence. Jofre-Monseny et al. (2018) find that the closure of large manufacturing plants has a positive impact on the local industry. Shoag & Veuger (2018) focus on the closure of retail chains and find a negative impact on employment and survival of nearby businesses.

[4]Bernard & Fort (2015) and Bernard et al. (2017) examine factoryless goods producers (FGPs) in the U.S. and Denmark, respectively. FGPs are out of manufacturing according to official statistics but perform most of the tasks manufacturing firms do (design, coordination of production etc). The plants that transition from T&C to printing activities in our data are likely FGPs. The transition to services and its impact on firm performance has been studied in the French context by Crozet & Milet (2017). We consider such transition as a form of resilience, though we cannot evaluate its impact of firm performance using our data. See Gebauer et al. (2005) for a discussion on the costs to transition to services.

[5]The end of the MFA had a deep impact on the *structure* and *composition* of the T&C industry in developed countries. Utar (2014) shows that increasing competition from China led to a change in the workforce composition of Danish firms. Sales, value-added, intangible assets, and employment dropped in firms affected by this new source of competition. Bloom et al. (2016) show that European firms exposed to increasing Chinese competition increased their volume of innovation. Finally, Martin & Mejean (2014) show that the quota removal on Chinese T&C exports led to a reallocation of activities in France from low- to high-quality firms.

2.1 Historical context

The origins of the Canadian textile industry date back to 1820–1840, when wool and cotton were the two main fabrics of the country.[6] The expansion of the textile industry during 19th century was triggered by several factors: (i) the growth of the internal market (the Canadian population almost doubled between 1870 and 1910); (ii) improvements in market access and political integration (expansion of the railroad system, proclamation of the Canadian Confederation); and (iii) strong import protection. Concerning the latter, the country significantly increased import protection under the Macdonald national policy in 1879: tariffs almost doubled, reaching close to 30%. The story of the Canadian textile industry after that date is a classic one of import substituting industrialization.

The geography of the textile industry by the end of the 20th century largely took shape a hundred years earlier. This fact will prove useful later in our analysis since it allows us to use historic patterns as instruments for contemporaneous clusters. Starting with wool, the location of the early industry was dictated by local market size, access to skilled labor, availability of raw materials, and proximity to hydraulic power. The wool industry was then made of numerous small family businesses, dispersed mainly across the province of Ontario. By contrast, the cotton industry was more geographically concentrated than wool. Also located in Ontario, but more importantly in Québec, it was a more capital intensive industry: its activity was automatically more concentrated geographically as it had larger plants. Because of its important capital and labor requirements, it was also more likely to be established in larger cities. In that respect, the province of Québec offered a geographically advantageous location. Access to railroads—Montréal being a national hub—allowed to import raw cotton from the U.S. and to dispatch finished products to geographically dispersed markets. Furthermore, the river system in Québec allowed to use cheap electric power which provided further incentives to locate in the Saint Lawrence valley between Québec city and Montréal. The latter city—being Canada's financial capital during that period—had finally a distinct advantage when it came to providing the large funds required to operate large cotton textile mills.

A substantial geographic shift occurred between 1870 and 1900, driven by two forces. First, the 1882–1883 recession hit the textile industry hard. The cotton industry saw the formation of large enterprises that controlled many textile mills and manufactures. The consolidated industry colluded, and firms managed to weather the crisis relatively well. Such consolidation did not happen in the more fragmented wool industry, explaining its decline. Second, the different dynamics of wool and cotton were amplified after 1897 when trade protection was relaxed as the principle of the British preference was introduced. This led to a surge of imports of wool products which eroded further the industry. The decreasing importance of wool and

[6] The following developments are largely based on Rouillard (1974), Mahon (1984) and McCullough (1992). A more detailed historical account of the material can be found in the online Appendix T.

the rise of cotton induced a shift in the geographic composition of the textile industry from Ontario to Québec's urban centers.[7]

Turning to the 20th century, the key development was the emergence and strong growth of man-made fabrics during the inter-war years. The silk and synthetics industry started operating in eastern Ontario and Québec and quickly became fairly concentrated, both in geographical and industrial terms. This concentration, when combined with the trade protection enforced in the wake of the Great Depression of 1929, cemented the geographic concentration of this industry. The textile industry prospered that way until 1951 (the date at which it recorded its highest employment level ever in Canada). After that date, decreasing protection, stagnating exports, and rising labor costs caused many bankruptcies and several mergers which reinforced industrial concentration. It is fair to say that the T&C industry—which developed in a fairly protected environment since the 19th century—had difficulties adjusting to international competition in the face of lower protection. The outcome was the 1971 textile policy that aimed to wrestle some power and trade concessions from the staples industries. This was completed by the Multifibre Arrangement (MFA) in 1973, which was signed by Canada to limit textile imports from developing countries. Most of the MFA remained in place until the early 2000s, which is the starting point of our analysis.

2.2 Defining the sector

Our analysis is concerned with the resilience of T&C clusters. Going back to its definition, a cluster is *"a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities"* (Porter 1990, p.16). Though conceptually clear, the 'field' in the definition empirically rarely conforms to standard industrial classifications. Therefore, our first step consists in grouping textile- and clothing-related industries from the NAICS industrial classification into a coherent and broader field that we refer to as the T&C sector. Similar to Delgado et al. (2016), we use a mathematical cluster algorithm to group 4-digit industries according to their similarity along various dimensions of industrial relatedness. Let s_{ij} denote the similarity of industries i and j. We use five distinct measures of s_{ij}: (i) the share of plants in industry i that report secondary activities in industry j; (ii) the strength of input-output links between industries i and j, based on national input-output tables; (iii) the similarity of industries i and j in terms of 553 occupational categories that they employ; (iv) the frequency with which patents in industry i cite patents originating

[7]While less is known about the history of the clothing industry, the evidence we have suggests that it started with a high level of concentration in larger cities, especially Montréal: "*By the mid-1850s, large-scale clothing manufacturing companies were typically located in Montréal with one factory employing eight hundred people* [...] *Sole-sewing machines made it efficient to concentrate shoe manufacturing in steam-driven factories. By the 1860s, there were five major shoe manufacturers located in Montréal that produced the majority of the footwear sold in Canada.*" (Balakrishnan & Eliasson 2007, p.271)

in industry j; and (v) the extent of labor mobility across industries i and j. Details about the construction of those measures—which capture the 'commonalities and complementarities' of industries, a defining characteristic of geographic clusters—and the data underlying them are provided in Appendix A.1. Note that none of the aforementioned measures makes directly use of geographic information. However, it is known that industrial relatedness, as proxied by (i)–(v), partly translates into geographic proximity (see Ellison et al. 2010, Behrens 2016, and Table 16 in online Appendix T).

For each measure s_{ij}, the cluster algorithm partitions all 4-digit industries into groups such that industries are the most similar along s_{ij} within groups, and the most dissimilar along s_{ij} between groups. This procedure is used to delineate a single and coherent group of industries that we collectively call the T&C sector. Table 1 summarizes the results of that procedure. As that table shows, the T&C sector is well delineated by NAICS 3131 to NAICS 3169. Roughly speaking, it encompasses all textile mills, apparel, cut-and-sew clothing, leather and hide, and footwear industries.[8]

2.3 Aggregate facts: industry dynamics

The late 1990s to late 2000s were a decade of profound change that significantly reshaped the T&C sector. Figure 1 depicts the evolution of employment in T&C and other manufacturing industries during that period, broken down by production and non-production jobs. The left panel shows that manufacturing employment experienced a small increase from 2001 to 2007, followed by a decrease in the aftermath of the Great Recession. The evolution of T&C employment in the right panel is more marked and has a different time profile. More specifically, employment in this sector declined sharply between 2005 and 2013, dropping from about 150,000 to a mere 50,000 workers. This decline has been mostly driven by production jobs as the number of non-production jobs remained relatively stable. Consequently, the share of

[8]Our T&C sector is close to that of Delgado et al. (2016) in their 'Benchmark Cluster Definition': it encompasses their four clusters 'Apparel', 'Footwear', 'Leather and related products', and 'Textile manufacturing'. Note that we include the 'Leather and footwear' part in our definition of the T&C sector. As Table 1 shows, plants and firms engaged in textile manufacturing also tend to engage in footwear and leather-related activities ('Within-firm complementarities'). Note further that, although they use all industries in their analysis, the four textile-related clusters delimited by Delgado et al. (2016) contain only manufacturing industries. Put differently, the T&C sector does not have extensive interactions with service or primary industries. Hence, the critique that our clusters 'abstract from the service industry' does not readily apply to our analysis. Furthermore, interviews with several Canadian apparel manufacturers revealed that 'associated institutions' do not seem to play a major role in textile industries: *"According to the respondents, the roles that associated institutions, such as government, trade associations and educational institutions, play in this industry is quite limited."* (Campaniaris et al. 2010, p.23). Table 18 in online Appendix S summarizes the aggregation of the T&C sector in terms of the underlying NAICS industries to produce time-consistent industry definitions.

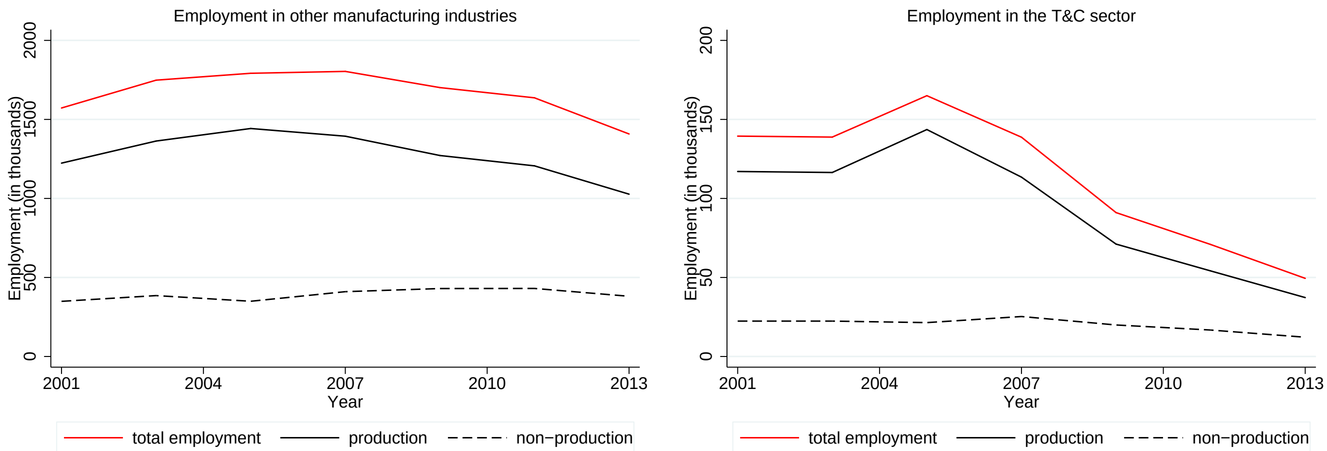
Table 1: T&C industry groupings, based on different similarity measures s_{ij} for 3,570 4-digit industry pairs.

	Groups into which the textile, apparel, footwear, and leather-related NAICS industries are partitioned			
Similarity measure s_{ij} used:	**Group 1**	**Group 2**	**Group 3**	**Residual groupings**
Within-firm complementarities	3141, **3379** Rugs and *furniture*	3131, 3149, 3133, 3132, 3159, **3231** Textile mills and *printing*	3151, 3161, 3162, 3169, 3152 Apparel and footwear	
Input-output linkages	**3116**, 3161, 3162, 3169 Footwear, leather, and *meat*	3131, 3132, 3133, 3141, 3149, 3151, 3152, 3159 Textiles mills, apparel and 'cut-and-sew'		
Occupational employment correlation	3131, 3132 Textile mills	3133, 3141, 3151, 3149, 3152, 3159, 3162 Textiles, apparel, and 'cut-and-sew'	3169 (a singleton cluster)	3161 (alone in one big cluster)
Patent citation flows	3161, 3162, 3169 Leather and footwear	3159, 3152 Cut-and-sew	3132 (a singleton cluster)	3131, 3133, 3149, 3141 (together in one big cluster)
Cross-industry labor mobility	3152, 3159, 3162 Cut-and-sew and footwear	3131, 3132, 3141, 3133, 3149, 3151, **3231** Textiles mills, rugs, hosiery and *printing*		3161, 3169 (together in one big cluster)

Notes: See Appendix A.1 for details on how we construct the different similarity measures. The clustering of industries is done using the Markov cluster algorithm (MCL) by Dongen (2000). The underlying graphs in the cluster algorithm are constructed with positive weights for all links with values above the median, and zero weights for all links below the median. Cutting off links at the median introduces more variability in the link weights, thereby making the graph less connected and allowing for sharper groupings. We run the algorithm on all 3,570 4-digit NAICS industry pairs, but we report only groups that contain industries related to textile and clothing in this table. Industries included in the T&C groups but which in the end are not included in our definition of the T&C sector (furniture, meat, printing) are italicized and their industry codes are reported in bold font.

non-production workers increased from less than 15% to almost 50% in the T&C sector.[9]

Figure 1: Employment trends in manufacturing and the T&C sector.



Notes: Our computations, based on the industry-level *Annual Survey of Manufacturers* dataset from Statistics Canada.

Table 2 shows that the fall in T&C employment was accompanied by a decrease in the number of plants, which fell from 4,465 in 2001 to 2,057 in 2013. This decline has been markedly stronger in the T&C sector compared to the rest of the manufacturing industries so that the share of textile plants in Canada fell from 8.6% to 5.8% of manufacturing between 2001 and 2013. Observe that the largest loss of T&C plants occurred between 2005 and 2007. Table 2 also summarizes the evolution of plant sizes, multiunit status, and export status over time. Contrary to the general trend of increasing plant sizes in manufacturing, the average plant size in the T&C sector has decreased over time: textile plants have downsized over our study period. Furthermore, we observe a decrease in the share of multiunit plants—as can be seen from the last column of Table 2—which fell more strongly in the T&C sector than in the remaining manufacturing industries. When taken together, these two evolutions suggest that large firms may have suffered more from changes in the economic environment than small firms, consistent with findings by Holmes & Stevens (2014) for the U.S. furniture industry. Last, Table 2 also reveals that the share of exporters increased in the T&C sector, which suggests that either exporters were better equipped to face competition from low-income countries or that more plants started exporting in the more globalized environment.

While downsizing and exit are two possible responses to adverse economic shocks, changing business activity is another one. Unfortunately, we do not have information on the relative importance of textile manufacturing and service activities at the plant level. However, we do

[9] As noted in a 2004 report on changes in the Canadian apparel industry: "*Apparel executives intuitively are aware of the necessity to change* [...] *the industry intends to hire more than 3,000 white collar workers with expertise in areas such as logistics, sales and marketing. In implementing the required changes, the downsized apparel industry will shift from a blue collar to a white collar industry.*" (RichterConsulting 2004, p.3)

Table 2: Descriptive statistics for plants by year.

Year	Number of plants			% Exporter		Avg. plant size		% Multiunit	
	all	textile	% textile	textile	non-textile	textile	non-textile	textile	non-textile
2001	52,051	4,465	8.58	39.80	43.81	32.39	33.33	4.77	9.33
2003	51,893	4,386	8.45	41.43	45.06	31.54	33.96	4.58	8.99
2005	49,228	3,803	7.73	43.33	45.60	30.01	35.32	4.05	8.57
2007	46,272	3,170	6.85	45.55	45.95	28.13	36.21	3.82	8.22
2009	44,684	2,910	6.51	45.84	45.31	27.41	36.21	3.37	7.78
2011	42,219	2,696	6.39	45.51	45.48	25.81	35.59	2.74	7.65
2013	35,336	2,057	5.82	45.99	45.82	25.30	37.92	2.67	7.18

Notes: Our computations, based on the *Scott's National All* database (see Section 3.1 for a description). Textile plants are in NAICS industries 3131–3169. All industries are concorded to a stable classification. Plant size is measured by total employment. Plants indicate whether or not they are engaged in export activities (dummy variable). Multiunit is based on plants reporting the same legal name of the firm (see online Appendix U for additional information). Average plant size is reported in terms of total plant employment.

know plants' primary activity. Our dataset being a Business Register, establishments report a primary activity in order to be found easily by potential buyers. We then consider that plants switch activity when they declare a new primary activity outside the T&C sector. We disregard plants that switch their primary activity but remain in the T&C sector.

Table 3: Change in primary sector of activity for T&C plants.

NAICS	Industry name	Number of switchers
Manufacturing industries:		
3231	Printing and related support activities	158
3399	Other Miscellaneous Manufacturing	55
3261	Plastic Product Manufacturing	30
3332	Industrial Machinery Manufacturing	24
—	All other manufacturing industries	110
Service industries:		
4141	Textile, clothing and footwear wholesaler-distributors	217
4189	Other miscellaneous wholesaler-distributors	55
4143	Home furnishings wholesaler-distributors	37
4191	Business-to-business electronic markets, and agents and brokers	26
—	All other service industries	117
Total number of T&C plants switching		377 + 452 = 829

Notes: We consider that a T&C plant switches industry between t and $t+2$ if it reports a primary NAICS code in the T&C sector in t, and a non-T&C primary NAICS code in $t+2$. The figures summarize industry switching between 2001 and 2013. Plants that exit are not considered as switchers, i.e., we only consider switching conditional on survival.

Table 3 summarizes the number of T&C plants that changed their main line of business at some point between 2001 and 2013. According to our above definition of switching, and taking 2001 as our base year, about 18.6% of textile plants changed their primary activity over our sample period.[10] Many of those switches were towards the service industries. This is in line with general perceptions concerning some segments of the T&C sector: *"Based on the perceived*

[10]Out of these 829 plants, one-fourth switched to 'Textile, clothing and footwear wholesaler-distributors' (NAICS

importance of the primary activities, it appears that Canada's apparel supply is becoming more of a service industry." (Campaniaris et al. 2010, p.24). The Canadian T&C industry is also widely engaged in product switching, product upgrading, and the development of product niches, which are adjustment margins that are hard to measure in a domestic context in our data and, therefore, beyond the scope of our analysis.[11]

2.4 Aggregate facts: geographic patterns

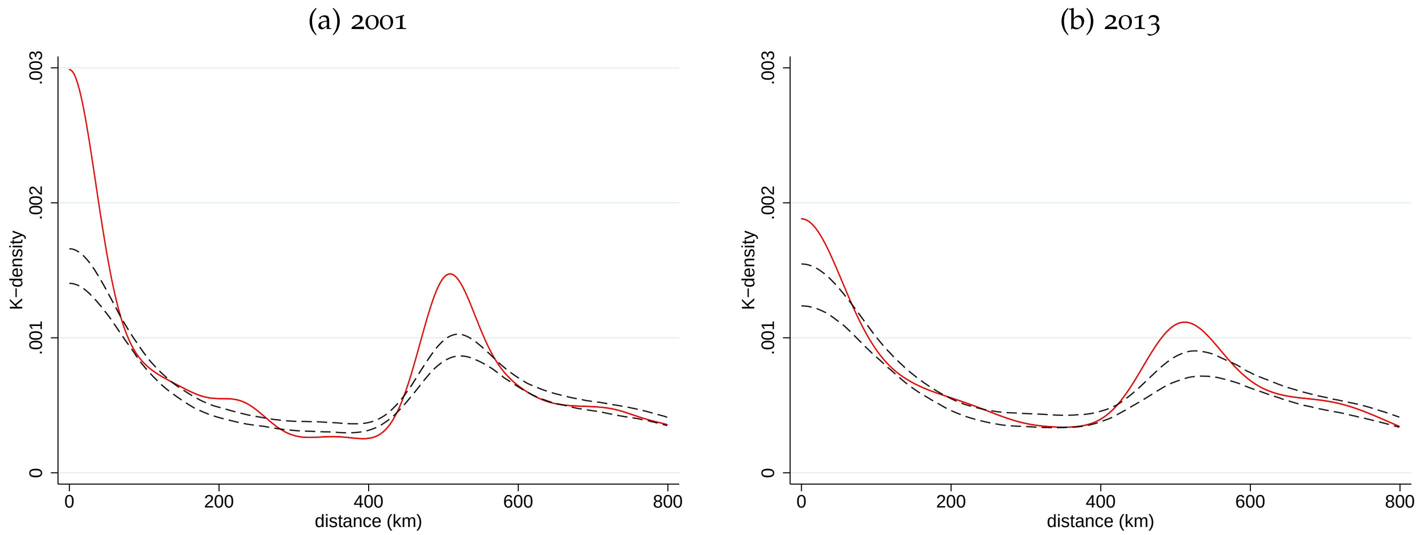
As explained in Section 2.1, textile industries have been strongly concentrated geographically in Canada since the late 19th century. We now show that the T&C sector: (i) remained among the most strongly localized sectors in 2001; (ii) was still substantially localized in 2013; yet (iii) experienced significant geographic deconcentration between those two years. To make those points, we exploit the microgeographic dimension of our data and measure the geographic concentration of industries using the distance-based K-densities pioneered by Duranton & Overman (2005, henceforth DO). A technical description of that approach is provided in online Appendix V. Figure 2 summarizes the changes in the T&C K-densities between 2001 and 2013, based on plant counts. As shown, the T&C sector was significantly localized in both years, with substantial excess agglomeration (compared to the rest of manufacturing) at short distances of less than about 80 kilometers.[12] However, the strength of localization decreased substantially over the years, especially at extremely short distances. We provide additional descriptive ev-

4141) and one-fifth switched to 'Printing and related support activities' (NAICS 3231). Interestingly, Delgado et al. (2016) mention that they found a link between clothing and printing industries in the U.S. However, the absence of theoretical relations *a priori* between these two industries leads them to consider this association as an 'outlier' in their data. Our descriptive statistics on industry switching suggest that these industries may indeed be related, since a substantial fraction of textile firms that changed their activity as of 2001 changed it for printing activities. There is also a substantial fraction of T&C plants that report NAICS 3231 as a secondary activity. That share increased from 2.36% in 2001 to 6.60% in 2013. This suggests that there may be technological complementarities between textiles and printing, which would explain why printing is often a secondary activity of T&C plants and why they tend to switch into that activity. The links between textile manufacturing and printing are historically documented. For example, the first company that combined textile and printing in Canada—the Magog Textile and Printing Company—opened in 1884 (see Gaudreau 1995, for a detailed account).

[11]Recent anecdotal evidence illustrating those kinds of evolutions abound in the press. As stated for example in a Québec business newspaper (our translation): *"Forget about cotton T-shirts: at the Expo Hightex 2009, the conferences were about 'nano-porous materials for drug transfers', 'preformed 3D textiles for aerospatial composites' or 'naturally flame-retardant cellulosic fibers'* [...] *Production is scaled back. The industry is oriented towards niche products with substantial value added and without aiming necessarily at large production runs."* (Source: `http://affaires.lapresse.ca/economie/Québec/200910/16/01-912111-le-retour-du-textile-Québecois.php`, last accessed on June 13, 2017).

[12]These findings are consistent with many studies that have substantiated the existence of strong geographic concentration in the T&C sector, especially at fine geographic scales. See Duranton & Overman (2005) for the United Kingdom; Ellison et al. (2010) for the U.S.; Nakajima et al. (2012) for Japan; Barlet et al. (2013) for France; and Behrens & Bougna (2015) for Canada.

Figure 2: Changes in the spatial concentration of the T&C sector between 2001 and 2013.



Notes: The figures report the K-densities (in solid red) and the 90% global confidence bands (in dashed black) for the T&C sector in 2001 and 2013, using plant counts. Distributions of distances that fall into this confidence band can be considered 'as good as random' and are, therefore, not considered to be either localized or dispersed. See online Appendix V for additional details.

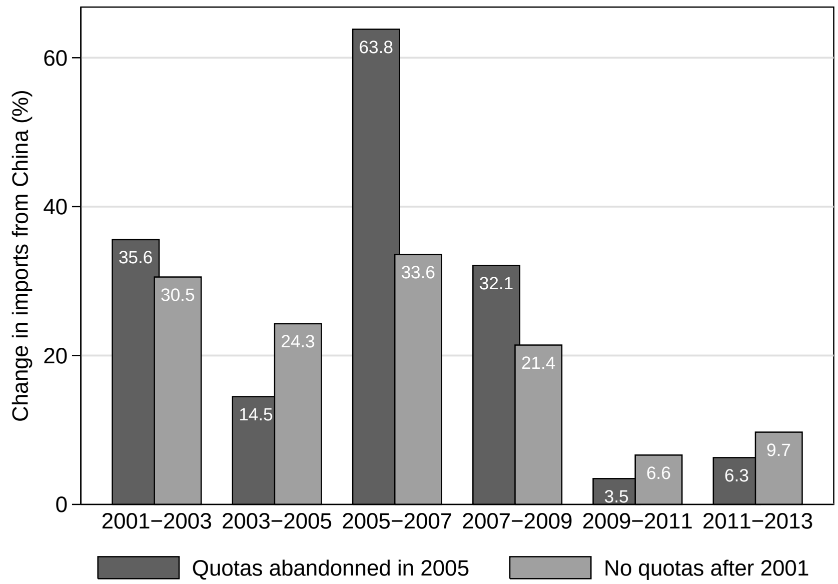
idence for geographic concentration and changes therein in online Appendix T (in particular, see Figure 12 for evidence of significantly more plant exit at short distances).

2.5 Aggregate facts: trade protection

The entry of China into the World Trade Organization (WTO) in 2001 and, more importantly, the end of the Multifibre Arrangement (MFA) on January 1st, 2005, profoundly altered the landscape of the T&C sector. Since 1973, the MFA regulated—via a quota system—how much textile and clothing products developing economies could export to developed countries. As described by Brambilla et al. (2010), quotas were removed in four phases in 1995, 1998, 2002, and 2005. Because China was not part of the WTO, quotas on Phases I, II, and III products were all relaxed in 2002. Phase IV—which we focus on in the remainder of the paper—relaxed the remaining quotas on Chinese exports (see Table 12 in Appendix B for a summary of the industries that were subject to active quotas until the end of 2004). This last wave of quota removal caused a dramatic increase in imports of formerly protected products from China and had the largest adverse impact on Canadian exports (Brambilla et al. 2010). As opposed to the U.S. or the European Union, who implemented safeguard measures to limit the growth of T&C imports from China until 2008, this policy was not impeded by subsequent import restrictions in Canada (Audet 2007, p.270).

Figure 3 shows that, as expected, sectors that had an active quota until December 31, 2004, experienced a much larger increase in imports than the remaining sectors in the wake of the

Figure 3: Changes in T&C imports from China by quota status.



MFA: total imports in industries that were subject to a quota rose by 270% between 2001 and 2013, as compared to 144% for the rest of the sector. For example, imports from China in the 'Hosiery and Sock Mills' industry (NAICS 315110) were multiplied by 24 between 2001 and 2013, and China's market share in Canadian imports in that industry jumped dramatically from 5 to 50%. Clearly, the textile industry experienced very substantial changes in its international trading environment over our study period. Furthermore, these effects were especially strong between 2005 and 2007, i.e., when 'the floodgates opened'.

The surge in Chinese imports that followed the end of the MFA had strong impacts on the T&C sector. To see that, we regress industry-level measures of the number of plants, employment, and productivity on a measure of trade exposure. The latter is measured by: (i) an MFA dummy that takes the value one as of 2005—i.e., after the end of the Multifibre Arrangement—and zero otherwise; and (ii) a quota dummy that indicates whether the industry was protected by a quota until 2005 (see Table 12 in Appendix B). We further control for year and industry fixed effects.

Columns (1) and (2) of Table 4 show that the end of the MFA was associated with substantial exit of T&C plants and a drop in industry-level employment in industries that were subject to a quota prior to 2005. Column (3) shows that the end of the MFA was not associated with significant productivity gains. The question we ask in the rest of the paper is whether plants inside and outside clusters felt this shock in different ways.

Table 4: Changes in the number of plants, employment, and productivity (T&C industries only).

	Number of plants	**Industry employment**	**Industry productivity**
	(1)	(2)	(3)
Post 2005 × Quota	-0.160^{a}	-0.215^{c}	0.140
	(0.046)	(0.120)	(0.117)
Fixed effects	Industry (6-digit NAICS) and year		
Additional controls	Export share of the industry to high-income countries		
Obs.	152	152	152
R^2	0.982	0.918	0.861

Notes: All variables are measured at the NAICS 6-digit level and in logs, except for the export share controls which are in levels. 'Industry productivity' is measured by the value added per worker. High-income countries are defined as countries whose GDP per capita is higher than 95% of U.S. GDP per capita (Bernard et al. 2006). Huber-White robust standard errors in parentheses. ^{a} = significant at 1%, ^{b} = significant at 5%, ^{c} = significant at 10%.

3 T&C plants and geographic clusters

3.1 Data

Our primary data source is the *Scott's National All Business Directories Database*. This proprietary establishment-level database contains information on plants operating in Canada, with a very exhaustive coverage of the manufacturing sector. These data—which draw on the business register—are very similar to those of the *Annual Survey of Manufacturers* (ASM) Microdata Files and the *Canadian Business Patterns* (CBP) in terms of coverage and industry-level breakdown of plants and, therefore, provide a fairly accurate picture of the overall manufacturing structure in Canada over our study period. Our cleaned dataset contains 321,683 manufacturing plant-year observations from 2001 to 2013, in two-year intervals. For every plant, we have self-reported information on the primary 6-digit NAICS code and up to four secondary 6-digit NAICS codes; its employment; its export status; up to 10 products produced; and its 6-digit postal code. We do not have firm identifiers for plants, but we create those using the legal name of the entity to which the plant belongs (see online Appendix U for additional details).

Because our dataset uses four different NAICS classifications (NAICS 1997, 2002, 2007, and 2012), we concord all 6-digit industries to 242 time-consistent industries using the crosswalks provided by Statistics Canada.[13] We include all manufacturing plants—i.e., plants that report a manufacturing sector, NAICS 31–33, as their primary sector of activity—in our analysis and apply a 0.5% trimming from above on employment to get rid of some obvious coding mistakes. We also drop a few plants for which we have partial information only.

We geocode plants by using latitude and longitude information of postal code centroids obtained from the Postal Code Conversion Files (PCCF). These files associate each postal code

[13]We exclude two industries (NAICS 325110 'Petrochemical manufacturing', and 311830 'Tortilla manufacturing') from our analysis because they contain only a very small number of plants. Table 18 in online Appendix T shows which textile industries are aggregated to obtain our stable NAICS classification for T&C.

with different geographical classifications that are used for reporting census data. We match plant-level postal code information with geographic coordinates from the PCCF, using the postal code data for the next year in order to consider the fact that there is approximately a six months delay in the updating of postal codes. Since postal codes have no one-to-one correspondence with the census geography, we match our postal codes using the Single Link Indicator of the PCCF in case of multiple matches. Note that postal codes are very fine-grained in Canada, especially in denser and more urban areas. There were, e.g., 818,907 unique postal codes as of May 2002, and 890,317 unique postal codes as of October 2010. Postal code centroids thus provide a fairly precise description of microgeographic location patterns. Although they are somewhat less fine-grained in very rural areas, those areas contain fewer plants. Figure 7 in online Appendix T illustrates the granularity of our data.

3.2 Mapping clusters

We use our geocoded plant-level data to identify geographic clusters of T&C plants based on two criteria: specialization and size (see also Delgado et al. 2016). Starting with specialization, we first compute for each T&C plant j, the number of *other* T&C plants and the number of non-T&C plants in a radius of 15 kilometers around plant j. Assume that there are n_j T&C plants and m_j non-T&C plants within that radius. Assume also that there are N T&C plants and M non-T&C plants in the total population of manufacturing plants. Then, the probability that there are more than n_j T&C plants among the $n_j + m_j$ plants around j can be computed from a cumulative distribution function (CDF) of a hypergeometric distribution. Assume that the value of the CDF is 0.9 for plant j. This means that there is only a 10% chance of observing more than n_j T&C plants around plant j, conditional on having $n_j + m_j$ plants in total around plant j and conditional on the overall share $N/(N+M)$ of T&C plants in the manufacturing population. We consider that such a case—with a p-value below 0.1—represents 'clustering' of T&C plants around plant j, and we refer to such plants j as *focal plants*. Turning next to size, we require that clusters have a minimum number of plant counts around the focal plants identified before. This criterion is required to exclude the case of areas with only few plants that happen to belong to the T&C sector. Such plants would always seem 'clustered' based on specialization alone, though it is hard to talk about clusters of very small numbers of plants. Hence, we impose a minimum requirement of 5 other T&C plants around focal plants in order to talk about clusters.

Using focal plants and our size thresholds, we define clusters as follows. We take all focal plants (with p-values below 0.1) that have at least 5 other T&C plants around them. We then draw a 15 kilometers buffer around these focal plants and define the clusters as the unions of those buffers (see Buzard et al. 2017 for a similar approach called 'multi-scale core clustering'). Each disjoint set of the union corresponds to a separate geographic cluster. For descriptive purposes, we also split clusters into 'big' and 'small' clusters, where the former have a size threshold of 25 plants compared to 5 plants for the latter. Plants that are used to define big clusters are excluded from the construction of small clusters (big and small clusters may overlap). In a last step, we associate all other manufacturing plants to the clusters as defined above. Our cluster mapping procedure allows us to delimit 24 T&C clusters—9 big and 15 small—in Canada in 2001. Table 17 in online Appendix T reports selected characteristics of plants that belong to these 24 clusters.

Figure 4: 'Unweaving' textile clusters in Québec (top panel) and Ontario (bottom panel).

(a) 2001. (b) 2013.

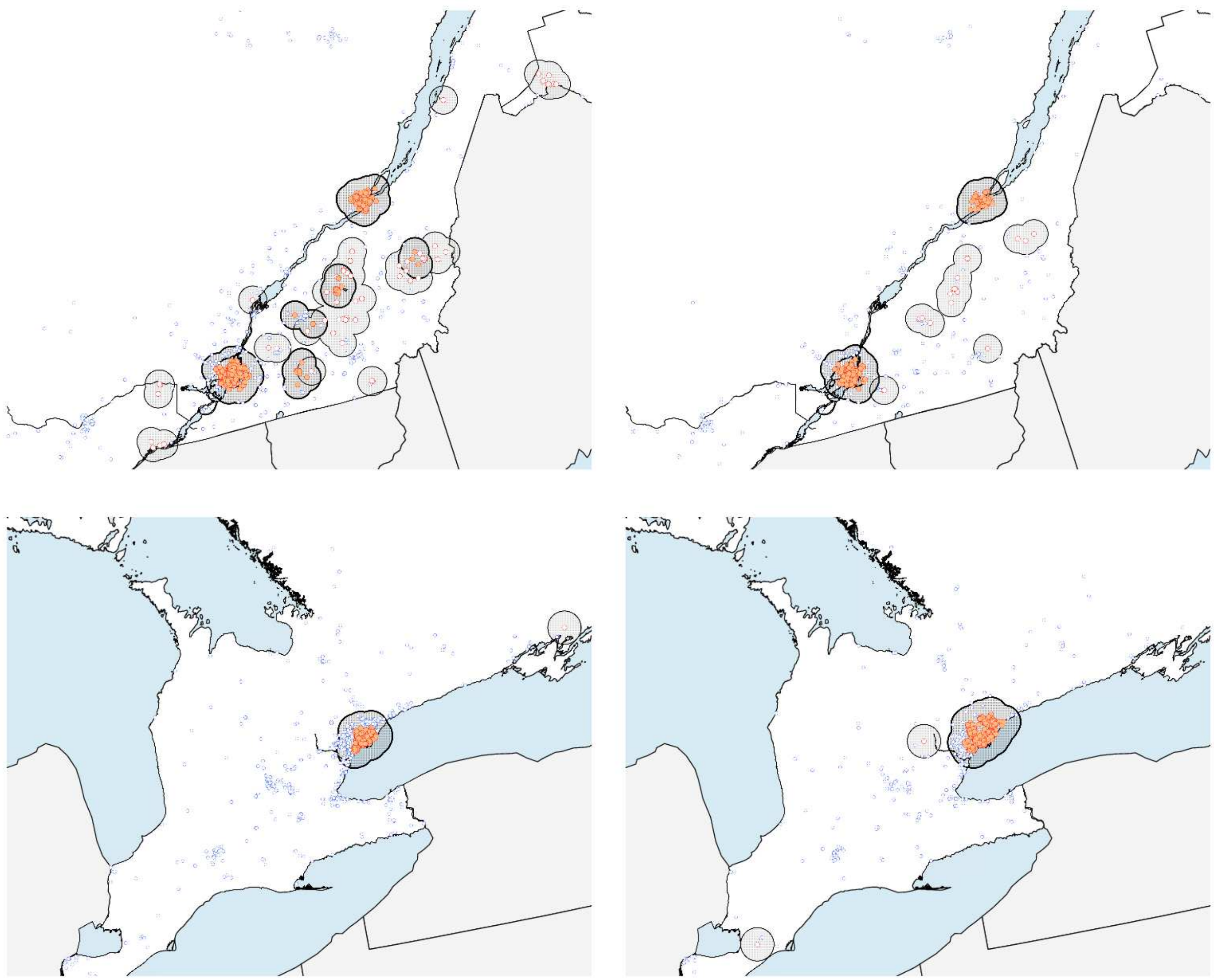


Figure 4 shows our T&C clusters in Québec and Ontario in 2001 and 2013, respectively. Québec is the province with the highest share of employment in the T&C sector (53% in 2001, see Table 5), and both provinces account for more than 75% of total employment in that sector. As explained in Section 2.1, this pattern has a long history. The location of big clusters is depicted by the bold shaded areas, and big cluster focal plants are depicted by red orange-filled points. Small clusters are depicted by light shaded areas, and small cluster focal plants are depicted by red empty circles. Last, T&C plants that are not focal (i.e., with a p-value above 0.1) are depicted by blue empty circles. As mentioned before, although non-focal plants do not serve to define clusters, they may belong to a cluster if they are located less than 15 kilometers away from a focal plant. A visual inspection of Figure 4 shows that T&C clusters have been 'unweaving'—the number of small clusters decreases substantially, while big clusters shrink—and only a few clusters remain in 2013.

The substantial and rapid changes in the geography of clusters pose a problem when it comes to analyzing their impacts on plant-level outcomes. While clusters are inherently dynamic objects, their changing geographic boundaries complicate the econometric analysis (we return to that point later in more detail). To cope with that problem, we assign in what follows plants to clusters as defined by the clusters' geography in 2001.

Table 5: Allocation of T&C plants to textile clusters.

	Constant cluster definitions, based on 2001 delimitations		Share of Canadian T&C
Year	Number of plants	Share clustered	empl. in Québec
2001	4,465	64.12%	53.41%
2003	4,386	63.91%	51.34%
2005	3,803	63.24%	52.60%
2007	3,170	61.55%	48.31%
2009	2,910	60.86%	47.33%
2011	2,696	59.57%	46.72%
2013	2,057	57.80%	45.82%

Notes: We report the allocation of T&C plants to clusters, where clusters are defined based on their 2001 delimitations (i.e., we do not report results based on the contemporaneous delimitation of clusters as given by the spatial structure in the current year t). The last column reports the share of T&C employment located in Québec (all plants, including those not in clusters).

Table 5 summarizes the allocation of plants to clusters for our different years. It shows that the T&C sector is strongly clustered as 64% of the textile plants are in a cluster in 2001. This share remained stable until 2005—despite a large drop in the total number of plants—and then declined to finally reach 58% in 2013. Again, the empirical evidence suggests that plants in clusters exited more than more isolated plants (see also Figure 12 in online Appendix T).

4 Empirical analysis

We now use our plant-level data and geographic clusters to investigate whether or not plants in clusters are more resilient to adverse economic shocks than plants outside clusters. To begin with, we first define what we mean by resilience and look at some of its dimensions.

4.1 Resilience: empirical framework

Any empirical analysis of resilience must ask two questions: What is resilience (concept) and who is resilient (object)? Let us start with the question 'What is resilience'? Following Martin & Sunley (2015, pp. 3–7), we can define a variety of types of resilience: (i) engineering resilience, defined as *"a system's ability to absorb a shock without changing its structure, identity and function"*; (ii) ecological resilience, defined as *"how fast a system that has been displaced from equilibrium by a disturbance or shock returns to that equilibrium while undergoing change so as to still retain essentially the same function, structure, and identity"*; and (iii) adaptative resilience, defined as the ability to *"resist external and internal disturbances and disruptions if necessary by undergoing plastic change in some aspects of its structure and components."* In what follows, we refer to (i) and (ii) as '*within* resilience' and to (iii) as '*between* resilience'. Let us next ask 'Who is resilient'? Is it plants? Industries? Regions? Clearly, the answer to that question largely determines the analysis. For example, assume that plants in industry i and region r are hit by shocks. If they die, we can surely say that there is no resilience, neither at the plant-, nor at the industry- or region level. If they, on the contrary, stay and continue with business-as-usual, then the plant—and industry and region—are resilient ('within' resilience). However, if plants switch from industry i to industry j, or move from region r to region s, then there is resilience at the level of the plants, but not for the industry or the region ('between' resilience).

To fix ideas on how to operationalize the concepts of resilience described above, consider a plant that operates in the T&C sector and faces either idiosyncratic or industry-wide shocks. The plant can either: (i) stay in the T&C sector ('stay'); or (ii) exit from the T&C sector ('exit'). Exit can further take one of the following forms: plant death ('die'); or switching out of textile manufacturing into some other manufacturing or service activity ('switch'). A plant that stays exhibits within resilience since it absorbs the shock without changing its structure, identity, and function. A plant that exits without dying exhibits between resilience since it has to change in order to adapt to the disturbance. Finally, a plant that dies is not resilient.

Let $P(\cdot)$ denote the probability of an event, and let $P_X(\cdot)$ denote the probability of that event conditional on a set of covariates X. Let $C = 1$ if the plant belongs to a cluster, and $C = 0$ otherwise. Let $\Delta P_X(\text{die})$ denote the difference in the probability of death between a 'clustered' plant and a plant outside of the cluster, conditional on X. This probability premium of death for a plant in a cluster can be written as:[14]

$$\begin{aligned} \Delta P_X(\text{die}) &\equiv P_X(\text{die}, C=1) - P_X(\text{die}, C=0) \\ &= \beta \Delta P_X(\text{exit}) - \alpha \Delta P_X(\text{switch}|\text{exit}), \end{aligned} \tag{1}$$

with $\alpha \equiv P_X(\text{exit}, C=1) > 0$ and $\beta \equiv P_X(\text{die}|\text{exit}, C=0) > 0$. Equation (1) shows that the

[14]To derive this formula, we use the following: (i) exit is due to either plant death or switching, i.e., $P_X(\text{switch}|\text{exit}) + P_X(\text{die}|\text{exit}) = 1$; (ii) the conditional probability $P_X(\text{die} \cap \text{exit}) = P_X(\text{die}|\text{exit}) \times P_X(\text{exit})$; and (iii) $P_X(\text{die} \cap \text{exit}) = P_X(\text{die})$, since a plant necessarily exits if it dies.

difference in the probability of death between 'clustered' and 'unclustered' plants rises with the probability of exiting from the T&C sector and, conditional on this exit, decreases with the probability to switch into another industry. In a nutshell, the three terms in equation (1) are linked to our three concepts of interest: (i) $\Delta P_X(\text{die})$ is related to the absence of resilience; (ii) $\Delta P_X(\text{exit})$ is related to within resilience; and (iii) $\Delta P_X(\text{switch}|\text{exit})$ is related to between resilience. The subsequent presentation of our empirical results is thus organized along these lines. We examine whether plants in cluster are more resilient or not in a broad way, as captured by $\Delta P_X(\text{die})$, and what is the effect of the ability to stay active in the industry, $\Delta P_X(\text{exit})$, and the ability to switch activity when exiting, $\Delta P_X(\text{switch}|\text{exit})$. Note, finally, that between resilience could also encompass the relocation of plants across regions following localized shocks. We abstract from this since the shock we consider affected all of Canada in the same way, and since we observe very few geographic relocations of plants within Canada in our data.

4.2 The resilience of T&C clusters

As explained above, we are interested in several adjustment margins—plant death, exit from textile manufacturing, and adaptation—to gauge how resilient plants are to adverse shocks.[15]

4.2.1 Baseline results

We start by estimating the following econometric model:

$$y_{jpt} = \beta_1 CL_j^{01} + \beta_2' X_{jt} + \gamma_{i(j)t} + \phi_p + \epsilon_{jpt} \qquad (2)$$

where y_{jpt} alternatively refers to our three dimensions of resilience of a plant j, active in industry i and located in province p at time t. We regress these variables on a binary variable CL_j^{01} that takes value one if the plant belongs to a T&C cluster as defined in 2001, and zero otherwise. As explained in Section 3.2, clusters change over time, and their geographic extent is endogenous to plants' survival and location choices. Hence, to minimize endogeneity concerns, we use constant cluster definitions based on 2001 data. We estimate equation (2) for 2003–2013 using a linear probability model (LPM) and restrict our sample to plants that were present in 2003, i.e., we do not consider entry and (eventually) subsequent exit of new plants. We believe this is a cleaner econometric exercise, and the results including the (few) new entrants are basically the same. Our main coefficient of interest is β_1. Since theory is inconclusive as to

[15]We also analyze downsizing, as measured by employment changes, conditional on staying in the T&C sector. We find almost no effects at the intensive margin (see Table 13 in Appendix B). The aggregate industry-level analysis in Table 4 reveals that employment in textile industries fell after the end of the MFA. We may thus conclude that this effect is driven by the extensive margin (exit) rather than by the intensive margin (downsizing). The aggregate analysis does not allow to disentangle these two effects.

whether clusters make plants more resilient or not, we have no prior on its sign (see the online Appendix W for a simple model that makes this point formally).

To control for the influence of plant-level characteristics and the potential self-selection of plants with different characteristics into clusters, we control for a number of time-varying plant characteristics X_{jt}, including employment, a dummy variable indicating whether the plant exports or not, a dummy variable indicating whether the plant belongs to a multiunit firm or not, and a measure of the plant's 'industry breadth', defined as the number of non-T&C industries declared by the plant as secondary activities. We further include industry-year fixed effects, $\gamma_{i(j)t}$, and province fixed effects, ϕ_p, in our baseline estimations and cluster the standards errors by census division.[16] Finally, ϵ_{jpt} is the error term.

In Table 6, we first estimate model (2) without controls and fixed effects. Column (1) reports results for plant death, i.e., our indicator y_{jpt} ('die') equals one if the plant ceases to exist between year t and $t+4$, and zero if it is still active in $t+4$. The coefficient on cluster shows that plants belonging to a cluster are more likely to die than other plants. This suggests that T&C plants that belong to a cluster do not perform better than more isolated ones in terms of pursuing operations.

Table 6: Dimensions of resilience of T&C sector plants (LPM, no controls).

	Die	Exit	Switch | Exit	Services | Switch
	(1)	(2)	(3)	(4)
Cluster	0.027^a	0.012	-0.085^a	0.233^a
	(0.010)	(0.009)	(0.021)	(0.055)
Observations	14,615	14,615	3,141	826
R^2	0.001	0.000	0.009	0.054

Notes: Standard errors clustered by census division in parentheses. ^{a} = significant at 1%, ^{b} = significant at 5%, ^{c} = significant at 10%.

Column (2) shows that this higher probability of death in clusters does not translate into a higher probability of exiting the T&C sector: plants in clusters do not exit more than unclustered plants. According to our empirical framework in (1), we thus expect clustered plants to be less prone to switch to a non-T&C activity. This is verified in column (3), which shows that clustered plants have a lower probability of changing activity conditional on exit. In a nutshell, clusters seem to harm the resilience of T&C plants by increasing their probability to die, and by reducing their ability to survive by adapting their main line of business (conditional on exit). Quantitatively, we find that clustered plants are on average 2.7% more likely to die, and those that exit the T&C sector are 8.5% less likely to switch to a non-T&C industry than more isolated plants, conditional on exit.

As previously shown in Table 3, about half of the switching plants changed for service industries, while the other half switched to a different (non-T&C) manufacturing activity. Hence, in column (4) of Table 6, we further investigate whether there are systematic differences in the

[16] There were 288 census divisions in Canada in 2001, and 244 of them contained at least one T&C plant.

switching behavior inside and outside clusters, i.e., we look at the determinants of switching into services conditional on switching. The estimation on these 'switchers' shows that plants in clusters are 23.3% more likely to switch into services than unclustered plants. Put differently, isolated plants are more likely to switch into another manufacturing industry but less likely to make the transition to the service sector. This suggests that, conditional on switching, clusters facilitate transitions from blue collar to white collar activities.

One may worry that firms self-select into clusters. Indeed, plants with different characteristics can sort differently across space. For instance, low- or high-performing plants can disproportionately sort into clusters. To understand how differences in plant characteristics inside and outside clusters can affect our results, we estimate our model including important plant-level controls, as well as industry-year and province fixed effects. The results are provided in Table 7.

Table 7: Dimensions of resilience of T&C sector plants (LPM).

	Die	Exit	Switch | Exit	Services | Switch
	(1)	(2)	(3)	(4)
Cluster	0.008	0.012	0.014	0.073^b
	(0.008)	(0.009)	(0.013)	(0.036)
Employment	-0.022^a	-0.023^a	0.018^b	-0.029^c
	(0.004)	(0.004)	(0.007)	(0.016)
Exporter	-0.039^a	-0.036^a	0.048^a	0.066
	(0.007)	(0.007)	(0.016)	(0.052)
Multiunit	0.058^a	0.057^a	-0.038	-0.008
	(0.014)	(0.016)	(0.041)	(0.065)
Industry breadth	-0.054^a	0.030^a	0.295^a	-0.051
	(0.006)	(0.008)	(0.021)	(0.031)
Fixed effects	Industry-year and province			
Observations	14,615	14,615	3,134	802
R^2	0.043	0.074	0.306	0.425

Notes: Standard errors clustered by census division in parentheses. ^{a} = significant at 1%, ^{b} = significant at 5%, ^{c} = significant at 10%.

Comparing the results with and without controls suggests that plants inside and outside clusters differ along various dimensions including employment, export status, multiunit status, and plant diversification. Because these characteristics are correlated with the plant outcomes we examine and affect the results, we conclude that it is important to control for selection in our analysis.[17] Of course, we acknowledge that our list of controls is not exhaustive. However, we do believe that they are highly correlated with most of the theoretical characteristics that may influence a plant's location choice—on top of them, performance—and the various outcomes we consider.

[17] In an unreported exercise, we find that, among these controls, plants' diversification (i.e., industry breadth) is central to understand how the empirical results vary with the inclusion of control variables. Plants outside clusters are twice as diversified as plants within clusters. Since diversification is also an important determinant of industry switching, controlling for this plant-level characteristic is crucial.

The results in Table 7 show that large plants and exporters tend to be more resilient: they are less likely to die and to exit (see Bernard et al. 2007, for similar results), and more likely to change primary activity conditional on exiting. Stand-alone plants, instead, 'only' perform better than multi-unit establishments in terms of *within* resilience. Besides, the industrial breadth of a plant—the extent of its cross-sectoral diversification—is also negatively correlated with the probability to die. However, it is associated with a higher probability of exiting the sector. These two opposite results imply that, conditional on exiting, plants have a higher chance to change their main line of activity if they were initially more diversified.

Conditional on plant characteristics, the coefficients on our variable of interest show that, over the 2003–2013 period, plants in clusters were as likely to die, to exit, or to switch activities than more isolated plants. We hence conclude that industrial clustering had no impact on the resilience of plants in the T&C sector in Canada. However, we still find that clusters matter when it comes to transitioning from manufacturing to services. Textile plants are, indeed, on average 7.3% more likely than unclustered plants to transition to services conditional on switching and conditional on observable plant-level characteristics.

4.2.2 Robustness

We next perform a series of robustness checks. First, we investigate whether the coefficient on cluster captures the influence of agglomeration more broadly defined. If dense areas favor resilience while industrial clusters reduce it (or vice versa), the net effect may be nil, explaining the absence of plants' resilience in clusters. To disentangle both effects, we add the employment density of the cluster in which the plant is located as a control variable.[18] The results are provided in panel (a) of Table 8. For the sake of simplicity, we only report the results for our variable of interest—the cluster variable—in that table. The results show that including this measure of agglomeration does not affect the estimated impact of clusters on plants' resilience. The coefficients on our three adjustment margins are insignificant. However, column (4) shows that the higher likelihood of plants to switch to services conditional on switching is driven by the employment density of the area. The coefficient on density shows that, as employment density rises by 1%, plants are 2.4% more likely to switch into services conditional on switching.

Until now, our measure of clustering is a dummy variable that takes value one if the plant belongs to a cluster and zero otherwise. Yet, a plant located at the border of a cluster could still benefit from its positive externalities or, conversely, suffer from increased competition in factor and product markets. As a second robustness check, we use a continuous measure of exposure to clusters by computing each plant's distance to the centroid of the closest cluster.

[18]We compute this variable in a 15km radius around the plant. Taking the log of employment or the log of density is then, up to a constant term, the same.

This introduces variation within unclustered plants between those which are relatively close to a cluster and the ones that are truly isolated. Similarly, we introduce variations within clusters between centrally located plants and those which are at the cluster fringe. Our results are summarized in panel (b) of Table 8. The results are fairly similar to those using the dummy variable, though more precisely estimated given more variability in exposure to clusters. Our main message remains however unchanged: clusters do not make plants more resilient. If anything, being closer to a cluster center has a positive effect on plants' tendency to exit, and a negative impact on their ability to switch activity. Consistent with our previous findings, we also find that, as distance to the centroid of a cluster increases by 1%, plants are 3.2% less likely to switch into services conditional on switching.

As a third robustness check, we control for the fact that clusters delineated in 2001 could be the result of recent anticipations of individual plants. For instance, plants anticipating their switching to services could choose to locate near city centers. Observed clusters would thus be implied by individual plants' decisions regarding their transition. To deal with these endogeneity issues, we use historical information on clusters. More specifically, panel (c) Table 8 reports results where we instrument for the presence of a plant in a cluster using information on the spatial distribution of T&C industries in 1871. As explained in Section 2.1, the T&C sector was historically strongly concentrated in Québec and Ontario. The presence of these historical clusters may have persisted over time as they offered local skilled labor and dedicated infrastructure (e.g., proximity to hydraulic energy). Hence, we instrument our cluster dummy by computing, for each plant, its distance to historic census sub-districts, weighted by the T&C employment share of each sub-district in the 1871 Census.[19] The instrument thus reflects how close the plant is from historical T&C jobs. If there is persistence in the location patterns of plants, the instrument helps to predict the location of T&C clusters without being affected by contemporaneous considerations on plants' resilience. The first stage shows that distance to 1871 T&C employment strongly predicts the presence of a plant in a 2001 cluster. Once instrumented, the coefficients of the baseline regressions show that clusters are associated with more death and exit, while having no effects on switching. To summarize, all of our specifications point to one main conclusion: no matter how we gauge the resilience of plants, belonging to a cluster did not make Canadian textile plants more resilient to shocks. If anything, it is rather the opposite.

Last, we run a number of additional robustness checks. For the sake of brevity, the results

[19]Details on the 1871 Canadian Census are provided in Appendix A.2. Our instrument is constructed as: $Dist1871_j = \sum_d w_d log(dist_{jd})$, with w_d the share of sub-district d in 1871 T&C employment, and $dist_{jd}$ the distance between plant j and subdivision d. There are 1,793 sub-districts in our data. The sub-districts are quite precise around cities in the provinces of Québec and Ontario, but larger in western territories. This reflects the distribution of the population at the time of the census. See Figures 5 and 6 in online Appendix T for an illustration of our historic data at the level of the historic districts.

Table 8: Dimensions of resilience of T&C sector plants (robustness checks).

	Die	Exit	Switch | Exit	Services | Switch
	(1)	(2)	(3)	(4)
Panel (a): Controlling for employment density				
Cluster	0.008	0.007	0.001	0.020
	(0.009)	(0.010)	(0.017)	(0.043)
Employment $\leq$ 15km (log)	-0.000	0.002	0.005	0.024^b
	(0.002)	(0.003)	(0.005)	(0.012)
Observations	14,615	14,615	3,134	802
R^2	0.043	0.074	0.306	0.429
Panel (b): Continuous exposure to T&C clusters				
Distance to cluster	-0.004	-0.006^b	-0.008^b	-0.032^a
	(0.003)	(0.003)	(0.005)	(0.012)
Observations	14,615	14,615	3,134	802
R^2	0.043	0.074	0.306	0.428
Panel (c): Instrumental variables estimates				
Cluster	0.047^a	0.072^a	0.025	0.098
	(0.022)	(0.026)	(0.031)	(0.094)
Observations	14,615	14,615	3,134	802
R^2	0.042	0.071	0.305	0.425
F-stat	25.55	25.55	28.51	16.53
First stage				
Dist. to 1871 empl.	-0.660^a	-0.660^a	-0.701^a	-0.725^a
	(0.131)	(0.131)	(0.131)	(0.178)
Observations	14,615	14,615	3,134	802
Plant-level controls	Included			
Fixed effects	Industry-year and province			

Notes: Standard errors clustered by census division in parentheses. ^{a} = significant at 1%, ^{b} = significant at 5%, ^{c} = significant at 10%. Plant-level controls are included but not reported. The excluded instrument is the average distance of the plant to 1871 historic census sub-districts, weighted by the 1871 T&C employment of the sub-districts. The F-statistics are Kleibergen-Paap Wald F-statistics.

are not reported in the paper but are available upon request. First, we change the geographic extent of our clusters by adjusting our cluster detection procedure to use either a smaller radius of 10 kilometers or a larger radius of 20 kilometers to detect focal plants and to construct the cluster buffers. Second, we replicate the estimations using a probit model instead of the linear probability model. In both cases, the results remain very similar, both qualitatively and quantitatively.

4.3 Resilience after the end of the MFA

Our foregoing analysis provides insights into the resilience of clusters. However, it does not pay explicit attention to the source and the nature of the economic shocks. In order to more precisely evaluate how plants react to specific shocks, we need the latter to be exogenous to the clusters. Given that clusters are rather small areas that host subsets of strongly interconnected industries, idiosyncratic shocks to establishments may simultaneously drive firm-level outcomes and cluster dynamics, thereby complicating identification. On top of being exogenous, the shock should be large in magnitude and specific to the clustered industries.[20] With this in mind, we refine our identification strategy by exploiting the end of the MFA as an industry-wide shock to Canadian T&C firms. As explained in Section 2.5, starting from 2005 we observe a surge in imports from China for goods in industries that were previously protected by an active quota until the end of 2004. Since having an active quota in 2004 is a good predictor of the magnitude of the sectoral trade shock (see Figure 3), we will use a 'quota dummy' as a proxy for the increase in import exposure. Contrary to trade flows, this variable is much less likely to suffer from potential endogeneity biases. Industries with an active quota in 2004 should display a stronger reaction since they experienced a more severe treatment. By contrast, we do not expect any specific change in imports from China for unprotected goods or for products protected by quotas that were not binding.

Before proceeding, it is worth pointing out that the end of the MFA was anticipated. In the words of Harrigan & Barrows (2009, p.282), the end of the MFA was a "[...] *large, sudden, fully anticipated, easily measured, and statistically exogenous change in trade policy.*" This raises the question of potential anticipation effects that may blur the treatment as firms already adjusted prior to the shock. However, we do not think that extensive pre-shock adjustements are important in our case. Indeed, the Apparel Human Resource Council of Canada commissioned a study in 2004 to evaluate potential adverse consequences of the end of the MFA (see RichterConsulting 2004). A survey of senior executives of Canadian apparel manufacturers and contractors revealed that, although "*[m]ost executives are aware of the pending free trade agreements and most believe that there will be major ramifications resulting there from* [...] *a startling 83% of companies do not have a clear strategic plan to deal with these changes.*"[21] Also, should anticipation effects have been important, we should not have seen the spike in exit after 2005. If plants under import quotas anticipated the removal in 2005, then the effects we estimate should capture a lower bound. This should work in our favor. Last, we instrument the contemporaneous presence in a cluster by historical information on geographic concentration to deal with the possible interactions of anticipations with geographic patterns.

[20]Large macroeconomic shocks—such as the Great Recession or the trade collapse—are probably too diffuse to allow for clean identification, and are not well suited to tease out the effects of that shock and its interaction with the geographic structure of the industry (Martin et al. 2013, Delgado & Porter 2017).

[21]For that survey, 109 questionnaires were completed in September and October 2003. The firms that were surveyed represented about 25% of the workforce in the apparel industry (93% of the respondents operated in urban areas, with 66% manufacturers and 34% contractors). See RichterConsulting (2004).

4.3.1 Main results

To investigate the consequences of the loss in trade protection, we now recast equation (2) as follows:

$$\begin{aligned} y_{jpt} \; = \; & \beta_0' X_{jt} + \beta_1 CL_j^{01} + \beta_2 \, Quota_{i(j)} + \beta_3 \, Post2005_t \times CL_j^{01} \\ & + \beta_4 \, Post2005_t \times Quota_{i(j)} + \beta_5 \, Quota_{i(j)} \times CL_{jt}^{01} \\ & + \beta_6 \, Post2005_t \times Quota_{i(j)} \times CL_j^{01} + \gamma_{i(j)t} + \phi_p + \epsilon_{jpt}, \end{aligned} \tag{3}$$

where $Post2005_t$ is a dummy variable that takes value one for the period after the end of the MFA, and zero otherwise; and $Quota_{i(j)}$ is our proxy of trade exposure which indicates whether plant j belongs to an industry i that was subject to quota restrictions until 2005. Our coefficient of interest is β_6, which measures whether plants in clusters that operated in quota-constrained T&C segments were affected differently after the end of the MFA.

Table 9: Dimensions of resilience of T&C sector plants after the end of MFA (LPM, no controls).

	Die	Exit	Switch | Exit	Services | Switch
	(1)	(2)	(3)	(4)
Cluster	0.023	0.000	-0.102^b	0.141^b
	(0.015)	(0.015)	(0.043)	(0.069)
Quota	0.028	-0.026	-0.225^a	0.497^a
	(0.021)	(0.021)	(0.059)	(0.128)
Post2005	-0.006	-0.027^a	-0.054	0.198^a
	(0.012)	(0.013)	(0.038)	(0.059)
Post2005 × Quota	0.025	0.068^b	0.122	-0.211
	(0.029)	(0.027)	(0.074)	(0.150)
Cluster × Quota	0.004	0.024	0.071	0.041
	(0.028)	(0.026)	(0.069)	(0.145)
Cluster × Post2005	0.002	0.013	0.026	0.022
	(0.015)	(0.019)	(0.040)	(0.081)
Cluster × Post2005 × Quota	-0.027	-0.041	-0.012	-0.021
	(0.032)	(0.031)	(0.078)	(0.177)
Observations	14,615	14,615	3,141	826
R^2	0.003	0.001	0.023	0.187

Notes: Standard errors clustered by census division in parentheses. ^{a} = significant at 1%, ^{b} = significant at 5%, ^{c} = significant at 10%.

We first estimate equation (3) without controls and fixed effects in Table 9. The results show that there are no systematic differences in plant deaths depending on the initial protection of the industry, and this pattern holds before and after the end of the MFA. We see in column (2) that establishments belonging to sectors in which quotas were active under the MFA exited more after 2005. Besides, plants active in these sectors were less likely to switch industry conditional on exiting, even if we do not see more action after the quota removal in 2005. Finally, column (4) shows that plants in protected industries disproportionately switched to services over the sample period. However, no matter how we gauge the resilience of plants under this shock, we do not observe any difference in the response of plants located inside and outside clusters. This confirms our main finding that establishments in clusters are, on average, not more resilient than those outside clusters.

Table 10: Dimensions of resilience of T&C sector plants after the end of MFA (LPM).

	Die	Exit	Switch | Exit	Services | Switch
	(1)	(2)	(3)	(4)
Cluster	0.017	0.014	0.007	0.013
	(0.014)	(0.016)	(0.035)	(0.047)
Cluster × Quota	0.005	0.016	-0.023	0.091
	(0.027)	(0.025)	(0.069)	(0.167)
Cluster × Post2005	-0.005	0.006	0.003	0.094^c
	(0.012)	(0.017)	(0.051)	(0.053)
Cluster × Post2005 × Quota	-0.040	-0.053^c	0.057	-0.125
	(0.031)	(0.030)	(0.073)	(0.199)
Plant-level controls			Included	
Fixed effects			Industry-year and province	
Observations	14,615	14,615	3,134	802
R^2	0.043	0.074	0.306	0.427

Notes: Standard errors clustered by census division in parentheses. ^{a} = significant at 1%, ^{b} = significant at 5%, ^{c} = significant at 10%. 'Quota', 'Post2005' and 'Post2005 × Quota' are included but absorbed by the industry-year fixed effects.

Controlling for plant-level characteristics as well as the influence of industry-year and province common patterns does not substantially change our results, as seen from Table 10. Almost none of the estimated coefficients are significantly different from zero. The coefficients on the '$Cluster \times Quota \times Post2005$' interaction are not significant in the regressions explaining plants' death and switching. However, the coefficient on the triple interaction is significant in the exit regression, but only at the 10% level. This suggests that plants inside and outside clusters had basically the same level of resilience following the end of the quotas in the more exposed sectors. These results are confirmed in a specification accounting for the potential endogeneity of our clusters based on 2001 definitions. We again instrument the cluster variable (and its interactions with our trade policy dummies) with the distance to 1871 T&C employment (and its interaction with our trade policy dummies). The results are provided in Table 14 in Appendix B. The instrumented specifications deliver similar results as our baseline regressions since almost none of the estimated coefficients on clusters, trade protection, and the post-2005 dummy are significantly different from zero. The only exception, again, is that we find a marginally significant cluster effect on reduced exit probabilities in initially protected industries.

4.3.2 Dynamics

We finally check whether the absence of an effect of clusters on resilience in the 8-year period following the end of the MFA might hide short-run effects. The results interacting our cluster variables with year fixed-effects and the quota dummy are summarized in panel (a) of Table 11. We do not find any specific patterns in terms of plants' reaction before the end of the MFA (see

Table 15 in Appendix B for the complete results for these specifications). Yet, we find that plants in quota-protected industries were less likely to die and to exit between 2005 and 2007 when they were in a cluster. This effect, however, is transitory and dissipates after 2007. While we have found until now that, if anything, plants inside clusters were less resilient than plants outside clusters, this new set of regressions suggests that clusters increased the resilience of plants in the immediate aftermath of the end of quotas on Chinese products. This is, however, a one-time resilience premium as we do not observe any advantage of being in a cluster for plants that survived after 2007. It is also important to notice that being in cluster only enhances the *within* resilience of plants.

To gauge the robustness of this result, we restrict our sample to the period 2003–2007 in panels (b) and (c) of Table 11. Focusing on the immediate post-MFA period, the results are—quantitatively and qualitatively—similar as shown by the coefficients on the interaction term. Hence, plants in initially protected industries and located in clusters tended to die and to exit less after the end of the MFA and the surge of Chinese imports that followed. In panel (c), we instrument the variable of interest with the distance to 1871 T&C employment and its interaction with the 'Post2005' and 'Quota' dummies. The coefficients on the first two columns are larger but less precisely estimated. Overall, they confirm that clustered plants in quota-protected industries were more resilient right after the end of the MFA.

5 Conclusion

The Canadian textile and clothing sector is geographically strongly concentrated, organized around a few economic clusters, and was subject to substantial import protection until the beginning of the 2000s. Therefore, it provides an ideal laboratory for evaluating the interplay between resilience and geographic patterns in a changing environment. In this paper, we have dissected the recent changes faced by this sector between 2001 and 2013, a period where it experienced large adverse industry-specific shocks. We question the ability of geographic clusters to shelter firms from these shocks. We find little evidence supporting this view when considering the entire T&C sector over almost a decade. Over that period, we find that plants in clusters were not more resilient than the others. This result is mitigated by the finding that, immediately after the end of the MFA—and in the most exposed industries—plants died and exited less when they were located in a cluster. This resilience premium of clusters was short-lived and dissipated in the two years following the end of the MFA.

With plant-level data, we are also able to show that many textile plants changed their main line of business over the period, meaning that 'adaptation' is an important margin of adjustment for firms facing tougher competition. In that respect, we find that plants in clusters do not statistically adapt more but, when they do, are more likely to switch into services. This

Table 11: Dimensions of resilience of T&C sector plants after the end of MFA (year-by-year).

	Die	Exit	Switch | Exit	Services | Switch
	(1)	(2)	(3)	(4)
	Panel (a): Dynamic effects			
Cluster × Quota × 2005	-0.105[b]	-0.102[b]	0.140	-0.274
	(0.041)	(0.042)	(0.093)	(0.296)
Cluster × Quota × 2007	-0.016	-0.032	0.028	-0.159
	(0.035)	(0.037)	(0.107)	(0.225)
Cluster × Quota × 2009	-0.028	-0.020	0.071	-0.283
	(0.047)	(0.049)	(0.095)	(0.255)
Cluster × Quota × 2011	0.036	-0.030	-0.082	-0.025
	(0.042)	(0.046)	(0.093)	(0.211)
Observations	14,615	14,615	3,134	802
R^2	0.043	0.074	0.306	0.429
	Panel (b): 2003-2007 sample			
Cluster × Quota × Post2005	-0.104[b]	-0.103[b]	0.124	-0.306
	(0.041)	(0.042)	(0.093)	(0.311)
Observations	7,746	7,746	1,740	364
R^2	0.038	0.060	0.254	0.611
	Panel (c): 2003-2007 sample (IV)			
Cluster × Quota × Post2005	-0.221[c]	-0.326[c]	-0.036	0.157
	(0.115)	(0.172)	(0.356)	(0.666)
Observations	7,746	7,746	1,740	364
R^2	0.013	0.021	0.244	0.590
Plant-level controls	Included			
Fixed effects	Industry-year and province			

Notes: Standard errors clustered by census division in parentheses. [a] = significant at 1%, [b] = significant at 5%, [c] = significant at 10%. Plant-level controls are included but not reported. Regressions include all interaction terms between 'Quota', 'Cluster' and the yearly dummies.

effect seems particularly strong in 'urban clusters' that have a high employment density.

Overall, in the face of major disturbances—such as the 'China shock'—whether firms belong to a cluster or not does not seem to be of first-order importance in the medium- and long-run, as plants roughly die evenly across space. However, local communities that host large clusters of firms will tend to suffer more. In levels, they are prone to experience more closures and exits. Therefore, knowing the exact location of industrial clusters is at least as useful as knowing whether an industry is concentrated in the aggregate, i.e., nation-wide. This substantiates the need for operational tools and methods that help us define clusters using a bottom-up approach. Such tools, as the ones developed in this paper, allow us to go beyond broad industry-level measures of geographic concentration.

The present papers calls for more work on the topic since there exists a variety of economic clusters and our results may not apply to all contexts. We have focused here on clusters in the T&C sector. This is a century-old light manufacturing industry with clusters characterized by their relatively 'urban nature' (in Canada, the largest T&C clusters are in major cities). However, we have developed a flexible methodology that can easily be applied to other industries, contexts, or regions. Hence, future research shall examine the resilience of clusters in other industries such as heavy manufacturing or services, or in clusters organized around small or medium-sized cities.

References

Audet, D. (2007), 'Smooth as silk? A first look at the post MFA textiles and clothing landscape', *Journal of International Economic Law* **10**(2), 267–284.

Balakrishnan, J. & Eliasson, J. B. (2007), 'Factors affecting the evolution of manufacturing in Canada: An historical perspective', *Journal of Operations Management* **25**(2), 260–283.

Barlet, M., Briant, A. & Crusson, L. (2013), 'Location patterns of service industries in France: A distance-based approach', *Regional Science and Urban Economics* **43**(2), 338–351.

Behrens, K. (2016), 'Agglomeration and clusters: Tools and insights from coagglomeration patterns', *Canadian Journal of Economics* **49**(4), 1293–1339.

Behrens, K. & Bougna, T. (2015), 'An anatomy of the geographical concentration of Canadian manufacturing industries', *Regional Science and Urban Economics* **51**(C), 47–69.

Bernard, A. B. & Fort, T. C. (2015), 'Factoryless goods producing firms', *American Economic Review* **105**(5), 518–23.

Bernard, A. B., Jensen, J. B., Redding, S. J. & Schott, P. K. (2007), 'Firms in international trade', *Journal of Economic Perspectives* **21**(3), 105–130.

Bernard, A. B., Jensen, J. B. & Schott, P. K. (2006), 'Survival of the best fit: Exposure to low-wage countries and the (uneven) growth of U.S. manufacturing plants', *Journal of International Economics* **68**(1), 219–237.

Bernard, A. B., Smeets, V. & Warzynski, F. (2017), 'Rethinking deindustrialization', *Economic Policy* **32**(89), 5.

Bloom, N., Draca, M. & Reenen, J. V. (2016), 'Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity', *Review of Economic Studies* **83**(1), 87–117.

Brambilla, I., Khandelwal, A. K. & Schott, P. K. (2010), China's experience under the Multi-Fiber Arrangement (MFA) and the Agreement on Textiles and Clothing (ATC), *in* 'China's growing role in world trade', NBER Chapters, National Bureau of Economic Research, Inc, pp. 345–387.

Breinlich, H., Soderbery, A. & Wright, G. C. (2014), From selling goods to selling services: Firm responses to trade liberalization, CEP Discussion Papers 1303, Centre for Economic Performance, LSE.

Buzard, K., Carlino, G. A., Hunt, R. M., Carr, J. & Smith, T. E. (2017), 'The agglomeration of American R&D labs', *Journal of Urban Economics* **101**, 14–26.

Campaniaris, C., Hayes, S., Jeffrey, M. & Murray, R. (2010), 'The applicability of cluster theory to Canada's small and medium-sized apparel companies', *Journal of Fashion Marketing and Management* **15**(1), 8–26.

Combes, P.-P. & Gobillon, L. (2014), The empirics of agglomeration economies, *in* G. Duranton, J. V. Henderson & W. C. Strange, eds, 'Handbook of Regional and Urban Economics', Vol. 5 of *Handbook of Regional and Urban Economics*, Elsevier, chapter 5, pp. 247–348.

Crozet, M. & Milet, E. (2017), 'Should everybody be in services? The effect of servitization on manufacturing firm performance', *Journal of Economics and Management Strategy* **26**(4), 820–841.

Delgado, M. & Porter, M. E. (2017), Clusters and the Great Recession, Technical report.

Delgado, M., Porter, M. E. & Stern, S. (2016), 'Defining clusters of related industries', *Journal of Economic Geography* **16**(1), 1–38.

Dongen, S. (2000), A cluster algorithm for graphs, Technical report, Amsterdam, The Netherlands.

Duranton, G. & Overman, H. G. (2005), 'Testing for localization using micro-geographic data', *Review of Economic Studies* **72**(4), 1077–1106.

Duranton, G. & Puga, D. (2004), Micro-foundations of urban agglomeration economies, *in* J. V. Henderson & J.-F. Thisse, eds, 'Handbook of Regional and Urban Economics', Vol. 4 of *Handbook of Regional and Urban Economics*, Elsevier, chapter 48, pp. 2063–2117.

Ellison, G., Glaeser, E. L. & Kerr, W. R. (2010), 'What causes industry agglomeration? Evidence from coagglomeration patterns', *The American Economic Review* **100**(3), 1195–1213.

Gaudreau, S. (1995), *Au fil du temps: Histoire de l'industrie textile à Magog (1883–1993)*, Magog: Groupe Scabrini Imprimeur.

Gebauer, H., Fleisch, E. & Friedli, T. (2005), 'Overcoming the service paradox in manufacturing companies', *European Management Journal* **23**(1), 14 – 26.

Harrigan, J. & Barrows, G. (2009), 'Testing the theory of trade policy: Evidence from the abrupt end of the Multifiber Arrangement', *The Review of Economics and Statistics* **91**(2), 282–294.

Helsley, R. W. & Strange, W. C. (2014), 'Coagglomeration, clusters, and the scale and composition of cities', *Journal of Political Economy* **122**(5), 1064–1093.

Holmes, T. J. & Stevens, J. J. (2014), 'An alternative theory of the plant size distribution, with geography and intra-and international trade', *Journal of Political Economy* **122**(2), 369–421.

Jofre-Monseny, J., Marín-López, R. & Viladecans-Marsal, E. (2011), 'The mechanisms of agglomeration: Evidence from the effect of inter-industry relations on the location of new firms', *Journal of Urban Economics* **70**(2-3), 61–74.

Jofre-Monseny, J., Sanchez-Vidal, M. & Viladecans-Marsal, E. (2018), 'Big plant closures and local employment', *Journal of Economic Geography* **18**, 163–186.

Kerr, W. R. (2008), 'Ethnic scientific communities and international technology diffusion', *The Review of Economics and Statistics* **90**(3), 518–537.

Khandelwal, A. K., Schott, P. K. & Wei, S.-J. (2013), 'Trade liberalization and embedded institutional reform: Evidence from Chinese exporters', *American Economic Review* **103**(6), 2169–95.

Madrian, B. C. & Lefgren, L. J. (1999), A note on longitudinally matching Current Population Survey (CPS) respondents, Technical Working Paper 247, National Bureau of Economic Research.

Mahon, R. (1984), *The Politics of Industrial Restructuring: Canadian Textiles*, University of Toronto Press.

Martin, J. & Mejean, I. (2014), 'Low-wage country competition and the quality content of high-wage country exports', *Journal of International Economics* **93**(1), 140–152.

Martin, P., Mayer, T. & Mayneris, F. (2013), Are clusters more resilient in crises? Evidence from French exporters in 2008-2009, CEPR Discussion Papers 9667, C.E.P.R. Discussion Papers.

Martin, R. (2012), 'Regional economic resilience, hysteresis and recessionary shocks', *Journal of Economic Geography* **12**(1), 1–32.

Martin, R. & Sunley, P. (2003), 'Deconstructing clusters: Chaotic concept or policy panacea?', *Journal of Economic Geography* **3**(1), 5–35.

Martin, R. & Sunley, P. (2015), 'On the notion of regional economic resilience: Conceptualization and explanation', *Journal of Economic Geography* **15**(1), 1–42.

McCullough, A. B. (1992), *L'Industrie Textile Primaire au Canada: Histoire et Patrimoine*, Ottawa: Environnement Canada.

Melitz, M. J. (2003), 'The impact of trade on intra-industry reallocations and aggregate industry productivity', *Econometrica* **71**(6), 1695–1725.

Mion, G. & Zhu, L. (2013), 'Import competition from and offshoring to China: A curse or blessing for firms?', *Journal of International Economics* **89**(1), 202–215.

Nakajima, K., Saito, Y. U. & Uesugi, I. (2012), 'Measuring economic localization: Evidence from Japanese firm-level data', *Journal of the Japanese and International Economies* **26**(2), 201–220.

Pendall, R., Foster, K. A. & Cowell, M. (2010), 'Resilience and regions: building understanding of the metaphor', *Cambridge Journal of Regions, Economy and Society* **3**(1), 71–84.

Pierce, J. R. & Schott, P. K. (2009), A concordance between ten-digit U.S. Harmonized System codes and SIC/NAICS product classes and industries, NBER Working Papers 15548, National Bureau of Economic Research.

Porter, M. E. (1990), *The Competitive Advantage of Nations*, New York: Free Press.

Pouder, R. & John, C. H. S. (1996), 'Hot spots and blind spots: Geographical clusters of firms and innovation', *Academy of Management Review* **21**(4), 1192–1225.

RichterConsulting (2004), The Canadian apparel industry: The shape of the future, Technical report, Richter Consulting.

Rouillard, J. (1974), *Les Travailleurs du Coton au Québec 1900–1915*, Les Presses de l'Université du Québec.

Shoag, D. & Veuger, S. (2018), 'Shops and the city: Evidence on local externalities and local government policy from big-box bankruptcies', *Review of Economics and Statistics* **100**(3), 440–453.

Utar, H. (2014), 'When the floodgates open: "Northern" firms' response to removal of trade quotas on Chinese goods', *American Economic Journal: Applied Economics* **6**(4), 226–250.

Wolfe, D. A. & Gertler, M. S. (2004), 'Clusters from the inside and out: Local dynamics and global linkages', *Urban studies* **41**(5-6), 1071–1093.

Appendix

A. Data sources and construction of variables

A.1. Construction of our economic proximity measures.

We construct five economic proximity measures s_{ij} between industries i and j: (i) the share of plants in industry i that report secondary activities in industry j; (ii) the strength of input-output links between industries i and j, based on national input-output tables; (iii) the similarity of industries i and j in terms of 553 occupational categories that they employ; (iv) the frequency with which industry i cites patents originating in industry j; and (v) the extent of labor mobility across industries i and j. Details on our plant-level data are provided in Section 3.1, whereas Appendix A.2 provides information on our industry-level data.

(i) 'Within-firm complementarities' is the share of plants in a 4-digit industry i (based on the plant's primary NAICS code) that also report at least one secondary code in another 4-digit industry j. We construct that measure year-by-year using all our manufacturing plants.

(ii) 'Input-output linkages' is the maximum element in the input-output tables between i and j (Ellison et al. 2010). Formally, it is given by $s_{ij}^{IO} = \max\{input_{ij}, input_{ji}, output_{ij}, output_{ji}\}$.

(iii) 'Occupational employment correlation' is the correlation coefficient between industries i and j's employment shares in 553 occupations, computed from the U.S. Occupational Employment Surveys (Ellison et al. 2010). We exclude all occupations that report zero employment in manufacturing industries (e.g., surgeons).

(iv) 'Knowledge flows' is the use-based share of patents that originate in industry j and are embodied (cited) in patents of industry i. See Kerr (2008) for additional details.

(v) 'Labor mobility between industries' is the share of workers leaving industry i and moving to industry j (conditional on moving), computed using 2000–2005 Current Population Survey data that is made 'panel-consistent' as decribed in Madrian & Lefgren (1999).

A.2. Industry-level and trade data.

Input-output tables. We use detailed input-output tables for the years 1998–2010, which we associate with our study period 2001–2013, respectively. These tables are constructed using the finest public release of the Canadian input-output tables at the L-level (link level), which is between NAICS 3- and 4-digit. We first disaggregate the input-output matrices to the W-level (NAICS 6-digit) using sales or employment data as sectoral weights, and then reaggregate them to the 4-digit level.[22] The shares in (ii) of Appendix A.1 are computed taking into account all

[22]Due to confidentiality reasons, we cannot directly use the W-level matrices that are internally available at *Statistics Canada*. However, tests we ran using those matrices yielded similar results to those using the matrices

industries (including primary industries and services, but excluding private consumption and the different government aggregates and imports/exports).

OES and CPS data. We construct a measure of occupational employment similarity of the workforce in the different industries. To this end, we use Occupational Employment Survey (OES) data from the Bureau of Labor Statistics (BLS) for 2002–2011 to compute the share of each of 554 occupations in each 4-digit NAICS industry.[23] We use 2002 as the starting year for the OES data to avoid the difficult concordance from SITC to NAICS. Our measure of occupational employment similarity for total employment, OES^0_{ij}, is computed as the correlation between the vectors of occupational shares of industries i and j. This yields (iii) of Appendix A.1.

To compute (v) of Appendix A.1, we compute an index of labor mobility across manufacturing industries. To do so, we use the 2000–2005 annual public use files of the Current Population Survey (MORG, March supplement). We extract all moves from the database (12,269 moves between manufacturing industries), and we construct a matrix that contains the share of moves from industry i to industry j, mov_{ij}. We consider that industries with a larger value of mov_{ij} are more similar in terms of their labor requirements. Note that because of sample size limitations, we cannot compute a time-varying measure of labor movements. Hence, we use the same values of mov_{ij} across all years of our geographic data.

Knowledge flows. Last, we construct proxies for 'knowledge spillovers' for (iv) of Appendix A.1 using the NBER Patent Citation database, following previous work by Kerr (2008). We construct two proxies: (i) know^m_{ij}, which is the maximum of the shares of patents that industry i (or j) manufacture and which originate from the other industry; and (ii) know^u_{ij}, which is the maximum of the shares of patents that industry i (or j) use and which originate from the other industry.

Trade protection and import/export data. Quotas on Chinese imports in the textile sector have been removed in four phases: in 1995, 1998, 2002 and 2005. Khandelwal et al. (2013) provide information on quotas faced by Chinese exporters in Canada and the year of the removal of these quotas. Products subject to quota restrictions are described in the Chinese HS8 nomenclature. We aggregate these products to the HS6 level and use the correspondence table developed by Pierce & Schott (2009) to map the quota information to the NAICS level. We consider that a NAICS industry was subject to quotas until 2005 if at least 90% of HS6 products in that industry were subject to a quota until this date. These industries are listed in Table 12,

constructed by our methodology.

[23]There are 808 occupations in total in the OES data. We only use occupations for which there is at least some employment in manufacturing (e.g., there are no 'Surgeons' in manufacturing industries, hence we exclude them completely from our data).

as well as the change in imports from China and the Chinese market share. For the latter, we use international trade data from *Innovation, Science and Economic Development Canada's Trade Data Online*. The data report import values by NAICS 6-digit industry, province, and trading partner from 1992 to 2011. We concord the data to our stable NAICS classification and aggregate them to the national level. We then compute industry import values from China.

ASM industry data. Finally, we complement our industry-level data with the aggregate version of the *Annual Survey of Manufacturers* (ASM), which reports industry values for employment (both production and non-production), value-added, and revenue at the 6-digit level. We also use detailed input-output tables at the 6-digit level for 2001–2013 in two-year steps. Those use-based tables are constructed from the publicly available more aggregated (L-level) tables, and we break them down to the 6-digit level using either sectoral employment or sales weights.

Canadian Census data, 2001. We use the list of Canadian dissemination areas, and position them using the latitude and longitudes of their centroid. We measure employment using the '2001 Profile of Dissemination Areas / Labour force activity, class of worker, occupation, industry, place of work, mode of transportation, language of work and unpaid work' table. The variable we are interested in is aggregate employment, labeled 'Total labour force 15 years and over by industry - 1997 North American Industry Classification System - 20% Sample Data'. The data has been retrieved from CHASS.

Canadian Industrial Census from 1871. To construct our historic instrument, we use the Canadian Industrial Census 1871. This census (henceforth, CANIND71) has been digitized by researchers at the University of Guelph, Ontario, and it is freely available at the following address: `http://www.canind71.uoguelph.ca`. We use all 45+ thousand plants that are available in the census. We define textile and clothing industries using the census SIC codes 5.04 ('Leather Industries'), 5.05 ('Textile Industries'), 5.06 ('Knitting Mills'), and 5.07 ('Clothing Industries'). Each establishment is associated with a historic census district and a historic census sub-district, for which we can retrieve the centroid coordinates using digitized versions of the historic census maps. For each historic census sub-district, we compute a count of the textile plants in 1871, and the total employment in those industries. Figures 5 and 6 in the online Appendix S depict the geographic distribution of textile and clothing employment and plants in the Dominion of Canada in 1871 (using census districts to make the map legible). Note that there are many zeros in the data—for establishments that are run by their owner and which have no employees. To adjust for this, we consider those establishments as having one employee. This marginal change makes virtually no difference to our results.

B. Additional tables and results

This appendix reports additional tables and results. In Table 12, we indicate whether the 6-digit T&C industry was subject to quotas under the Multifibre Arrangement (MFA). For each industry, we also report the level and the share of imports from China in 2001 and 2013. In Table 13, we replicate our main results using employment changes as the dependent variable—i.e., as the measure of resilience. In Table 14, we instrument the presence in a cluster (and its interactions) by the distance to 1871 employment (and its interaction with the $Post2005$ dummy and/or the $Quota$ dummy). In Table 11, we interact the MFA dummy with yearly dummies to capture potential anticipation and adjustment effects.

Table 12: MFA quotas in Canadian textile and clothing NAICS industries.

Stable NAICS	Industry name	Subject to quotas until 2005	Imports from China 2001	Imports from China 2013	Chinese market share 2001	Chinese market share 2013
313210	Broad-woven fabric mills	**Yes**	91.8	120	0.06	0.19
313320	Fabric coating	**Yes**	1.3	17.4	0.00	0.09
315110	Hosiery and sock mills	**Yes**	5.6	137	0.05	0.50
315220	Men's and boys' cut and sew clothing manufacturing	**Yes**	347	973	0.22	0.38
315249	Women's and girls' cut and sew clothing manufacturing	**Yes**	381	1,920	0.21	0.53
315990	Clothing accessories and other clothing manufacturing	**Yes**	154	452	0.47	0.69
313110	Fibre, yarn and thread mills	No	7.8	11.5	0.02	0.08
313220	Narrow fabric mills and machine embroidery	No	3.3	17.4	0.03	0.22
313230	Nonwoven fabric mills	No	364	13.6	0.00	0.03
313240	Knit fabric mills	No	48	50,9	0.09	0.26
313310	Textile and fabric finishing	No	0.9	2.6	0.02	0.09
314110	Carpet and rug mills	No	12.3	57.4	0.02	0.08
314120	Curtain and linen mills	No	98.2	592	0.17	0.57
314910	Textile bag and canvas mills	No	71.2	139	0.46	0.49
314990	All other textile product mills and cut-and-sew clothing contracting	No	28.4	155	0.04	0.25
315190	Other clothing knitting mills	No	64.3	709	0.14	0.58
315291	Infants' cut and sew clothing manufacturing	No	15.4	121	0.23	0.57
315292	Fur and leather clothing manufacturing	No	69	58.1	0.60	0.56
315299	All other cut and sew clothing manufacturing	No	47.3	231	0.22	0.58
316110	Leather and hide tanning and finishing	No	1.8	6.5	0.01	0.06
316210	Footwear manufacturing	No	655	1,420	0.49	0.70
316990	Other leather and allied product manufacturing	No	280	733	0.56	0.70

Notes: All values are expressed in millions of current C$. Following Khandelwal et al. (2013), a NAICS industry is considered as being subject to quotas if at least 90% of the products in this industry were subject to quotas until 2005. We report quotas based on our stable NAICS industries as defined in Table 18 in online Appendix S.

Table 13: Resilience as captured by employment changes in T&C plants (OLS and IV).

	d ln(Employment)				
	(1)	(2)	(3)	(4)	(IV)
Cluster	-0.015^c	0.005	-0.017	0.007	0.015
	(0.009)	(0.008)	(0.015)	(0.017)	(0.086)
Cluster × Quota				-0.031	-0.004
				(0.028)	(0.066)
Cluster × Post 2005				0.004	-0.085
				(0.028)	(0.066)
Cluster × Post 2005 × Quota				0.021	0.132
				(0.032)	(0.091)
Plant-level controls	Included				
Fixed effects	Industry-year and province				
Observations	10,220	10,220	10,220	10,220	10,220
R^2	0.001	0.018	0.018	0.018	0.011

Notes: Standard errors clustered by census division in parentheses. ^{a} = significant at 1%, ^{b} = significant at 5%, ^{c} = significant at 10%.Plant-level controls are included but not reported. 'Quota', 'Post2005' and Post2005 × Quota' are included but absorbed by the industry-year fixed effects. Cragg-Donald Wald F-statistic. Cluster dummy is instrumented by the distance of the plant to 1871 T&C employment in column (IV).

Table 14: Dimensions of resilience of T&C sector plants after the end of MFA (IV regressions).

	Die	Exit	Switch | Exit	Services | Switch
	(1)	(2)	(3)	(4)
Cluster	0.020	-0.048	-0.150	0.144
	(0.059)	(0.109)	(0.114)	(0.225)
Cluster × Quota	-0.065	0.028	0.168	-0.204
	(0.111)	(0.089)	(0.190)	(0.302)
Cluster × Post2005	0.117	0.231	0.149	-0.059
	(0.112)	(0.181)	(0.116)	(0.332)
Cluster × Post2005 × Quota	-0.152	-0.219^c	0.098	0.212
	(0.097)	(0.131)	(0.189)	(0.378)
Plant-level controls	Included			
Fixed effects	Industry-year and province			
Observations	14,615	14,615	3,134	802
R^2	0.030	0.057	0.289	0.421

Notes: Standard errors clustered by census division in parentheses. ^{a} = significant at 1%, ^{b} = significant at 5%, ^{c} = significant at 10%. 'Quota', 'Post2005' and Post2005 × Quota' are included but absorbed by the industry-year fixed effects. Plant-level controls are included but not reported. The excluded instrument is the average distance of the plant to 1871 historic census sub-districts, weighted by the 1871 T&C employment of the sub-districts.

Table 15: Dimensions of resilience of T&C sector plants after the end of MFA (year-by-year).

	Die	Exit	Switch | Exit	Services | Switch
	(1)	(2)	(3)	(4)
Cluster	0.017	0.014	0.006	0.012
	(0.014)	(0.016)	(0.036)	(0.046)
Cluster × 2005	0.004	0.024	0.006	0.182
	(0.022)	(0.029)	(0.058)	(0.142)
Cluster × 2007	-0.014	0.004	0.023	0.002
	(0.017)	(0.020)	(0.052)	(0.143)
Cluster × 2009	-0.012	0.001	0.033	0.069
	(0.018)	(0.024)	(0.063)	(0.172)
Cluster × 2011	0.001	-0.013	-0.020	0.080
	(0.025)	(0.029)	(0.040)	(0.089)
Cluster × Quota	0.005	0.016	-0.023	0.092
	(0.027)	(0.025)	(0.069)	(0.168)
Cluster × Quota × 2005	-0.105^{b}	-0.102^{b}	0.140	-0.274
	(0.041)	(0.042)	(0.093)	(0.296)
Cluster × Quota × 2007	-0.016	-0.032	0.028	-0.159
	(0.035)	(0.037)	(0.107)	(0.225)
Cluster × Quota ×2009	-0.028	-0.020	0.071	-0.283
	(0.047)	(0.049)	(0.095)	(0.255)
Cluster × Quota × 2011	0.036	-0.030	-0.082	-0.025
	(0.042)	(0.046)	(0.093)	(0.211)
Plant-level controls			Included	
Fixed effects			Industry-year and province	
Observations	14,615	14,615	3,134	802
R^2	0.044	0.074	0.308	0.429

Notes: Standard errors clustered by census division in parentheses. ^{a} = significant at 1%, ^{b} = significant at 5%, ^{c} = significant at 10%. 'Quota' is included but absorbed by the industry-year fixed effects.

Online appendix for "Are clusters resilient? Evidence from Canadian textile industries."

This online appendix is structured as follows. Appendix **S** presents a brief but detailed overview of the history of the T&C industries in Canada. In Appendix **T**, we present additional descriptive evidence. Appendix **U** provides methodological details on how we construct our firm identifiers. Appendix **V** provides a short summary of the methodology used to compute the K-densities in the paper. Last, in Appendix **W**, we develop a simple model of clusters and survival and show that agglomeration economies and selection effects have ambiguous effects on plant exit (resilience).

S. Detailed historical context

S.1. Early period (1850–1910): The emergence of industrial and geographic concentration.

This paper is about industry dynamics, trade protection, and geographic patterns. Without providing a detailed historical account—which is beyond the scope of our study—putting those factors into a historical context is important to understand how they jointly shaped the textile landscape between the 1850s and the end of the 20th century.[24]

The origins of the Canadian textile industry can be traced back to the 1820–1840 period, depending on the type of fabric considered. The transition from subsistence production to industrial enterprise occurred mostly between 1840 and the end of the 19th century, using domestic capital, on the one hand, and technology imported from Great Britain and the U.S., on the other hand. Policy changes and economic shocks first triggered industry expansion and then a wave of mergers and consolidation between 1870 and 1900. It is during that period that the macro-structure of the textile industry took shape, where all the large players that would dominate the landscape until after World War II were put in place. The fundamental geographic structure of the textile industry also emerged during that period. Initially centered in the province of Ontario, it progressively shifted to Québec as wool lost its dominant position to cotton and, later, to man-made fibers.

Numerous factors may serve to explain the expansion of the textile industry in the second

[24]The subsequent developments largely draw on Rouillard (1974) and McCullough (1992). While there are numerous detailed historical accounts of the primary textile industry (i.e., industries that transform primary fibers into fabrics), there are much less such accounts of the secondary textile industry (i.e., industries that transform fabrics into clothes and other derivatives). The historical elements related to the political economy, trade, and industrial restructuring of textiles after World War II are mostly drawn from Mahon (1984).

half of the 19th century:[25] (i) the growth of the internal market (between 1870 and 1910 the Canadian population almost doubled); (ii) improvements in market access (the expansion and extension of the railroad system across the country; and the political integration as formalized by the 1867 'Constitution Act' that officially proclaimed Canadian Confederation); and (iii) strong import protection under the Macdonald national policy.

We will not discuss the former two points, which are about market size, and focus instead on the latter, which is linked to trade protection. Historically, the Canadian market was a difficult one, for manufacturing in general and for textiles in particular: *"In textile, as in many other sectors, capitalists were confronted to stringent operating conditions. By its large geographic extent and its low population size* [...], *Canada was a very difficult market, especially for firms located outside big cities. Besides, it requires dealing with a major obstacle: the American and British competition."* (Gaudreau 1995, p.19, our translation). Despite support for free trade from many segments of the economy—especially the export-oriented staples industries like grains, ore, and lumber—as well as the public, Canada resorted to trade protection in manufactured goods early on: in the face of a geographically spread-out market and fierce competition, trade protection was seen as an option to make viable nascent manufacturing industries. The tension between the export promotion of staples and concessions in import protection for some manufacturing industries (including textiles) was one of the fundamental dynamics of the Canadian political economy during the second half of the 19th and most of the 20th century (Mahon 1984).[26] In textiles, cotton imports from the U.S. and wool imports from Great Britain, both raw materials and fabrics, were important for Canada but put substantial pressure on the textile industries. Indeed, the young Canadian industries had neither the scale nor the experience of their British or American counterparts and had to rely on their technologies. Hence, from its inception, the textile industry was evolving in a fairly competitive international context.[27]

Within that context, the Macdonald conservative government imposed in 1879 strong import protections—tariffs almost doubled, reaching close to 30%—which came to be known as the 'Macdonald national policy'. The story of the Canadian textile industry after that date is a

[25]See Gaudreau (1995) for the history of the Magog Textile and Printing Company, which provides a nice case study that illustrates well the various key elements of success: (i) the vision of local (and national) capitalists, which were able to raise funds and to lobby government for protection; (ii) the presence of hydraulic power, namely the Magog river which flows year-round; (iii) generous tax breaks (25 years) negotiated with the local authorities; and (iv) the advent of the railroad, with the opening of the Waterloo-Magog line and, later, the connection to the Canadian Pacific.

[26]The tension between free trade and protectionism can be seen early on from the fate of the Canadian-American Reciprocity Treaty (the Elgin-Marcy Treaty of 1854): *"The treaty was abrogated by the Americans in 1866 for several reasons. Many felt that Canada was the only nation benefiting from it and objected to the protective Cayley-Galt Tariff imposed by the Province of Canada on manufactured goods."* (quote from Wikipedia).

[27]Import competition in textiles from the U.S. and from Great Britain remained important until the early 1970s. Indeed, even in 1968, 30.3% of cotton fabrics and 47.6% of wool fabrics were imported from the U.S. and the UK, respectively (Mahon 1984).

classic one of import substituting industrialization. Many new large textile plants opened and industry output rose substantially until the 1890s in both the cotton and wool industries, both protected by import tariffs. Yet, as we will see below, the wool industry took a different path than the cotton industry and this led to a profound shift in the geographic patterns of textiles in Canada. Improved market integration within the Confederation and the higher import tariffs shifted market shares substantially towards domestic firms: the imports of cotton textiles fell by about 40% from 1870 to 1890, while spending on these textiles remained fairly constant. In a nutshell, the growth of the textile industry was driven by the interactions between a growing internal market and 'infant industry' protection vis-à-vis the U.S. and Great Britain.

The geography of the textile industry in place at the end of the 20th century largely took shape around the end of the 19th century, driven by the different paths that the wool and cotton industries took between 1870 and 1900. Figures 5 and 6 depict the geographic distribution of textile and clothing employment and plants in the Dominion of Canada in 1871, based on the Industrial Census from that date. Starting with the geographic patterns of wool, the location of the early industry was dictated by local market size and access to skilled labor, the availability of raw materials, as well as proximity to hydraulic power: *"[m]ost of the early woolen mills were set up in Ontario, west of Ottawa* [...] *where there was good sheep-raising country, skilled Scottish weavers, and good access to customers."* (Balakrishnan & Eliasson 2007). The industry was, though predominantly concentrated in Ontario, geographically fairly dispersed within that province.[28] The geographic dispersion of the wool industry was mirrored by the dispersion of ownership and capital across many small establishments. Actually, the wool industry was not very capital intensive, had a large number of establishments and, therefore, displayed fairly little industrial concentration throughout most of its existence.[29] It remained a relatively fragmented industry which, as we will see below, made it harder to adjust to negative shocks through the use of collusive agreements on prices or production volumes. The cotton industry was, by contrast, from the beginning more geographically concentrated than wool. Although it was initially located in both Ontario and Québec, it was more capital intensive and had larger plants, thus implying that its activity was automatically more concentrated geographically. Because of its important capital and labor requirements, it was also more likely to be established in larger cities, i.e., it was a more urban industry than wool.

[28]In 1871, Lanark, Waterloo, and Sherbrooke concentrated most of that industry, but by 1886 the Eastern Townships of Québec and the large cities—Toronto and Montréal—had grown in importance in that industry. The knitting industry, historically strongly linked to the wool industry, was also concentrated in Ontario, which had 70–80% of employment in the 19th century. In 1871, 73% of woolen draperies in Canada were produced in Ontario, with 83% of employment concentrated in that province (McCullough 1992, p.123). Until the 1930s, Toronto remained Canada's 'knitting capital'.

[29]By the end of the 19th century, the wool industry was still not dominated by a few large firms, although some firms like the Paton Manufacturing Company in Sherbrooke—the largest woolen factory in Canada—or the Canada Woolen Company in Ontario were substantial players.

Why did wool initially locate in Ontario and cotton predominantly in Québec? While there is inevitably some randomness to these early historic patterns, they can be linked to trade ties, immigration patterns, natural advantage, and the availability (and geographic concentration) of capital and skilled labor. First, there was a sizable British immigrant labor force in Ontario, and Great Britain had developed a lot of expertise in wool trade. As stated above, there was also a lot of raw material in Ontario, which produced a majority of wool in Canada. Québec lacked iron ore and coal deposits—which are key for the development of early heavy industries—but had an abundant, relatively cheap, and skilled labor force, concentrated in the relatively densely populated Saint Lawrence lowlands between Québec City and Brockville. Many French Canadians had acquired the 'skills of the trade' in the New England cotton industries.[30] Furthermore, some of the important capitalists involved in the development of the cotton industry in Québec had ties with Lancashire, which was the cotton capital of Great Britain. For example, William Hobbs from Magog brought in specialized workers from Lancashire to operate the new printing equipment that he purchased in Britain for his textile and printing plant that opened as the first of its kind in Canada in 1884 (Gaudreau 1995).

Second, Québec offered a geographically advantageous location. Good access to railroads, with Montréal being a national hub, allowed to import raw cotton from the U.S. and to dispatch finished products to geographically dispersed markets. Furthermore, Québec's river system allowed to use cheap hydraulic power (instead of more expensive steam-engine power) and, starting in the early 20th century, even cheaper hydro-electricity. The Montreal Cotton Company manufacture in Salaberry-de-Valleyfield began operating in 1896–1897 with an electric drive system. It is almost sure that this was the first Canadian textile manufacture using such a technology. As noted by Rouillard (1974, pp.45–46, our translation): "*It is the power of the flow of the [Saint Lawrence] river next to Valleyfield that gave William Hobbs the idea to construct his cotton mill there* [...] *It is precisely the insufficient availability of hydraulic energy and the high cost of running steam engines that compelled in 1898 the Dominion Cotton to close its factory in Brantford, Ontario* [...] *Québec's rivers favor the implantation of industries for which energy consumption is an important element of production costs.*"

Third, and contrary to wool, cotton was very capital intensive as already stated. It also had a financing scheme of a more capitalistic nature, essentially publicly traded companies versus more 'family business' in the wool industry. Raising funds to provide both starting capital and working capital was thus important. Local capitalists in smaller places had difficulties providing the huge amounts of funds required to operate large cotton textile mills. This

[30]The French Canadian workers also had a reputation for being skilled at textile manufacturing. As pointed out by historians, "*the inherent ability of the New England operatives as a distinct asset of the northern industry, the French Canadians in particular receiving a large share of the approbation*" (J. H. Burgy, 1932, p.167 "The New England Cotton Textile Industry", Baltimore, MD: Waverly Press). Around the turn of the 19th century, 46% of the textile labor force in New England was originally French Canadian.

shifted power to larger urban centers, which provided both capital and a large and relatively cheap labor force. Montréal, being Canada's financial capital during that period, had a distinct advantage when it came to providing funds. Combined with the access to water power and railway it offered, it thus naturally became Canada's cotton capital: "*This control—based on the financial resources of Montréal, the availability of labor force and electric power, and the access to markets and railroads—causes the vast majority of the industry to be located within a hundred mile radius around this city*" (McCullough 1992, p.162, our translation).

While the initial differences in geographic patterns favored Ontario for wool, and while cotton was more concentrated because of larger plants—but fairly evenly spread between Ontario, Québec, and the Maritimes in the beginning—a substantial geographic shift occurred between 1870 and 1900. While cotton saw an extraordinary increase in employment and output, wool stagnated and declined (production fell by 8%, while imports soared by 215%, despite the Macdonald national policy). The decline in wool progressively reduced the importance of Ontario for textiles and increased the importance of Québec that started to specialize in cotton. By 1900, 56% of cotton employment was located in Québec, against only 20% in Ontario.[31]

What triggered this important geographic shift? Since the Macdonald national policy protected wool and cotton on roughly similar terms, the reason has to be sought somewhere else. It probably started with the 1882–1883 recession and how that recession impacted the cotton and wool industries differently. During 1882–1883, it became clear that there was substantial excess capacity in all textile industries, due essentially to the large expansion in the wake of the 1879 trade protection. Cotton and wool adjusted to that excess capacity in different ways. The cotton industry saw the formation of large enterprises that controlled many textile mills and manufactures—with mergers initiated by D. Morrice and A.F. Gault ('the cotton king') who laid the foundations for the Dominion Textile which dominated the textile landscape for the century to come. The new 'cartelized' industry tried to limit price and quantity competition by leaving production capacities idle and by colluding tacitly (or openly) on prices and quantities. Those strategies worked relatively well, given the small number of players in the new industry. The wool and knitting industries had a much harder time to adjust than the cotton industry. As explained above, the industry was less capital intensive and more fragmented. It did not see a large wave of mergers and acquisitions, to that the number of firms remained large. Consequently, cartel agreements of the type seen in the cotton industry never worked well in the more fragmented wool industry. Many manufactures thus disappeared and the industry shrank in importance. Given its geographic concentration in Ontario, that province was especially hit. The effects of the excess capacity crisis were amplified later by changes in

[31]Even within Québec, the cotton textile production was fairly clustered: 32% in Montréal; 14% in the Eastern Townships; 9.5% in Montmorency; and 12.5% in Shawinigan-Trois Rivières (McCullough 1992). Until recently, up to two-thirds of Canadian cotton employment was located in Québec. Montréal was for many years the center of the cotton industry in Canada.

trade protection that affected essentially the wool industry. In 1897, trade protection was relaxed as the 'principle of the British preference' was introduced. The latter slashed tariffs and restrictions on imports from the Commonwealth countries, including Great Britain but also India and Pakistan. In 1899, additional concessions were granted to British textile imports, in return the export concessions for Canadian staple industries: "*the Canadian state was prepared to cede a portion of the domestic textile market to suppliers located in countries that were important customers of Canadian staples exports.*" (Mahon 1984, p.50).

The combined effect of industry consolidation and trade liberalization led to the strong geographic shift. Starting in the 1880s, Québec became the province of choice for the cotton textile industry. For example, the Dominion Textile Corporation concentrated its operations in Québec, and by 1930 it operated almost exclusively there. Between 1880 and 1890, cotton textile output in Canada, except Québec, rose by 26% from 4.6 to 5.8 million dollars. However, it rose by 73% from 3.5 to 6.1 million dollars in Québec (Rouillard 1974, p.11). Québec's national share of the cotton industry rose from 43% in 1890 to 69% in the 1920s, while the share of Ontario and the Maritimes fell. The concentration of the cotton industry necessarily also drew other related segments of textile, clothing, and shoe industries in its wake, which already happened to be fairly concentrated in Montréal.[32] Eventually, cotton overtook wool in the 1890s as the most important textile industry, thereby cementing Québec's dominance.

S.2. Later period (1910–1980): Shifting protection, lobbying, and industrial restructuring.

From 1910 to after World War II, the Canadian textile industry grew further and diversified. The importance of wool declined, synthetics emerged and developed rapidly, and knitting became more important. This period was one of maturity, characterized by slow industry growth and less volatility, though the inter-war years were subject to substantial fluctuations in the degree of trade protection. Furthermore, the industry continued to shift towards Québec during that period. Although the wool industry remained concentrated in Ontario until after World War II—when Québec finally overtook Ontario in that industry—it lost a lot of significance to the cotton industry first and, after World War I, to the rapidly growing man-made fibers industries.[33] By 1950, Québec also overtook Ontario in knitting, although the latter maintained

[32]While less is known about the history of the clothing industry, the evidence we have suggests that it started with a high level of concentration in larger cities, especially Montréal: "*By the mid-1850s, large-scale clothing manufacturing companies were typically located in Montréal with one factory employing eight hundred people* [...] *sole-sewing machines made it efficient to concentrate shoe manufacturing in steam-driven factories. By the 1860s, there were five major shoe manufacturers located in Montréal that produced the majority of the footwear sold in Canada.*" (Balakrishnan & Eliasson 2007, p.271)

[33]Silk and synthetics grew mostly starting around 1910–1920. In 1940, synthetics overtook wool as the second-largest primary textile segment in Canada. At the same time, the import shares of synthetics in Canadian sales

about one-third of the Canadian knitting employment even after that date.[34] In the wake of World War II, the textile industry was geographically strongly concentrated in Québec which had the largest national share in those industries.

One key development of the inter-war years was the emergence and strong growth of artificial silk and synthetics (mostly rayon, nylon, and later polyester). For example, the output of artificial silk was multiplied by 13 between 1925 and 1936.[35] The man-made fiber industry was initially dominated by American and British capital and it was extremely concentrated: two firms—Courtaulds and Canadian Celanese—dominated it. The synthetics industry started operating in eastern Ontario and Québec, and it became eventually again fairly concentrated, both in geographical and industrial terms. Just like cotton, that industry was capital intensive.

A second key development of the inter-war years was the substantial shifts in trade protection. Tariffs spiked in 1930–1932 in the wake of the Great Depression of 1929, except for imports from Great Britain and the Commonwealth. Part of the tariff increases were due to the textile industries' ability to efficiently lobby for protection (see, e.g., the Turgeon report of 1938, which explicitly points out that there was abusive lobbying by the textile industries).

The textile industry prospered until about 1951 (the date at which it recorded the highest employment level ever in Canada). Much of this was due to the war-time economy and restrictive trade policies, which stimulated domestic textile production. Following the 1951 peak, the structural problems of the textile industry became more obvious: it started to experience increasing problems due to a decrease in protection and a rise in imports; a stagnation of its exports; a rise in labor costs; and the increasing market share of synthetics which, in a stagnating market, came at the expense of traditional fabrics such as wool and cotton. Especially the growth of synthetics during and after World War II (a 211% increase between 1940 and 1950), which competed with the natural fibers, caused increasing difficulties for the traditional textile industries. They suffered from a 'triple squeeze' in their profit margins due to import competition, higher wages starting in the 1960s, and a decrease in market shares. It followed many bankruptcies and several mergers which further consolidated the industry, which mechanized even more and renewed a large part of its older equipment. The result was that Canadian primary textiles emerged as one of the most concentrated textile industries in the world (Ma-

fell from 36% in 1910 to about 20% in 1940, thereby showing that the Canadian synthetics industry competed efficiently against its international rivals.

[34]Knitting and hosiery, which are related to wool expanded notably because of increased demand for knit underwear and stockings. The heydays of the knitting industry were between 1900–1930, when it exceeded the wool industry and was approximately on par with the cotton industry in terms of employment. This industry, like wool, remained more dispersed, was less capital intensive, more local, and operated at a smaller industrial scale. A large part of its success can be explained by the import surcharge of 33% that targeted German imports of knit products starting in 1903. However, much of the imports came from Britain under the preferential rules.

[35]While tariffs and protection on most textile industries fell after World War I and until the 1930s, only synthetics managed to lobby for increasing protection, which explains part of its growth.

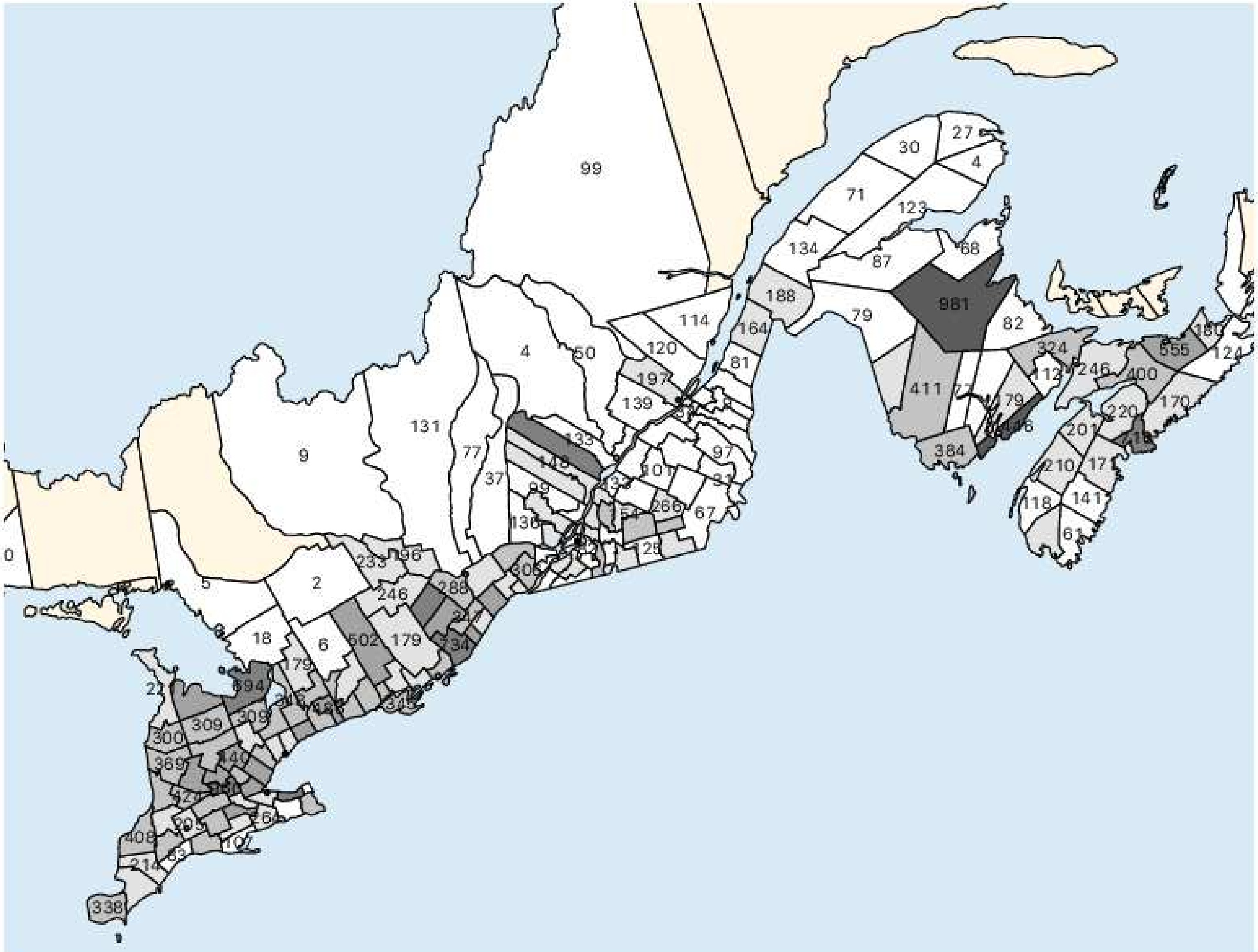
hon 1984, p.52). A few very large players dominated the market: DuPont, Canadian Celanses, Courtaulds, and Dominion Textile, all of which either operated in or expanded into synthetics and opened several new plants in Québec between 1957–1967.

In the end, the industry—which developed in a fairly protected environment in the 19th century—had difficulties adjusting to international competition in the face of lower protection. Even synthetics, which did well on average, saw its employment fall from 13,000 employees after World War II to about 8,500 employees in 1968, although sales doubled over that period.[36] Trade protection broadly decreased after World War II, as the public was in favor of lower tariffs, although the textile industry lobbied hard to maintain them. Yet, following Canada's entry into the GATT in 1947, the tendency for the future was clear. Despite temporary measures—following the U.S., Canada implemented its first voluntary export restraints (VER) with Japan in 1958—free trade was progressing. The debate about trade protection and the textile industry resurfaced in the 1960s, when the textile industry drew an increasing awareness to the 'low-cost import problem'. As is often the case, the 'low-cost import problem' was more of a strawman than a real problem. Indeed, increasing imports from the U.S. due to a weak dollar were a more serious problem, and according to some historians even the major problem (Mahon 1984). In 1974, 74% of textile imports were from high-income countries, and 54% of those were from the U.S. Hence, as noted by Mahon (1984, p.72): "*textile capital began to agitate for a "national policy for textiles" by the end of the 1960s.*"

In 1969, a demand for a new agreement on textiles was in the air. Several factors explain why this happened. On top of the increased import competition and rising wages, mounting separatism in Québec—the province with the highest stakes in textiles due to the geographic patterns of that industry—was exploited by the textile industry to weight into the balance and to push the Québec government to force the textile question onto the national stage. Geography and policy interacted to shape future industry dynamics. The outcome was the 1971 textile policy that aimed to wrestle some power and trade concessions from the staples industries (the old conflict resurfaced). This was completed by the 'Multifibre Arrangement' (MFA) in 1973, which was signed by Canada and which posed the framework for an 'orderly' (i.e., 'protected' from the perspective of the textile industries in developed countries) growth in world textile trade. Most of the MFA remained in place until 2005, which is the starting point of our analysis.

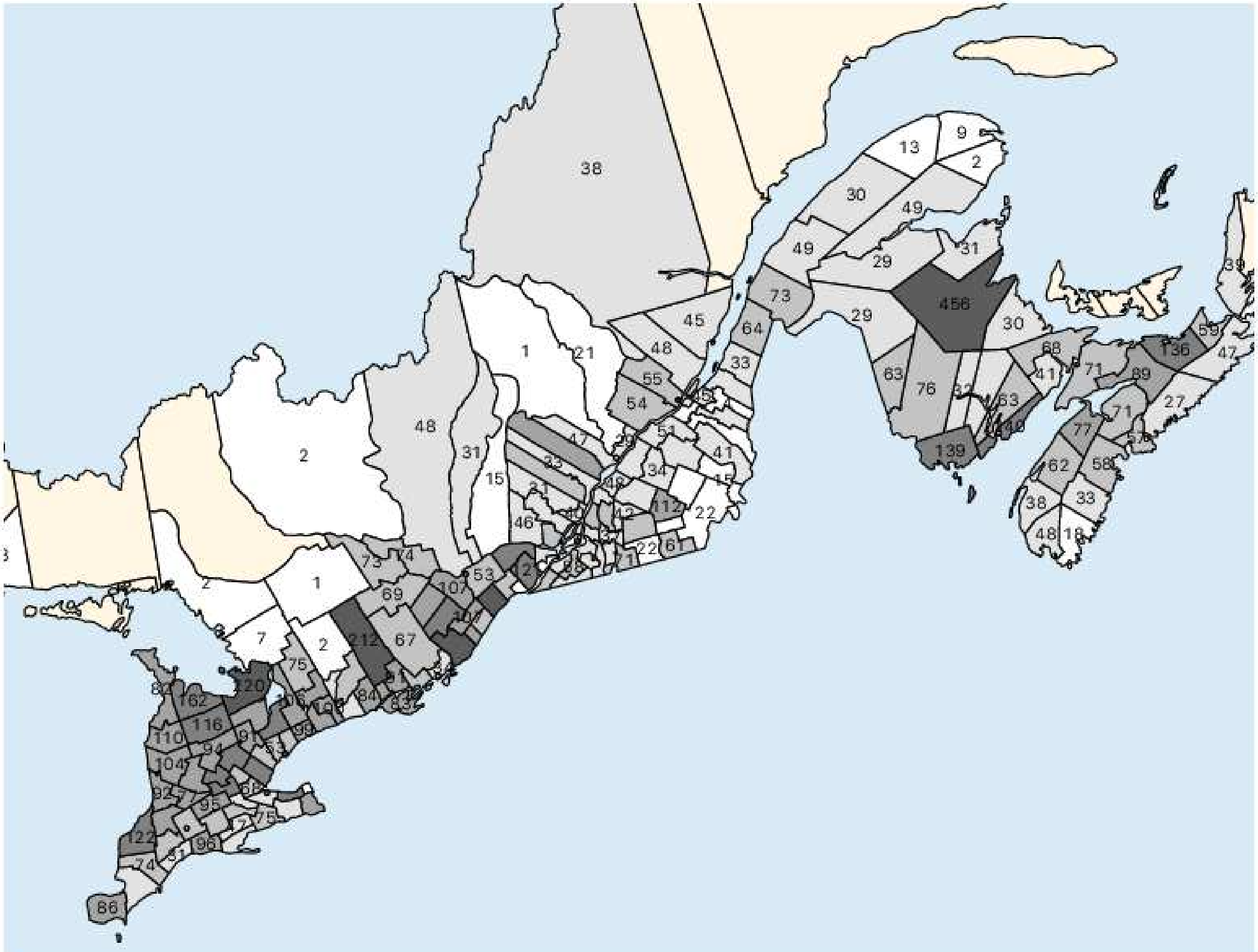
[36] Despite the general difficulties of the textile industries, synthetics resisted well, with about 85% of domestic market share. The other textile industries lost much ground to imports.

Figure 5: Geographic distribution of T&C employment in the Dominion of Canada, Industrial Census of 1871.



Notes: Based on the Canadian Industrial Census 1871 (Source: Canadian Industry in 1871—CANIND71—University of Guelph, Ontario, 1982–2008; `http://www.canind71.uoguelph.ca`). Textile and clothing is defined by SIC 5.04, 5.05, 5.06, and 5.07. Numbers on the map represent the total T&C employment in the historical census district. Yellow indicates missing data. The cities of Montréal, Toronto, and Québec have employment figures of 10,265, 4,053, and 3,503, respectively.

Figure 6: Geographic distribution of T&C establishments in the Dominion of Canada, Industrial Census of 1871.



Notes: Based on the Canadian Industrial Census 1871 (Source: Canadian Industry in 1871—CANIND71—University of Guelph, Ontario, 1982–2008; `http://www.canind71.uoguelph.ca`). Textile and clothing is defined by SIC 5.04, 5.05, 5.06, and 5.07. Numbers on the map represent the total number of T&C establishments in the historical census district. Yellow indicates missing data. The cities of Montréal, Toronto, and Québec have establishment figures of 421, 167, and 232, respectively.

T. Additional definitions and results

T.1. Construction of the average input-output strength and occupational labor correlation measures

Table 17 reports cluster-level measures of labor correlation and input-output strength. These two measures are constructed as follows.

Let $occup_{i,j}$ denote the correlation coefficient between the vectors of shares of workers of 553 different occupations in the total employment of industries i and j. Let $input_{i,j}$ and $output_{i,j}$ denote the input and output coefficients between industries i and j. See Appendix A.2 for additional information on the data. We construct measures of the average input-output strength (IS and OS) and the average occupational labor correlation (LC) around each plant p for a given distance threshold $\overline{d}$ as follows (see Jofre-Monseny et al. 2011 for the construction of similar, albeit more spatially aggregated, measures). Let $\mathcal{D} = \{q \neq p,\ d(p,q) \leq \overline{d}\}$ denote the set of plants q other than p that are located at less than $\overline{d}$ from plant p. We then compute

$$
\begin{aligned}
IS_p &= \frac{1}{\sum_{q \in \mathcal{D}} e_q} \sum_{k \in \mathcal{D}} e_k \times input_{i(p),j(k)} \\
OS_p &= \frac{1}{\sum_{q \in \mathcal{D}} e_q} \sum_{k \in \mathcal{D}} e_k \times output_{i(p),j(k)} \qquad (4) \\
LC_p &= \frac{1}{\sum_{q \in \mathcal{D}} e_q} \sum_{k \in \mathcal{D}} e_k \times occup_{i(p),j(k)}
\end{aligned}
$$

where e_q denotes the employment of plant q, and where $j(k)$ is the mapping from each plant to its industry. The former two measures capture the (employment weighted) average input or output coefficient at distance less than $\overline{d}$ around the plant. They thus provide a measure of the potential strength of input-output relationships in the region the plant is located in. The latter measure captures the (employment weighted) similarity of the other plants in terms of their occupational structure at distance less than $\overline{d}$ around the plant. This provides a measure of how similar the plant is to the others in its region regarding the labor pool from which it potentially hires.

Finally, we take the average of the measures (4) across all plants p in our clusters in 2001 to obtain the average input and output strength and occupational labor correlation for each cluster. Since the input and output measures are highly colinear, we combine them into a compound 'average input-output strength' measure for each cluster.

T.2. Geographic distribution

[1] Figure 7 depicts the geographic distribution of manufacturing plants in the south-eastern part of Canada in 2001. It shows that our data is very fine-grained, thus lending itself well to a continuous spatial analysis. Figure 8 zooms onto Montréal. As can be seen from the figure, the spatial resolution of our data is very fine within cities. Furthermore, one can clearly see the geographic concentration of T&C establishments along Saint-Laurent Boulevard, which started to attract clothing manufacturers, breweries, and other 'light' manufacturing industries in the second half of the 19th century.

[2] Figure 9 displays the level of clustering in the T&C sector relative to that in other manufacturing industries. More specifically, it plots the cumulative distribution of the bilateral distances in the T&C sector (the red curve; NAICS 3131–3169, see Table 18) and in other sectors (black curve). As can be seen from that figure, the T&C sector is significantly more concentrated than the other manufacturing industries, especially at short geographic distances.

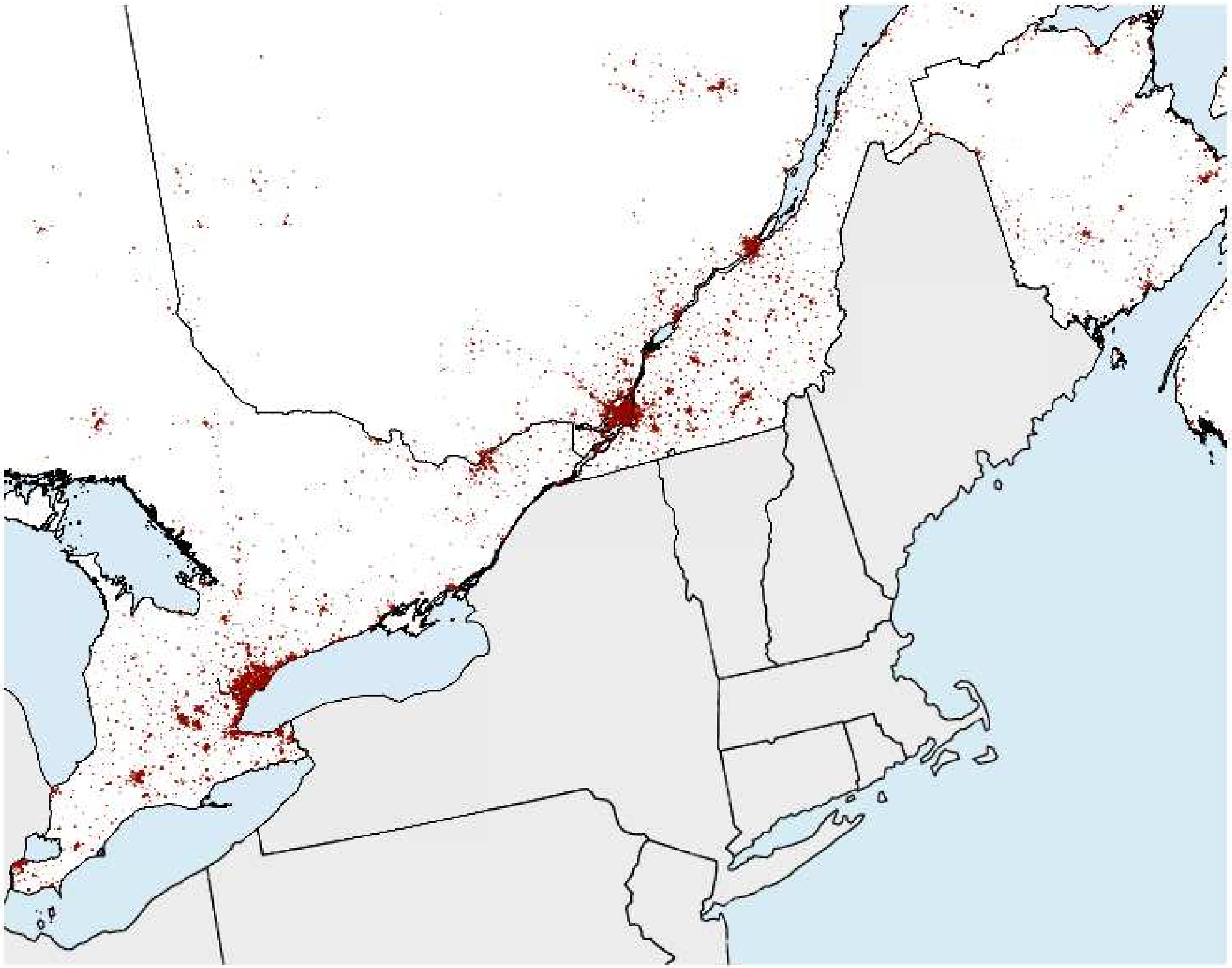
[3] Figure 10 is the employment-weighted counterpart to Figure 2 in the main body of the text. It shows the same pattern than when using plant counts as the unit of analysis. Hence, the spatial deconcentration that we document in the main body of the text does not depend on whether we use employment or plant counts.

[4] Figure 11 depicts the changes across years in the unweighted (left panel) and the employment-weighted (right panel) K-densities in the T&C sector. Clearly, we see that the geographic concentration has decreased, and the the strongest decreases occurred at short geographic distances.

[5] Figure 12 depicts the K-densities of plants that exit the T&C industry after 2001. It shows that plants exit in the T&C industry is concentrated at extremely short distances. This figure thus suggest that plants in 'geographic clusters'—which are essentially defined by the concentration of plants at short geographic distances—have been hit harder than plants that are outside of such clusters.

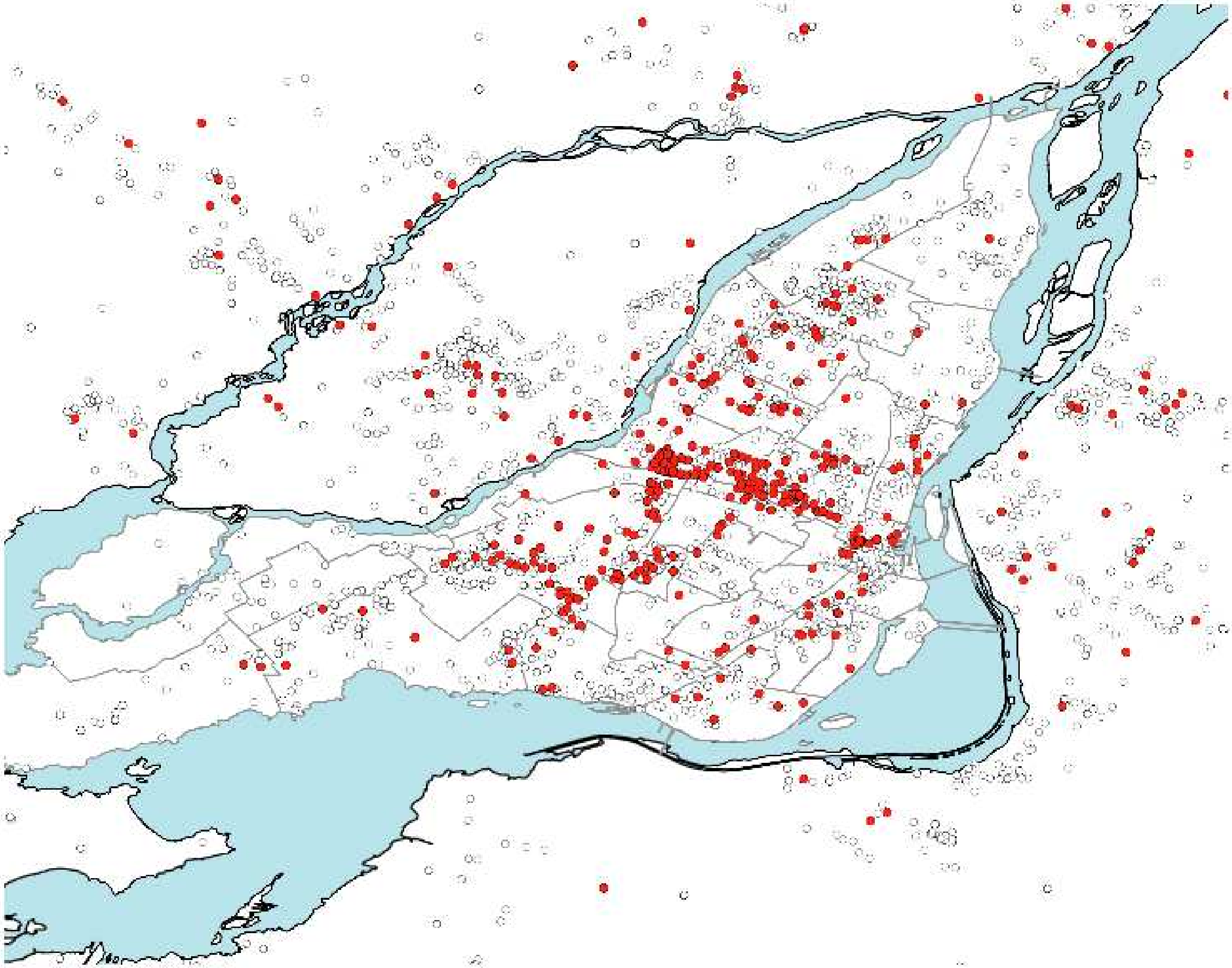
[6] Table 16 shows that the individual industries that constitute the T&C sector (see Table 18) are also substantially more coagglomerated than pairs of non-T&C industries or mixed industry pairs (one T&C, and one non-T&C). For example, in 2001, on average 3.84% of bilateral distances between plant pairs not belonging to the T&C sector, and 3.86% of plant pairs in mixed (one industry belonging to T&C, and one not) were less than 25 kilometers apart. For pairs of industries belonging to T&C, the corresponding figure is 5.26%, a 37% increase. Note that out of the 3,570 4-digit industry pairs for which we computed coagglomeration measures in 2001, the 3rd and 4th most coagglomerated were T&C industry pairs: 'Apparel Knitting Mills' (NAICS 3151), and 'Cut and Sew Clothing Manufacturing' (NAICS 3152) with 9.42% of plant pairs less than 25 kilometers apart; and 'Fabric Mills' (NAICS 3132) and 'Apparel Knitting

Figure 7: Geographic distribution of manufacturing establishments in the south-eastern part of Canada, 2001.



Notes: Spatial distribution of manufacturing establishments in Canada in 2001, based on the *Scott's National All database* (manufacturing portion only).

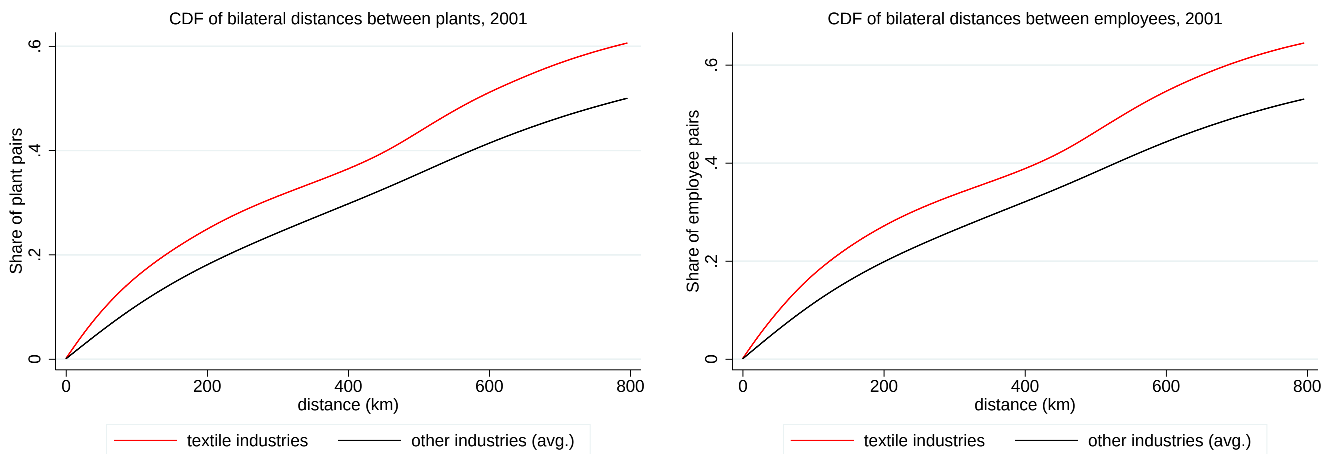
Figure 8: Saint-Laurent Boulevard ('The Main'), Montréal, 2005.



Notes: Spatial distribution of manufacturing establishments in Canada in 2001, based on the *Scott's National All database* (manufacturing portion only). Non-textile plants are depicted by black empty circles, while T&C establishments are represented with red-filled points.

Figure 9: The spatial concentration of textile industries relative to manufacturing in general.

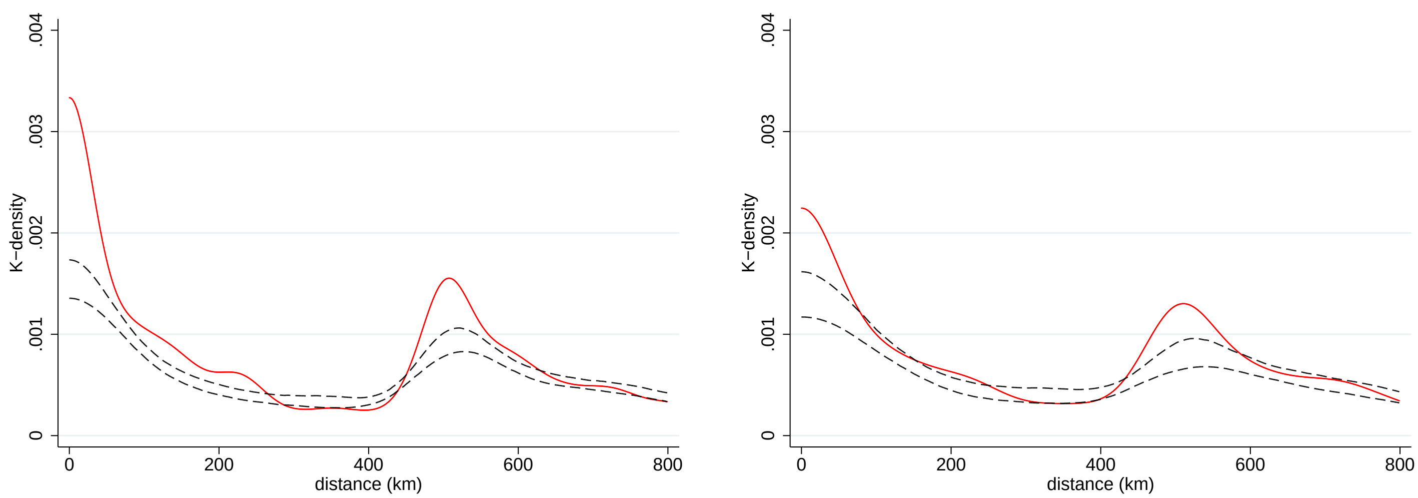
(a) Plant counts. (b) Employment weights.



Notes: We plot the unweighted averages of the K-density CDFs at the 6-digit NAICS level for the other (non-textile) industries (black line).

Figure 10: Changes in the spatial concentration of the T&C sector between 2001 and 2013, weighted.

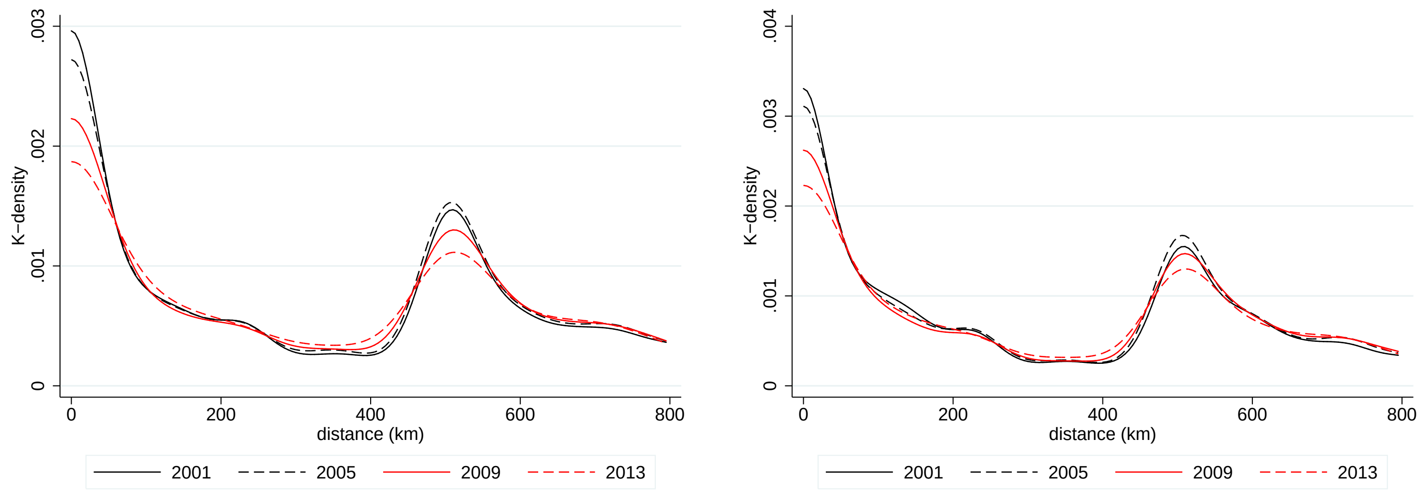
(a) 2001. (b) 2013.



Notes: The figures report the K-densities (in solid red) and the 90% global confidence bands (in dashed black) for the T&C sector in 2001 and 2013 using employment weights. Distributions of distances that fall into this confidence band could be considered 'as good as random' and are, therefore, not considered to be either localized or dispersed.

Figure 11: Spatial deconcentration of the T&C sector between 2001 and 2013.

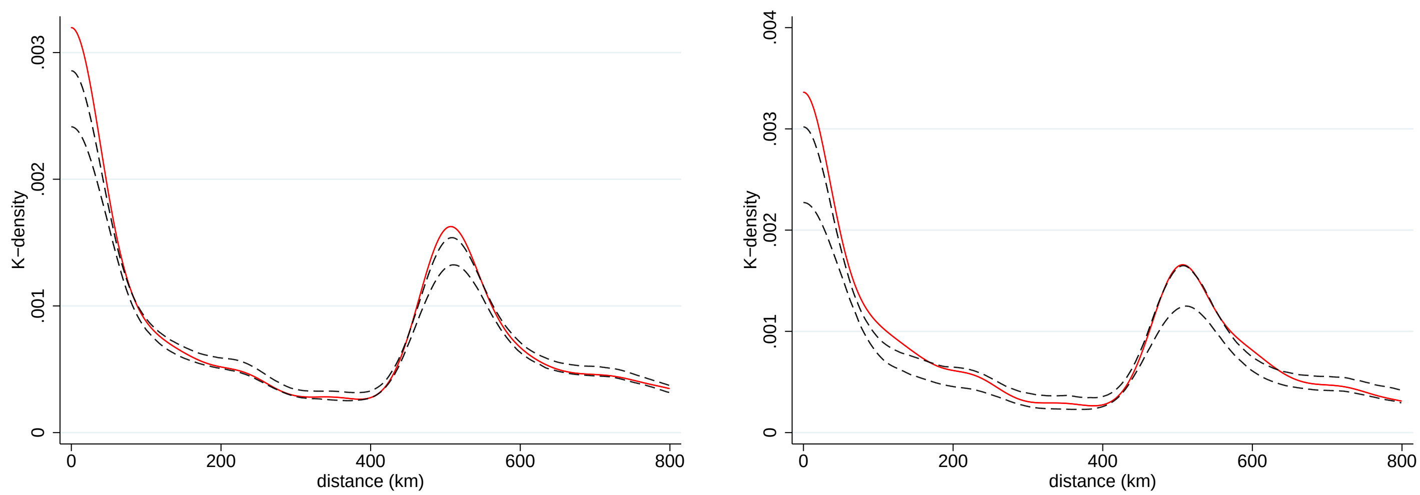
(a) Plant counts. (b) Employment weights.



Notes: The figures depict the K-densities in 2001, 2005, 2009, and 2013 using plant counts (left) and employment weights (right).

Figure 12: Spatial distribution of plant exits in the T&C sector between 2003 and 2013.

(a) Plant counts. (b) Employment weights.



Notes: The figure reports the K-densities (in solid red) and the 90% global confidence bands (in dashed black) for the exit of plants in the T&C sector after 2003. Exit of plants between 2003 and 2013 is compared to the overall distribution of the T&C sector in our base year 2003.

Mills' (NAICS 3151) with also 9.42% of plant pairs less than 25 kilometers apart. These findings show that the economic proximity between textile industries, as documented in Table 1, translates into geographic proximity. The combination of both proximities is what allows us to define well-identified geographic clusters as in the main body of the text.

Table 16: Economic relatedness translates into geographic proximity.

Average share of plant pairs	25 km	50 km
Non-'Textile & Clothing' industry pairs	3.84%	7.37%
Mixed industry pairs	3.86%	7.42%
'Textile & Clothing' industry pairs	5.26%	10.09%

Notes: Based on our own computations, using the CDF of the coagglomeration measure in Duranton & Overman (2005). The industries belonging to our T&C sector are listed in Table 18 in online Appendix T.

[7] Table 17 dissects our 24 clusters along various dimensions. In 2001, there were on average 2,465 plants (both T&C and non-T&C) in the nine big clusters, compared to 89 plants in the fifteen small clusters. The remaining 28,531 plants were not in T&C clusters. Big clusters had, on average, 296 T&C plants, compared to 13 in the small clusters. However, small clusters were more specialized, with an average share of T&C plants of 14.8%, compared to 12% in the big clusters and 5.6% for the rest of Canada.

As Table 17 shows, the average plant size in small clusters is about 49 workers, whereas that in big clusters is about 34 workers. Plants outside clusters are smaller, with an average size of about 28 workers. As can be seen from the bottom panel of Table 17, big clusters are very heterogeneous too. Some clusters have large average plant size—e.g., the 'Saint-Georges-Beauceville' cluster—whereas others have small average plant size—e.g., the 'Québec city' cluster.[37] The variation in average plant size is even larger for the small clusters, with some of them having very small plants (about 5 to 25 employees), while others have quite big plants (about 85 to 100 employees).

Table 17 further shows that cluster composition is also very heterogeneous. Small clusters host more plants that belong to multiunit firms, whereas big clusters host more standalone plants. Yet, plants in small clusters are less export-oriented than plants in the big clusters. Finally, we also provide summary measures of how strong input-output links are on average

[37] This partly reflects the different specializations of the clusters. In the 'Saint-Georges-Beauceville' cluster, 16 out of 30 plants belong to 'Cut and Sew Clothing Manufacturing' (NAICS 3152; see Table 18 in Appendix T). Historically, the Beauce region in Québec was home to the 'jeaners', i.e., the jeans-producing and transforming industry that ran large plants. Conversely, although Québec city also had 47 plants in 'Cut and Sew Clothing Manufacturing', it also had a large share of plants in footwear and leather manufacturing.

Table 17: Allocation of T&C plants to textile clusters and cluster characteristics in 2001.

	T&C plants		**Plant-level structure**			**Inputs and labor**		**Non T&C plants**	
	Number	Employment	Avg. size	% Multiunit	% Exporter	Input share	Labor corr.	Plants	Employment
Cluster types:									
Big clusters (9)	2,667	90,316	33.86	3.75%	44.32%	0.34%	0.18	19,520	647,906
Small clusters (15)	196	9,557	48.76	9.69%	29.08%	1.86%	0.20	1,132	33,868
Outside clusters	1,602	44,771	27.95	5.87%	33.58%	1.08%	0.17	26,929	904,059
Big cluster details:									
Montréal, QC	1,316	45,266	34.40	3.50%	44.38%	0.21%	0.20	6,093	210,259
Toronto, ON	676	20,701	30.66	4%	45.19%	0.14%	0.16	7,668	262,522
Vancouver, BC	279	7,433	26.74	2.87%	46.40%	0.22%	0.16	2,722	75,126
Québec City, QC	129	2,836	21.98	0.78%	24.81%	0.68%	0.16	1,047	28,480
Winnipeg, MN	125	5,597	44.78	3.2%	56%	1.06%	0.20	955	31,978
Granby, QC	40	3,274	81.85	17.5%	57.5%	2.07%	0.19	365	14,664
Victoriaville-Plessisville, QC	39	1,562	40.05	12.82%	17.95%	1.91%	0.19	234	8,247
Drummondville, QC	33	1,247	37.73	3.03%	42.42%	1.19%	0.16	275	10,036
Saint-Georges-Beauceville, QC	30	2,400	80	3.33%	56.67%	1.27%	0.19	161	6,594

Notes: See online Appendix T for details on how we construct the 'input share' and 'labor correlation' measures. 'Avg. size' measures the average employment in T&C plants. '% Exporter' refers to the share of plants that report exporting (to any destination). '% Multiunit' refers to the share of multiunit plants, where the latter are based on plants having the same legal firm name using the procedure explained in the online Appendix U.

across plants in the clusters, and on how similar the plants are on average in terms of the types of workers they hire (see Appendix T.1 for details on how we construct those measures using industry-level data and microgeographic location patterns). As Table 17 shows, small clusters are more specialized in the sense that plants there are close to other plants with whom they potentially have strong input-output relationships, and are also close to plants that hire more similar types of workers. These strong links and similarity may make these plants more vulnerable to adverse shocks that could propagate more easily in clusters. While the distinction between big and small clusters is of interest for mapping the economic activity of the T&C sector in Canada, we will abstract from this distinction in the rest of our analysis.[38]

T.3. Additional descriptives

[1] Table 18 displays the aggregation of the T&C sector in terms of the underlying NAICS 6-digit industries. Because of successive changes in the industrial classification, we aggregate all industries to a stable 6-digit classification that spans NAICS 1997, 2002, 2007, and 2012. Our T&C sector comprises 22 time-consistent 6-digit industries.

[2] Table 19 contains descriptive information on changes in Canadian import values by industry and countries of origin. We distinguish three types of imports: imports from China, from other low-income countries, and from high-income countries. This table shows that all textile industries experienced a massive increase in imports from China over the period 1999–2011. For instance, import values from China in the 'Cut and Sew Clothing Manufacturing' (NAICS 3152) increased by more than 1.6 billion C$ between 2003 and 2007. While this trend is primarily driven by China, imports from all low-income countries have also increased in most of T&C industries. Finally, this surge in imports from low-wage countries has occurred at the expense of high-wage countries that have seen their exports to Canada to fall sharply between 1999 and 2011 in almost all industries (the only exception being 'Other Leather and Allied Product Manufacturing', NAICS 3169).

U. Construction of firm identifiers for the multiunit dummy

The Scott's database—which has a very exhaustive coverage of the manufacturing sector since it is based on the Canadian Business Register—provides plant-level data but does not allow to easily group establishments into firms. We therefore exploit relevant information in the database to associate the establishments with the firms (or the firms' divisions) they belong

[38]Making this distinction does not change the key results of our regression analysis. To save space, we do not report them, but they are available upon request.

Table 18: Components and aggregation of textile industries for the T&C sector.

Industry name	**Stable NAICS**	**Aggregation**
Fibre, yarn and thread mills	313110	
Broad-woven fabric mills	313210	
Narrow fabric mills and schiffli machine embroidery	313220	
Nonwoven fabric mills	313230	
Knit fabric mills	313240	
Textile and fabric finishing	313310	
Fabric coating	313320	
Carpet and rug mills	314110	
Curtain and linen mills	314120	
Textile bag and canvas mills	314910	
All other textile product mills	314990	Aggregated
Cut and sew clothing contracting	314990	Aggregated
Hosiery and sock mills	315110	
Other clothing knitting mills	315190	
Other men's and boys' cut and sew clothing manufacturing	315220	Aggregated
Men's and boys' cut and sew suit, coat and overcoat manufacturing	315220	Aggregated
Men's and boys' cut and sew shirt manufacturing	315220	Aggregated
Men's and boys' cut and sew underwear and nightwear manufacturing	315220	Aggregated
Men's and boys' cut and sew trouser, slack and jean manufacturing	315220	Aggregated
Women's and girls' cut and sew blouse and shirt manufacturing	315249	Aggregated
Other women's and girls' cut and sew clothing manufacturing	315249	Aggregated
Women's and girls' cut and sew dress manufacturing	315249	Aggregated
Women's and girls' cut and sew suit, coat, tailored jacket and skirt manufacturing	315249	Aggregated
Women's and girls' cut and sew lingerie, loungewear and nightwear manufacturing	315249	Aggregated
Infants' cut and sew clothing manufacturing	315291	
Fur and leather clothing manufacturing	315292	
All other cut and sew clothing manufacturing	315299	
Clothing accessories and other clothing manufacturing	315990	
Leather and hide tanning and finishing	316110	
Footwear manufacturing	316210	
Other leather and allied product manufacturing	316990	

Notes: We aggregate all industries to a stable 6-digit classification that spans NAICS 1997, 2002, 2007, and 2012. Changes within the T&C industry occur mainly between the NAICS 2007 and NAICS 2012 classifications. There are several other changes for non-textile industries. The 4-digit classification remains essentially stable throughout the entire 2001–2013 period. There are 85 4-digit industries since our dataset has no plants in NAICS 3391 after our concordance has been applied.

to. The affiliation with a firm can be backed out in two ways: (i) by cross-comparison of the establishments' legal names; and (ii) by cross-comparison of the unique plant identifiers which are stable across time. Although the procedure of creating the firm identifiers is fairly straightforward, it is subject to the problems that typically arise when working with string variables and which lead to measurement error.

Table 20 shows that most establishments systematically feature the company name. Unfortunately, others do not. Using the data in Table 20, the idea underlying the assignment procedure is simple: if two establishments have identical legal names they must belong to the same firm (legal entity). We thus loop over the sorted legal names of the establishments, where the running variable is the firm identifier. Since the usual 'string problems' arise, we pre-clean

Table 19: Changes in import values from China and other country groups for the different textile industries.

NAICS	Industry name	Imports from China			Imports from low-income countries		
		Δ1999 – 2003	Δ2003 – 2007	Δ2007 – 2011	Δ1999 – 2003	Δ2003 – 2007	Δ2007 – 2011
3131	Fibre, yarn and thread mills	-0.701	0.535	3.797	-30.860	-41.485	-10.735
3132	Fabric mills	59.359	-10.977	9.791	-45.215	-64.515	-1.997
3133	Textile and fabric finishing and fabric coating	5.169	4.455	8.113	.547	2.531	1.912
3141	Textile furnishings mills	147.093	289.466	102.747	94.745	73.481	11.343
3149	Other textile product mills	65.887	80.471	48.053	13.069	26.800	39.075
3151	Clothing knitting mills	40.170	557.582	177.584	77.227	109.974	163.617
3152	Cut and sew clothing manufacturing	744.446	1624.757	77.262	459.394	259.150	835.000
3159	Clothing accessories and other clothing manufacturing	89.1302	89.1241	120.1234	9.7309	14.6381	33.1973
3161	Leather and hide tanning and finishing	2.626	1.244	0.864	1.976	-1.403	-1.453
3162	Footwear manufacturing	181.7469	344.4463	236.7850	19.5069	15.2499	110.0145
3169	Other leather and allied product manufacturing	79.327	204.511	170.035	1.544	0.891	27.245

NAICS	Industry name	Imports from high-income countries		
		Δ1999 – 2003	Δ2003 – 2007	Δ2007 – 2011
3131	Fibre, yarn and thread mills	-140.994	-98.884	
3132	Fabric mills	-447.623	-587.660	-168.280
3133	Textile and fabric finishing and fabric coating	-38.329	-37.217	-51.611
3141	Textile furnishings mills	-4.966	9.085	-118.278
3149	Other textile product mills	-54.667	-65.008	-44.656
3151	Clothing knitting mills	1.447	-181.923	-26.671
3152	Cut and sew clothing manufacturing	-52.837	-662.498	-192.119
3159	Clothing accessories and other clothing manufacturing	-3.422	-21.444	-3.277
3161	Leather and hide tanning and finishing	-18.663	-106.753	-39.909
3162	Footwear manufacturing	-92.224	-69.208	-80.607
3169	Other leather and allied product manufacturing	27.844	22.819	12.233

Notes: Author's computations, using *Innovation, Science and Economic Development Canada's Trade Data Online* from 1999–2011. Low-income countries are defined as in Bernard et al. (2006) by all countries with a GDP per capita below 5% of U.S. GDP per capita, and high-income countries are countries whose GDP per capita exceeds 95% of U.S. GDP per capita. All values are expressed in millions of current C$.

Table 20: Raw Scott's data for creating firm identifiers.

Year	scottsid	companyname	prov	empl
2001	317028	Lafarge Canada Inc.	13	2
2001	317029	Lafarge Construction Materials	13	2
2001	321875	Lafarge Canada Inc.	13	5
2001	382430	Lafarge Canada Inc.	48	37
2001	403219	Lafarge Construction Materials	35	8
2001	403221	Lafarge Construction Materials	35	22
2001	458100	Lafarge Canada Inc.	48	6
2001	458102	Lafarge Canada Inc.	48	3
2001	18317132	Lafarge Canada Inc.	12	84
2001	18323452	Lafarge Canada Inc.	12	19
2001	18855322	Air Liquide Canada Inc.	35	75
2001	18858178	Air Liquide Canada Inc.	35	12
2001	18858871	Air Liquide Canada Inc.	35	5
2001	18862939	Air Liquide Canada Inc.	59	26
2001	18862971	Air Liquide - Okanagan	59	26
2001	18881913	Air Liquide Canada Inc.	35	3
2001	18887333	Air Liquide Canada Inc.	35	100
2001	18901654	Air Liquide Canada Inc.	24	6
2001	18924713	Air Liquide Canada Inc.	24	7
2001	18933235	Air Liquide Canada Inc.	24	8
2001	18940933	Air Liquide Canada Inc.	35	10

Notes: Excerpt from the 2001 Scott's All National manufacturing directories. We only report a selected number of variables that are of interest to us. 'scottsid' is a unique plant-specific identifier (starting 2003); 'prov' denotes the census province code; 'empl' is the number of employees.

the data to allow for more accurate results. In particular, we trim the plant names to get rid of extra spaces and unify general naming patters (e.g., replacing the rare cases of "&" instead of "and", "mngmt" instead of "mgmt", etc.). We also eliminate differences in legal names stemming from the fact that Canada is a bilingual country, i.e., although 'Enterprise Rent-A-Car' and 'Entreprise Location d'Autos' belong to the same firm, the loop will split them into two different firms depending on the primary language of the province of operation.

The comparison of time-invariant plant identifiers allows us to associate a plant in year t with itself in year $t+1$. This provides a refinement of the assignment of the firm identifier in case the establishment's name has changed in a way that the preliminary data treatment could not accommodate. However, use of this 'tool' is limited to the 2003-2013 sample due to a structural change in the plant identifier design implemented by Scott's. Although we can match the plant identifiers for many plants between 2001 and 2003 using a correspondence file provided by Scott's, we loose a number of plants when doing so. This explains why we exclude the year 2001 from our exit analysis.

As a check of our assignment procedure, Table 21 reports the correlations between the shares of multiunit plants by industry in our data and in both the (manufacturing portion of the) Business Register (BR) and the Annual Survey of Manufacturers (ASM) Longitudinal Microdata file. These correlations use special-tabulation data that have been vetted for release

Table 21: Correlations between the multiunit shares in our data, the BR, and the ASM.

	Unweighted						Plant-count weighted					
	NAICS 4-digit			NAICS 6-digit			NAICS 4-digit			NAICS 6-digit		
	Our	BR	ASM	Our	BR	ASM	Our	BR	ASM	Our	BR	ASM
BR data	0.78	–		0.77	–		0.82	–		0.83	–	
ASM data	0.84	0.94	–	0.80	0.95	–	0.87	0.96	–	0.86	0.96	–

Notes: Our data come from the *Scott's National All Business Directories* database. Other data come from the manufacturing portion of the Business Register (BR) and the Annual Survey of Manufacturers (ASM) Longitudinal Microdata file. They have been computed as special tabulations by Statistics Canada. The vetted data have been approved by Statistics Canada and are available from the authors upon request.

by Statistics Canda, i.e., data that excludes very small industries (both in terms of plants and in term of multiunit plants). As one can see from the table, the correlations are generally high, hovering around 0.8 for the BR and 0.85 for the ASM. They are slightly higher when weighting industries by plant counts, i.e., the small industries have a slightly worse match in terms of the shares of plants identified as belonging to multiunit firms than the large industries. This is expected, because share errors are more substantial in small samples.

Using a slightly different sample, we also checked the correlations between our shares and the confidential data multiunit shares from Statistics Canada. The correlations are slightly lower, between 0.7 and 0.84, when using the confidential data. This is expected because misclassifications of plants in small industries—the confidential data includes all industries, even those for which the multiunit shares cannot be released either because the industries are too small or because there are not enough multiunit plants in those industries—have a very strong effect on shares, whereas that effect is much smaller in industries with many plants. Overall, the results in Table 21 suggest that our procedure to detect multiunit plants works sufficiently well to have confidence in the quality of our control. We do not expect systematic errors in the construction of this variable, and the measurement error introduced should (if anything) bias the coefficient of our control towards zero.

V. Computing K-densities and their cumulatives

The following description largely draws on Behrens & Bougna (2015). To compute the kernel density distribution of bilateral distances, as well as the cumulative distribution, and to compare it with randomly drawn distributions, we proceed as follows.

First step (kernel densities). Consider sector s with n plants. We compute the great circle distance, using postal code centroids, between each pair of plants in that sector. This yields $n(n-1)/2$ bilateral distances for sector s. Let us denote the distance between plants i and j by d_{ij}. Given n etablishments, the kernel-smoothed estimator of the density of these pairwise distances, which we henceforth call K-density as in Duranton and Overman (2005), at any distance d is:

$$\widehat{K}(d) = \frac{1}{hn(n-1)} \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} f\left(\frac{d-d_{ij}}{h}\right), \tag{5}$$

where h is the optimal bandwidth (set according to Silverman's rule), and f a Gaussian kernel function. The distance d_{ij} (in kilometers) between plants i and j is computed as:

$$d_{ij} = 6378.39 \cdot \text{acos}\left[\cos(|\text{lon}_i - \text{lon}_j|)\cos(\text{lat}_i)\cos(\text{lat}_j) + \sin(\text{lat}_i)\sin(\text{lat}_j)\right].$$

We also compute the employment-weighted version of the K-density, which is given by

$$\widehat{K}_W(d) = \frac{1}{h\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}(e_i+e_j)} \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} (e_i+e_j) f\left(\frac{d-d_{ij}}{h}\right), \tag{6}$$

where e_i and e_j are the employment levels of plant i and j, respectively. The weighted K-density thus describes in some sense the distribution of bilateral distances between employees in a given industry, whereas the unweighted K-density describes the distribution of bilateral distances between plants in that industry.

Since the K-density is a distribution function, we can also compute its cumulative (CDF) up to some distance d:

$$\text{CDF}(d) = \int_0^d \widehat{K}(i)\text{d}i \quad \text{and} \quad \text{CDF}_W(d) = \int_0^d \widehat{K}_W(i)\text{d}i. \tag{7}$$

The CDF at distance d thus tells us what share of plant pairs (or of employees) is located less than distance d from each other. Alternatively, we can view this as the (kernel smoothed) probability that two randomly drawn plants (workers) in an industry will be at most d kilometers away.

Second step (counterfactual samples). Using the full distribution of all manufacturing plants in our sample, we randomly draw as many locations as there are plants in sector s. To each of these locations, we assign randomly a plant from sector s, using its observed employment. This procedure ensures that we control for the overall pattern of concentration in manufacturing as a whole, as well as for the within-sector concentration. We then compute the bilateral distances of this hypothetical sector and estimate the K-density of the bilateral distances. Finally, for each sector s, we repeat this procedure 1,000 times. This yields a set of 1,000 estimated values of the K-density at each distance d.

Third step (confidence bands). To assess whether a sector is significantly localized or dispersed, we compare the actual K-density with that of the counterfactual distribution. We consider a range of distances between zero and 800 kilometers to construct our K-densities and confidence bands.[39] We then use our bootstrap distribution of K-densities, generated by the counterfactuals, to construct a two-sided confidence interval that contains 90 percent of these estimated values. The upper bound, $\overline{K}(d)$, of this interval is given by the 95th percentile of the generated values, and the lower bounds, $\underline{K}(d)$, by the 5th percentile of these values. Distributions of observed distances that fall into this confidence band could be 'as good as random' and are, therefore, not considered to be either localized or dispersed.

Fourth step (identification of location patterns). The bootstrap procedure generates a confidence band, and any deviation from that band indicates localization or dispersion of the sector. If $\widehat{K}(d) > \overline{K}(d)$ for at least one $d \in [0, 800]$, whereas it never lies below $\underline{K}(d)$ for all $d \in [0, 800]$, sector s is defined as globally localized at the 5 percent confidence level. On the other hand, if $\widehat{K}(d) < \underline{K}(d)$ for at least one $d \in [0, 800]$, sector s is defined as globally dispersed. We can also define an index of global localization, $\gamma_i(d) \equiv \max\{\widehat{K}(d) - \overline{K}(d), 0\}$, as well as an index of global dispersion

$$\psi_i(d) \equiv \begin{cases} \max\{\underline{K}(d) - \widehat{K}(d)\} & \text{if} \quad \sum_{d=0}^{800} \gamma_i(d) = 0 \\ 0 & \text{otherwise.} \end{cases} \tag{8}$$

Intuitively, if we observe a higher K-density than that of randomly drawn distributions, we consider the sector as localized. Similarly, if we observe a lower K-density than that of randomly drawn distributions, we consider the sector as dispersed. Last, the strength of localization and dispersion can be measured by $\Gamma_i \equiv \sum_d \gamma_i(d)$ and $\Psi_i \equiv \sum_d \psi_i(d)$, which corresponds roughly to a measure of the 'area' between the observed distribution and the upper- and lower-bounds of the confidence band. It can be viewed as the excess probability of drawing a plant of sector s at a given distance from another plant of that sector, conditional on the overall distribution of manufacturing.

W. A simple model of clusters and survival

We present a simple model of clusters and survival with heterogeneous firms. Assume that there are $s = 1, 2, \ldots S$ sectors and $c = 1, 2, \ldots C$ clusters. A firm with productivity m in sector s and cluster c has the production function: $y_c^s(m) = m \times A(\mathbf{L_c}) \times L^{\alpha} K^{1-\alpha}$, where m is firm-level productivity, L is labor input, and K is capital used. In the above production function,

[39]The interactions across 'neighboring cities' mostly fall into that range in Canada. In particular, a cutoff distance of 800 kilometers includes interactions within the 'western cluster' (Calgary, AB; Edmonton, AB; Saskatoon, SK; and Regina, SK); the 'plains cluster' (Winnipeg, MN; Regina, SK; Thunder Bay, ON); the 'central cluster' (Toronto, ON; Montréal, QC; Ottawa, ON; and Québec, QC); and the 'Atlantic cluster' (Halifax, NS; Fredericton, NB; and Charlottetown, PE). Setting the cutoff distance to 800 kilometers allows us to account for industrial localization at both very small spatial scales, but also at larger interregional scales for which market-mediated input-output and demand linkages, as well as market size, might matter much more.

$A(\mathbf{L_c})$ denotes an external agglomeration effect that depends on the sectoral composition of the cluster, given by $\mathbf{L_c} = (L_c^1, L_c^2, \ldots, L_c^s, \ldots L_c^S)$.

Let w_c denote the cluster-specific wage—which is the same across sectors—and r the nation-wide rental rate of capital. Given the foregoing production function, the variable unit cost is given by

$$\gamma(m) = \frac{w_c^{\alpha} r^{1-\alpha}}{A(\mathbf{L_c})m}\kappa_1, \tag{9}$$

where $\kappa_1 \equiv \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$ is a positive constant. We assume that each firm has a fixed cost F incurred in terms of output, and that it faces an iso-elastic demand that originates from consumers' CES preferences. We denote by Y_c the aggregate spending that a firm in cluster c faces. Since demand is iso-elastic, it can be written as $D(m) = [Yp(m)^{-\sigma}]/\mathbb{P}^{1-\sigma}$, where $\mathbb{P}^{1-\sigma}$ is a CES price aggregator. Profit is given by

$$\pi(m) = [p(m) - c(m)]\,\frac{Yp(m)^{-\sigma}}{\mathbb{P}^{1-\sigma}} - Fc(m), \tag{10}$$

where we suppress the cluster and sector indices c and s to alleviate notation. Given iso-elastic demands, profit maximization implies as usual a constant markup over marginal cost

$$p(m) = \frac{\sigma}{\sigma-1}c(m) \tag{11}$$

so that

$$\pi^*(m) = \frac{Y}{\mathbb{P}^{1-\sigma}}c(m)^{1-\sigma}\kappa_2 - Fc(m), \tag{12}$$

where $\kappa_2 = \sigma^{-\sigma}(\sigma-1)^{\sigma-1}$ a positive constant.

Let M denote the mass of firms in the industry selling in the economy, and $\mathrm{d}F(\cdot)$ the productivity distribution. We denote by $\widetilde{m}$ the endogenously determined productivity selection cutoff for firms operating in the cluster. Substituting the profit-maximizing prices into the CES price aggregator, we have

$$\mathbb{P}^{1-\sigma} = \frac{M}{1-F(\widetilde{m})}\int_{\widetilde{m}}^{\infty} p(m)^{1-\sigma}\mathrm{d}F(m) = \left[\frac{\sigma}{\sigma-1}\frac{w^{\alpha}r^{1-\alpha}}{A(\mathbf{L})}\kappa\right]^{1-\sigma} M\overline{m}^{1-\sigma} \tag{13}$$

with

$$\overline{m}(\widetilde{m}) = \left[\frac{1}{1-F(\widetilde{m})}\int_{\widetilde{m}}^{\infty} m^{\sigma-1}\mathrm{d}F(m)\right]^{\frac{1}{\sigma-1}} \tag{14}$$

the average productivity of firms operating in the cluster. The profit hence becomes

$$\pi^*(m) = \frac{Y}{M\sigma}\left[\frac{m}{\overline{m}(\widetilde{m})}\right]^{\sigma-1} - Fc(m). \tag{15}$$

As usual, we have two equilibrium conditions: (i) zero cutoff profit (ZCP) for the marginal firm, $\pi^*(\widetilde{m}) = 0$; and (ii) zero expected profits (ZEP) for entrants, $E(\pi^*) = 0$.[40]

[40] Note that we could replace condition (i) with $\pi^*(\widetilde{m}) = w$ if there is occupational choice between running firms (earning $\pi^*(\widetilde{m})$) or working as a worker (earning w). This makes the following analysis more involved but does not change fundamentally the results.

ZCP. The zero cutoff profit condition is given by

$$\frac{Y}{M\sigma}\left[\frac{\widetilde{m}}{\overline{m}(\widetilde{m})}\right]^{\sigma-1} - F\frac{w_c^{\alpha}r^{1-\alpha}}{A(\mathbf{L_c})\widetilde{m}}\kappa_1 = 0. \tag{16}$$

ZEP. The zero expected profit condition is given by

$$E(\pi) = \int_{\widetilde{m}}^{\infty} \pi^*(m)\mathrm{d}F(m) = [1-F(\widetilde{m})]\left[\frac{Y}{M\sigma} - F\frac{w_c^{\alpha}r^{1-\alpha}}{A(\mathbf{L_c})\overline{m}_H(\widetilde{m})}\kappa_1\right] = F_e, \tag{17}$$

where

$$\overline{m}_H(\widetilde{m}) = \left[\frac{1}{1-F(\widetilde{m})}\int_{\widetilde{m}}^{\infty} m^{-1}\mathrm{d}F(m)\right]^{-1}$$

is the harmonic mean of productivity. We thus have

$$M = \frac{Y}{\sigma[\frac{F_e}{1-F(\widetilde{m})} + F\frac{w_c^{\alpha}r^{1-\alpha}}{A(\mathbf{L_c})\overline{m}_H(\widetilde{m})}\kappa_1]} \tag{18}$$

which we can substitute into (15) to get

$$\left[\frac{\frac{F_e}{1-F(\widetilde{m})}A(\mathbf{L_c})\widetilde{m}}{Fw_c^{\alpha}r^{1-\alpha}\kappa} + \frac{\widetilde{m}}{\overline{m}_H(\widetilde{m})}\right]\left[\frac{\widetilde{m}}{\overline{m}(\widetilde{m})}\right]^{\sigma-1} - 1 = 0. \tag{19}$$

Parametrization. To derive sharper results, we now impose a specific parametrization for productivity. Assume that the latter is distributed as $F(m) = 1-(m^{\min}/m)^k$, so that $1-F(\widetilde{m}) = (m^{\min}/\widetilde{m})^k$ and $\mathrm{d}F(m) = k(m^{\min})^k m^{-k-1}$. As usual, we assume that $1+k-\sigma > 0$ for all integrals to converge. In that case, $\overline{m} = \left[k\widetilde{m}^k\int_{\widetilde{m}}^{\infty} m^{\sigma-k-2}\mathrm{d}m\right]^{\frac{1}{\sigma-1}} = \left[\frac{k}{1+k-\sigma}\right]^{\frac{1}{\sigma-1}}\widetilde{m}$ and $\overline{m}_H = \widetilde{m}[(k+1)/k]$.

Equilibrium. Using the above parametrization, equation (15) becomes

$$\left[\frac{\frac{F_e}{(m^{\min})^k}A(\mathbf{L_c})\widetilde{m}^{k+1}}{Fw_c^{\alpha}r^{1-\alpha}\kappa_1} + \frac{k}{k+1}\right]\frac{1+k-\sigma}{k} - 1 = 0 \tag{20}$$

We thus finally obtain the expression for the equilibrium cutoff productivity as follows:

$$\widetilde{m}^{k+1} \propto \overline{m}^{k+1} = C\frac{w_c^{\alpha}}{A(\mathbf{L_c})} \tag{21}$$

with $C = \frac{\kappa_1 k\sigma}{(k+1)(1+k-\sigma)}\frac{F}{F_e}(m^{\min})^k r^{1-\alpha} > 0$ a bundle of parameters.

What are the implications of (21)? As can be seen from that expression, $\widetilde{m}$ is increasing in w_c and decreasing in $A(\mathbf{L_c})$: higher wages in the cluster push the selection cutoff up as in Melitz

(2003), whereas external agglomeration effects ('agglomeration economies') make it easier for less productive firms to survive.

Without specifying a full equilibrium model—which is beyond the scope of our exercise here—we take into account that there is a labor supply function to the cluster, i.e., $w_c = w_c(L)$, where $L \equiv \sum_s L_c^s$ is the total labor employed in the cluster. Hence, (21) can be expressed as

$$\widetilde{m}^{k+1} \propto \overline{m}^{k+1} = C\frac{w_c(L)^\alpha}{A(\mathbf{L_c})}, \tag{22}$$

so that the effect of local industry size on the selection cutoff is given by:

$$\frac{\partial \ln \widetilde{m}^s}{\partial \ln L_c^r} = \frac{1}{k+1}\left[\alpha\frac{\partial \ln w_c(L_c)}{\partial \ln L_c^r} - \frac{\partial \ln(A^s(\mathbf{L_c}))}{\partial \ln L_c^r}\right]. \tag{23}$$

A simple way to close the model is to impose the 'canonical assumptions' on utility, geographic labor mobility, and housing supply. Assume hence that workers consume housing H and some (non-housing) consumption bundle C, and that utility is given by $U = C^{1-\gamma}H^\gamma$. Assume further that the housing stock in the cluster is given by $\overline{H}_c$. In that case, the indirect utility of a worker in cluster c is given by $V_c = \frac{w_c(L_c)}{\mathbb{P}^{1-\gamma}R^\gamma}(1-\gamma)^{1-\gamma}\gamma^\gamma$, where R is the rental price of housing, and $V_c = \overline{V}$ for all $c = 1, 2, \ldots, C$ if workers are freely mobile ($\overline{V}$ is determined nation-wide in equilibrium, but we take it as given here, making thus the implicity assumption that every cluster is small in the aggregate economy). Since $HL_c = \overline{H}_c$ because of housing-market clearing, we have $R = \frac{\gamma w_c L_c}{\overline{H}}$. Substituting into the indirect utility, we have

$$\overline{V} = \frac{w_c(L_c)^{1-\gamma}}{L_c^\gamma} \times \frac{(1-\gamma)^{1-\gamma}\overline{H}_c^\gamma}{\mathbb{P}^{1-\gamma}} \quad \Rightarrow \quad \frac{\partial \ln w_c(L_c)}{\partial \ln L_c} = \frac{\gamma}{1-\gamma}\left[1 - \frac{\partial \ln \overline{H}_c(L_c)}{\partial \ln L_c}\right], \tag{24}$$

assuming that the cluster is small in the national economy so that both the price index and $\overline{V}$ are fixed. Plugging (24) into (23), we finally obtain:

$$\frac{\partial \ln \widetilde{m}^s}{\partial \ln L_c^r} = \frac{1}{k+1}\left\{\alpha\frac{\gamma}{1-\gamma}\left[1 - \epsilon_H(L_c)\right] - \epsilon_{sr}(\mathbf{L_c})\right\}, \tag{25}$$

where $\epsilon_H(L_c)$ denots the housing supply elasticity in the cluster and $\epsilon_{sr}(\mathbf{L_c})$ the measure of agglomeration economies in sector s due to a shock to employment in sector r.

Implications for plant death and industry switching. As can be seen from (25), how productivity changes with changes in labor employed in the cluster depends on: (i) the labor share in production, as measured by α; (ii) the elasticity of the housing supply function, which captures partly the elasticity of labor supply to the cluster; and (iii) the strength of the (own- and cross-industry) agglomeration effects. If the labor share α is small, or if labor supply is elastic enough (w_c is flat enough), a positive shock to employment in the cluster makes the selection cutoff fall, i.e., survival gets easier for firms. Conversely, a negative shock that hits some firms and thus decreases L_c makes the selection cutoff rise, i.e., it gets harder for the remaining firms to survive. Hence, there is *amplification of negative shocks because of agglomeration effects*. The reverse holds if the labor share is large or if the labor supply schedule is steep enough. In that case, negative shocks to the cluster may well reduces the survival threshold, which stabilizes the cluster.

In the face of negative shocks, some firms may no longer be able to operate. How this affects the cluster—and how the remaining firms react—crucially depends on the specification of the external agglomeration effects, $A(\mathbf{L_c})$, as in Helsley & Strange (2014). Firms can obviously just go out of business ('die'). However, we could also think about a model in which firms can switch from industry s to industry t. Which industry are firms likely to switch into? Assume that for a firm operating in sector s and switching to a new sector t we have $A^t(\mathbf{L_c}^{-t}, L_c^t) \rightarrow \epsilon \approx 0$ if $L_c^t \rightarrow 0$, i.e., own productivity becomes fairly small if the firm switches into a new industry in which there are no other firms around and in which it has not conducted previously business. In that case, if there is switching, a firm will clearly only switch into industries where there is a large enough local presence to begin with. Alternatively, the firm may switch into an industry in which it has some prior experience.