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CULTURAL AND RECREATIONAL SERVICES AS FACTORS OF CITY RESILIENCE? EVIDENCE FROM BIG PLANT CLOSURES AND DOWNSIZING

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JEL Classification: J10, R11, R12, R23

Keywords: Socio-demographic change, Plant closures, Downsizing, Manufacturing, City resilience

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Cultural and recreational services as factors of city resilience?
Evidence from big plant closures and downsizing*

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December 14, 2023

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1 Introduction

The rich literature evaluating the impact of various shocks on city growth suggests that cities are much more vulnerable to political and economic dislocation than to physical destruction (Glaeser, 2022). How the demographic composition of cities changes in the wake of negative economic shocks—and what city-level characteristics favor urban resilience—are far less studied. The aim of our paper is to partly fill this gap.

We evaluate the impact of the closures of, and mass layoffs at, big manufacturing plants on the growth and the composition of cities' populations. To do so, we combine establishment level data and population census data from 2001 to 2017 for Canadian urban areas. We find that while plant closures do not systematically lead to lower subsequent population growth (we find a negative but statistically insignificant coefficient), they significantly affect the composition of the cities' populations. Big manufacturing plant closures and mass layoffs cause a decrease in the share of residents aged 0–19 and 20–54, and an increase in the share of residents aged 55+. We also find that households with kids are more likely to stay and migrants are more likely to leave. The impact on other population characteristics are not statistically significant. Cities that initially have a larger population and a bigger share of their workforce in the cultural and recreational services are more resilient to large negative employment shocks. These mitigating effects are heterogeneous across age groups.

Our findings are important for several reasons. First, central and local governments make substantial investments to ward off big plant closures. For example, in 2008 and 2009, the U.S. administration paid \$50 billion to General Motors and Chrysler to prevent the closure of their plants, whereas the Canadian federal government paid \$9.5 billion to General Motors to secure its business and thousands of jobs in Oshawa. Measuring the effects of big plant closures on local economies is thus important to understand whether the huge costs of those safeguard measures are justified compared to the short- and long-run costs of the closures. Second, the propensity to consume varies significantly across age groups, and the needs in terms of amenities and services also differ by age or family status. Assessing the heterogeneous impact of big plant closures across population categories is thus important to better understand the potential long-run consequences of these closures on the local economy. Finally, beyond safeguard measures, what makes cities resilient is a recurring question in urban and regional economics and a first-order policy concern. It is thus important to identify local factors that can explain why some cities succeed at retaining certain types of residents despite large adverse labor demand shocks.

Identifying the impact of poor local economic performance on population changes is challenging due to possible reverse causality. A rich literature has shown that denser labor markets offer higher wages (e.g., Glaeser and Mare, 2001; Combes et al., 2008), while the regional concentration of particular industries could provide insurance against idiosyncratic employment shocks (e.g., Ellison et al., 2010; Overman and Puga, 2010). Put differently, local economic conditions certainly influence population dynamics, i.e., *people follow jobs*. Yet, job opportunities are not the only factor that attracts population. Several papers also show that people move to cities with better amenities and higher quality-of-life (e.g., Glaeser et al., 2001; Rappaport, 2007; Albouy and Stuart, 2020). Then, firms might follow to reap the benefits from a denser labor markets and a larger pool of workers (e.g., Head and Mayer, 2004). In this case, population growth determines local economic conditions, i.e., *jobs follow people.*[1] This reverse causality would lead to overestimating the impact of big plant closures on local population. Another type of issue is that plant closures are partly compensated by plant openings. If, for some reason, the plant turnover varies across cities so that cities with a higher plant closure rate also have a higher plant creation rate, this would bias the estimated effect of big plant closures toward zero.

To deal with these endogeneity problems, we rely on an instrumental variables (IV) strategy. In our preferred specification, the treatment variable is the share of initial manufacturing jobs lost between 2003 and 2017 due to big manufacturing plant closures and mass layoffs in each Canadian city. We use a Bartik instrument, which is the predicted growth rate of the number of manufacturing jobs computed as the interaction between the initial manufacturing composition of the city (NAICS 4-digit industries) and the observed growth

[1] These bidirectional causal mechanisms are well explained by "New Economic Geography" models which suggest that agglomeration economies, where big markets attract firms, which in turn attract new workers and consumers, are conducive to self-reinforcing regional growth (Krugman, 1991; Fujita et al., 1999).

rate of the number of jobs of these same industries in the U.S. The instrument arguably captures global technology and trade shocks that affect manufacturing industries in both the US and Canada. Finally, we also control for observable characteristics that might influence city-level population changes such as local temperature, proximity to the coast and to other major urban centers, as well as regional policy differences.

Our work is related to three strands of the literature. First, research on job displacement has shown that workers who lose their jobs due to big plant closures or mass layoffs suffer from long-lasting income losses (e.g., Ruhm, 1991; Jacobson and LaLonde, 1993; Couch and Placzek, 2010), longer unemployment spells (e.g., Eliason and Storrie, 2006), and other adverse outcomes.[2] Building on the literature on multiplier effects[3], other studies analyze the spillover effects of plant closures and mass layoffs on neighboring plants and regional labor markets (see, e.g., Gathmann et al., 2020; Jofre-Monseny et al., 2018). However, we are not aware of any study on the relationship between plant closures and demographic changes at the local level. Yet, plant closures and mass layoffs can reshape the demographic composition of cities by displacing more mobile populations, which might in turn affect the growth prospects of those cities.[4]

Second, several studies have shown that high-skilled workers and immigrants are highly responsive to local labor demand shocks in terms of labor supply (see, e.g., Topel, 1986; Bound and Holzer, 2000; Cadena and Kovak, 2016). This is confirmed by Albouy et al. (2019), who show that positive local labor demand shocks in the 1990s and 2000s increase the local share of residents holding a university degree in Canada, but not in the US. Beyond different mobility costs, the inelastic housing supply, the existence of social transfers, and the immigration selection criteria can explain the heterogeneous response of workers to local labor demand shocks (see, e.g., Glaeser and Gyourko, 2005; Notowidigdo, 2019). Based

[2] These include reduced fertility (e.g., Huttunen and Kellokumpu, 2016), higher mortality (e.g., Sullivan and Von Wachter, 2009), higher risk of divorce (e.g., Charles and Stephens Jr., 2004), and lower income for their kids when they become adults (e.g., Oreopoulos et al., 2008).

[3] Using US data, Moretti (2010) finds that one additional manufacturing job generates 1.6 jobs in the non-tradable sector due to increased demand for local goods and services. Faggio (2019) and Jofre-Monseny et al. (2020) find significant multiplier effects from public-sector jobs in Spain and in the UK.

[4] In the context of adverse trade shocks, Twinam (2020) and Autor et al. (2021) find some negative effects on local population dynamics, especially for foreign-born and younger residents, even though the magnitude of these effects seems to be context-specific and to depend on the size of the local units that are considered.

on negative employment shocks from the recent decades of deindustrialization, we provide here a different—but complementary—view on this issue and further analyze the heterogeneous response depending on age and family status. Younger residents and immigrants selected to Canada on the basis of economic criteria are much more sensitive to local economic conditions affecting employment opportunities. On the opposite, we find that living in a household with at least one child constitutes a significant barrier to mobility for workers.

Last, we identify some city-level characteristics that explain resilience to big manufacturing plant closures, thereby contributing to the recent literature on the resilience of local economies. Martin et al. (2011) show that French exporting firms suffered more from the 2008 trade collapse when they were located close to other exporters or were targeted by cluster policies, which may be explained by higher dependence on the "fate" of the larger exporter in the cluster. Behrens et al. (2020) show that plants in Canadian textile clusters are not more likely to survive or to adapt by changing their main sector of activity than those outside clusters. Finally, Delgado and Porter (2017), show that industries located near other related industries experienced higher employment growth than unrelated industries during the great recession of 2007–2009. Whereas these studies focus on how firms adapt or survive, we adopt here a different angle by examining the performance of cities in retaining specific segments of their population following a negative shock to their local labor market. Some recent contributions investigate the role of cultural and recreational industries in local development. Using Canadian data, Polèse (2012) shows that if the presence of cultural industries fosters employment growth in other industries, this is true for specific industries and in the context of large cities only. Couture and Handbury (2020) and Behrens et al. (2022) show that the presence of some cultural and (re)creative industries in poor urban centers/neighborhoods is significantly associated with subsequent urban revival/gentrification. We have a different view here and show that the presence of cultural and recreational services is contributing to the demographic resilience of cities follow negative labor demand shocks.

The remainder of the paper is organized as follows. Section 2 describes the data used in the empirical analysis. Section 3 presents OLS and IV results on the impact of big manufacturing plant closures and downsizing on population composition. Section 4 examines the heterogeneous effects along initial characteristics of cities, thus identifying factors of resilience. Section 5 concludes.

2 Data and descriptive statistics

We first describe the establishment-level data we use to measure big manufacturing plant closures and downsizing, as well as the demographic, economic, and geographic data we use as controls in the empirical analysis. We then provide descriptive statistics that motivate the subsequent analysis.

2.1 Establishment-level data and plant-closure rate

The primary data source are the *Scott's National All Business Directories* that contain exhaustive information on establishments operating in Canada, with an extensive coverage of the manufacturing sector (NAICS 31–33). We use here the 2003 and 2017 editions of these data. Each plant in the database reports: a unique identifier, information on its primary 6-digit NAICS code, its opening year, its number of employees, whether it is an exporter or a headquarter, and complete address information. Thanks to the latter, we geocode the plants and assign them to cities. Table 1 summarizes the geographic structure of manufacturing in Canada in 2003 and 2017, respectively. Most manufacturing plants are located in Quebec and Ontario (within the 'manufacturing belt' that runs in practice from Quebec City to Windsor). Table 1 shows that the total number of manufacturing establishments in our sample has declined from 52,784 in 2003 to 34,135 in 2017. This follows from the deindustrialization process observed in most developed countries over the past decades. Observe also that while the number of plants has sharply declined between 2003 and 2017, their average size has slightly increased, from 31 employees in 2003 to 35 employees in 2017. This suggests positive selection among survivors: more productive and larger plants are more likely to survive strong negative shocks (see Bernard and Jensen, 2007).

While the Scott's database is very exhaustive, it is not a census of manufacturing plants.

Yet, it is probably the best alternative to restricted-access datasets such as Statistics Canada's Annual Survey of Manufacturers or the Business Register.[5] Correlations of sectoral or provincial establishment counts and employment in the Scott's Data and Statistics Canada datasets are very high (about 0.95 on average), which suggests that our data provide a fairly accurate picture of the overall manufacturing structure with respect to industrial composition, the number of plants, and employment.

Table 1: Geographic breakdown of manufacturing plants in Canada.

		2003		2017	
Region	Province	# of plants	Avg. jobs	# of plants	Avg. jobs
Western	Alberta	3,650	32.9	2,891	36.9
	British Columbia	5,923	27.7	3,966	30.6
	Manitoba	1,556	33.6	1,061	37.3
	Saskatchewan	1,291	23.5	895	25.8
		12,420	***29.5***	***8,813***	***33.0***
Atlantic	New Brunswick	1,376	32.0	740	37.2
	Newfoundland and Labrador	578	39.6	320	41.2
	Nova Scotia	1,576	26.0	816	30.7
	Prince Edward Island	303	24.0	154	34.9
		3,833	***30.0***	***2,030***	***35.1***
Ontario	Ontario	***21,758***	***35.3***	***14,277***	***36.1***
Quebec	Quebec	***14,773***	***34.5***	***8,980***	***39.4***
Canada		**52,784**	**30.9**	**34,135**	**35.0**

Notes: Data from the Scott's National All Business Directories. The table is based on manufacturing plants (NAICS 31–33). The three territories (Northwest Territories, Nunavut, and Yukon) are not reported in the table but are included in the total.

We construct measures of the manufacturing job-loss rate and plant-closure rate in city c. Our measures are based on the literature on the effects of mass layoffs that focuses on 'significant closures'.[6] We consider alternatively that a significant closure is either: (i) a big plant—at least 50 employees—present in 2003 but not present anymore in 2017; or (ii) a big plant—at least 50 employees—present in 2003 that disappeared or lost at least 30% of its employees by 2017. Using either one of those definitions, we construct the following

[5] See Tables B.1, B.2, and B.3 in the Appendix for a comparison between the Scott's database and other Statistics Canada databases listing establishments. In contrast to the Annual Survey of Manufacturers, it provides more information on smaller plants. In contrast to the Business Register, it tracks plants and information about them over 15 years.

[6] See, among others, Jacobson and LaLonde (1993); Sullivan and Von Wachter (2009); Couch and Placzek (2010); Huttunen and Kellokumpu (2016).

measure for each city c:

$$\text{Job loss rate}_c = \frac{\text{\# Employees in significant closures between 2003 and 2017 in } c}{\text{\# Employees in all plants in 2003 in } c} \quad (1)$$

where significant closures can be defined by either (i) or (ii) above.

In what follows, we use job loss rate related to big plant closures and downsizing (equation (1) with definition (ii) for significant closures) as our benchmark. We show in robustness checks that the results remain qualitatively unchanged when ignoring downsizing (definition (i) for significant closures). Table 2 reports descriptive statistics on job loss rates related to big plant closures and downsizing by industry in Canada.

Table 2: Descriptive statistics on significant closures by NAICS 3-digit sectors.

NAICS3	Manufacturing sector	(1) Significant closures: Job loss rate	(2) Significant closures: Avg. # jobs
311	Food	37.6%	143.7
312	Beverage and tobacco product	29.1%	146.8
313	Chemical	64.8%	156.7
313	Textile mills	48.8%	113.6
314	Textile product mills	55.6%	120.6
315	Clothing	44.7%	130.1
316	Leather and allied product	42.8%	132.5
321	Wood product	54.4%	187.6
322	Paper	34.3%	113.8
323	Printing and related support actv.	31.3%	181.6
324	Petroleum and coal product	38.1%	124.2
326	Plastics and rubber products	38.0%	119.8
327	Non-metallic mineral product	31.5%	116.8
331	Primary metal	44.9%	173.4
332	Fabricated metal product	29.2%	110.0
333	Machinery	30.9%	106.3
334	Computer and electronic product	42.6%	142.9
335	Electrical equipment, appliance	40.5%	140.2
336	Transportation equipment	48.7%	185.5
337	Furniture and related product	32.3%	120.4
339	Miscellaneous	34.8%	122.3
	All sectors	**38.9%**	**132.0**

Notes: "Significant closures" refers to the closure or downsizing by more than 30% of establishments with 50+ employees in 2003. The job loss rate measures the share of 2003 employment lost by 2017 due to significant closures. Data are from Scott's National All Business Directories. The data are from Scott's National All Business Directories. The 'All sector' averages are weighted by the sectoral employment shares.

Column (1) reports the industry share of overall employment of 2003 lost by 2017 due to the closure or downsizing of big plants. As shown, there is substantial heterogeneity across sectors. The average job loss rate (weighted by 2003 industry plant shares) equals 38.9%. Big plants' mass layoffs move many employees into unemployment at the same time, thus reducing employment opportunities in the city in addition to affecting businesses that depend on the big plant's output. The closure of small plants, unless there are many of them, does not produce such a substantial negative shock in local labor markets.[7] Column (2) shows that the average size of closing or downsizing establishments equals 132 employees.

Turning to the geography of plant closures, Table 3 shows substantial heterogeneity across Canadian provinces. The two big manufacturing provinces, Quebec and Ontario, were the most severely hit by deindustrialization, whereas the Western provinces fared better. This is especially striking when comparing the local job loss rate to the one observed in Canada at the level of Canadian urban areas, as shown in Figure 1. Urban areas in Western Canada had a lower manufacturing job loss rate than urban areas in Eastern Canada, especially in the manufacturing belt.

Table 3: Job loss rates due to significant closures in Canada.

Region	Province	Job loss rate	Avg. # jobs
Western	Alberta	33.5%	129.7
	British Columbia	34.9%	130.0
	Manitoba	33.1%	115.3
	Saskatchewan	34.4%	130.6
		34.1%	***127.7***
Atlantic	New Brunswick	38.5%	151.5
	Newfoundland and Labrador	43.1%	166.9
	Nova Scotia	33.3%	129.8
	Prince Edward Island	44.9%	130.7
		38.0%	***145.2***
Ontario	Ontario	***40.4%***	***135.5***
Quebec	Quebec	***40.5%***	***127.3***
Canada		**38.9%**	**132.0**

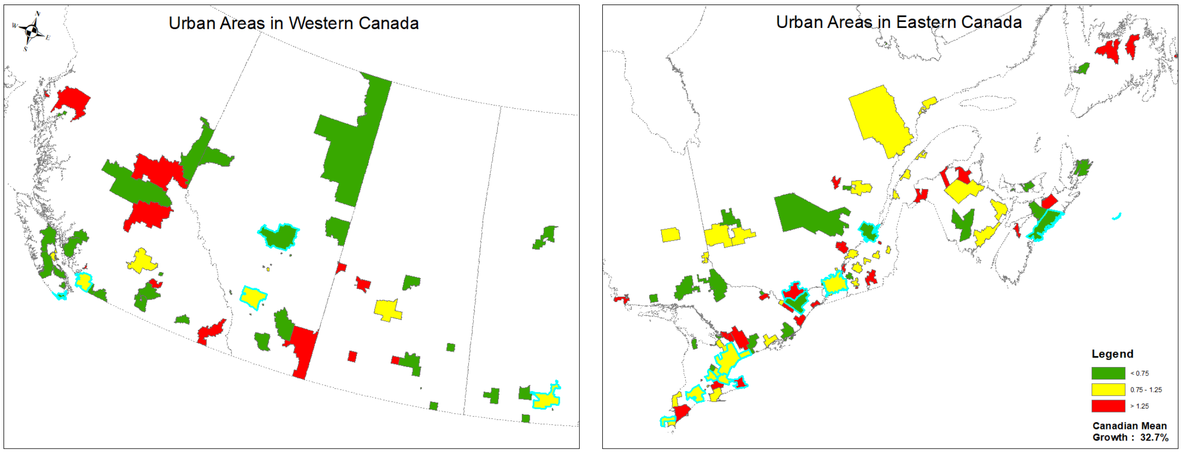
Notes: "Significant closures" refers to the closure or downsizing by more than 30% of establishments with 50+ employees in 2003. The job loss rate measures the share of 2003 employment lost by 2017 due to significant plant closures. Data are from Scott's National All Business Directories.

2.2 Socio-economic data

We use data from the Canadian census released by the Computing in the Humanities and Social Sciences (CHASS) data center at the University of Toronto. These data are available for *dissemination areas*, the smallest geographic units at which census data are publicly released. We have information on socio-demographic characteristics such as the total population and the demographic composition of urban areas. We will, in particular, use gender, age, education, and occupation for the years 2001, 2006, 2011, and 2016. Additional details are provided in Appendix A.

[7] Out of the 52,784 plants that were active in 2003, 8,941 were big plants with 50+ employees, and out of these, 5,188 closed or downsized, leading to the 38.9% job loss rate we mention.

Figure 1: Relative job loss rates due to big plant closures in Canadian urban areas



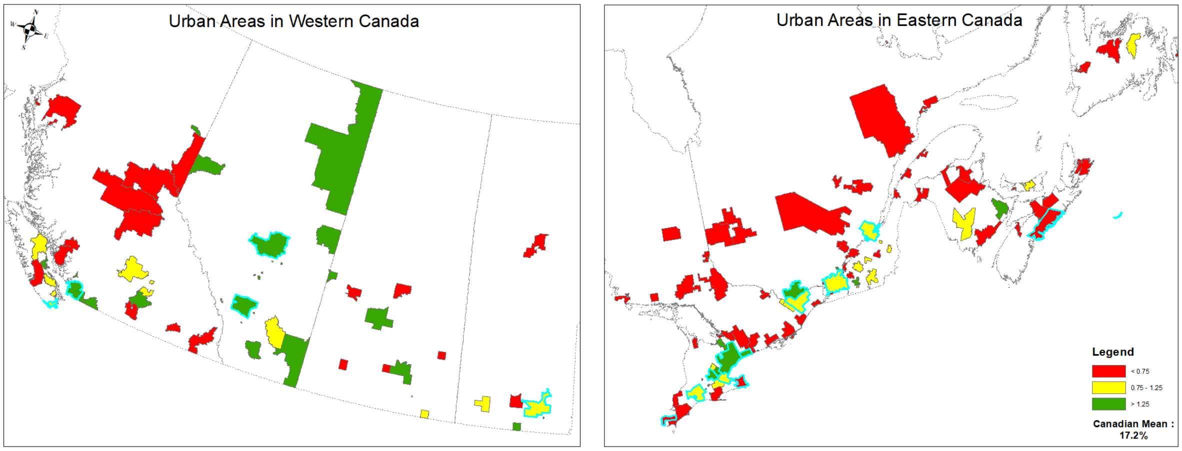
Notes: Distribution of manufacturing job loss rates due to significant closures in Canadian Urban Areas. Urban area job loss rates are measured relatively to the Canadian average. A value of 1 on the map means that the urban area's job loss rate is the same than the Canadian mean. Green zones are urban areas with a growth rate above 1.25 times the Canadian average. Yellow areas are urban areas with a growth rate between 0.75 and 1.25 times the Canadian average. Red areas are urban areas with a growth rate below 0.75 times the Canadian average. Cyan contours outline cities with population of at least 300,000.

Urban areas—defined as census metropolitan areas (CMA) and census agglomerations (CA)—consist of one or more neighboring municipalities located around a core area and strongly interconnected by commuting flows. Statistics Canada defines a CMA as an area with a total population of at least 100,000, of which 50,000 at least live in the core; whereas a CA is an area with a core population of at least 10,000. By construction, most people living in an urban area also work there. Thus, urban areas are the appropriate spatial units to investigate the links between plant closures and demographic changes. Our analysis is based on 154 Canadian urban areas whose boundaries are made stable between 2001 and 2016.[8]

Figure 2 shows there is wide variation in population growth rates across Canadian urban areas. The population of Campbellton in New Brunswick shrank the most (-18.2% from an initial population of 16,980 in 2001), while the population of Wood Buffalo in Alberta grew the fastest (+72.4% from an initial population of 42,475 in 2001). Large cities (with more that 300,000 inhabitants, outlined in cyan in the figure) all experienced population growth, with growth rates usually exceeding the Canadian average. On the contrary, small-

[8]Statistics Canada uses population thresholds to define urban areas. Hence, their number has changed from 145 in 2001 to 156 in 2017. We keep all areas that appear as an urban area for at least one of the census years under study. After eliminating some outliers, this leaves us with 154 urban areas. Statistics Canada also adjusts the boundaries of urban areas over time. To have a stable geography for our 154 urban areas, we take for each the envelope of the boundaries observed over the four census periods.

Figure 2: Relative population growth rates in Canadian Urban Areas



Notes: Growth rates are measured relatively to the Canadian average.The Canadian mean refers to the population growth rate of Canada. Green zones are urban areas with a growth rate above 1.25 times the Canadian average. Yellow areas are urban areas with a growth rate between 0.75 and 1.25 times the Canadian average. Red areas are urban areas with a growth rate below 0.75 times the Canadian average. Cyan contours outline cities with population of at least 300,000.

and medium-sized cities experienced sometimes population declines. The majority of urban areas in Eastern Canada experienced lower population growth than the Canadian average, particularly in the Atlantic provinces and in the peripheral parts of Ontario and Quebec.[9] In Western Canada, below average population growth is mostly observed in British Columbia, whereas Alberta has grown faster than the Canadian average.[10] Panel (a) of Figure 3 shows that the situation is even starker when looking at the growth of the working-age population. On the contrary, when looking at the growth of the highly skilled population—defined as those with at least a bachelor's degree—it appears that larger urban areas grew at a pace closer to the Canadian average (see panel (b) of Figure 3).

2.3 Additional data

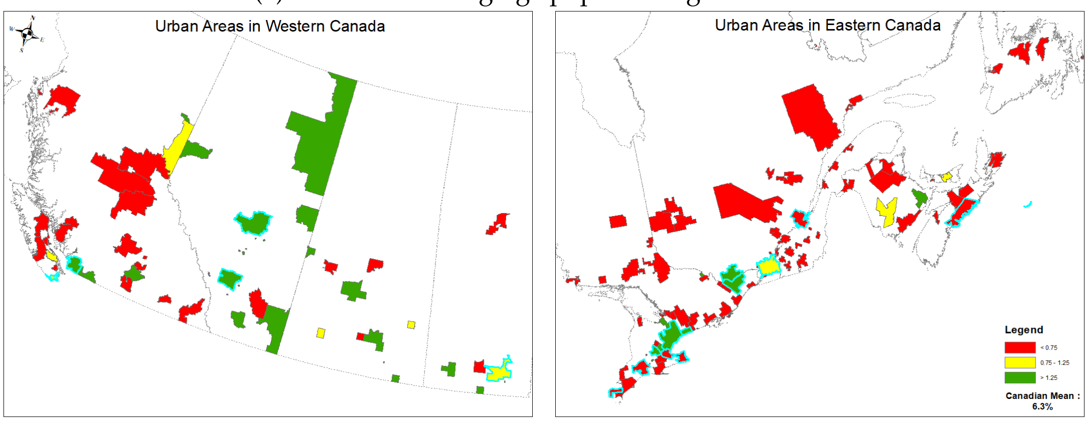
As documented above, some cities fare better than others in terms of demographic changes as measured by population growth, employment growth, and the growth in the highly skilled. Our goal in the subsequent analysis is to better understand if and how big manufacturing plant closures explain the contrasted demographic changes documented above, and

[9]See, e.g., Johnson (2002) and Polèse and Shearmur (2002) for a more detailed description of the decline of the workforce and the young population in Atlantic Canada.

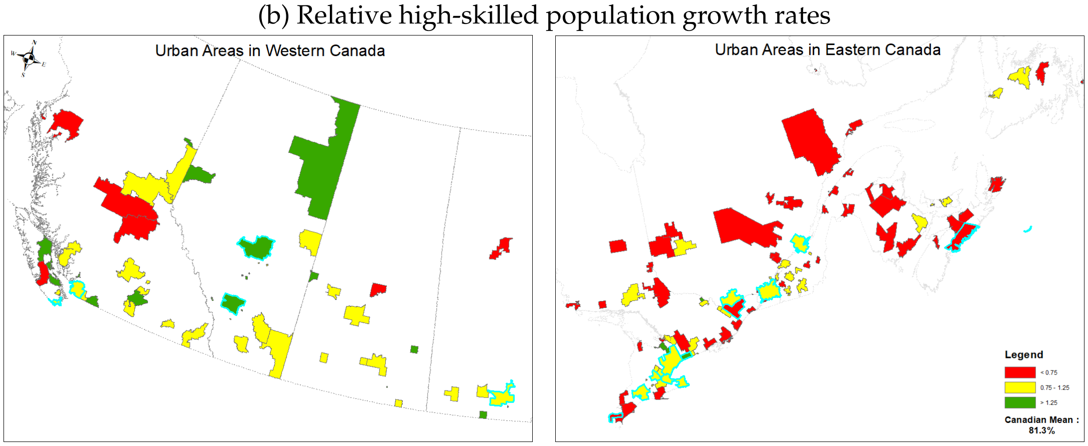
[10]The population dynamics in Alberta are certainly related to the oil boom and bust. The oil industry was particularly buoyant in the early 2000s but has experienced a significant slump since 2014. We add macro-regional fixed effects to our analysis to control for macro-regional specificities such as the availability of natural resources.

Figure 3: Relative working-age and high-skilled population growth rates in Canadian Urban Areas

(a) Relative working-age population growth rates



(b) Relative high-skilled population growth rates



Notes: Working age population are people aged 20 to 54. The high-skilled are residents of age 15+ with at least a bachelor degree. The urban areas' growth rates are measured relatively to the Canadian growth rate. Green zones are urban areas with a growth rate above 1.25 times the Canadian average. Yellow areas are urban areas with a growth rate between 0.75 and 1.25 times the Canadian average. Red areas are urban areas with a growth rate below 0.75 times the Canadian average. Cyan contours outline cities with population of at least 300,000.

what makes cities more resilient. To answer these questions, we need to control for many potential confounders, especially initial city characteristics such as human capital, geographic characteristics (climate, access to the coast), and differences in regional public policies. To better understand the mechanisms underlying the heterogeneity in city resilience, we leverage data on the initial share of the labor force working in arts and recreational employment (a measure of consumption amenities), as well as the share of the labor force in educational and health services. Additional details on the data sources for these variables are provided in Appendix A. Table A.1 presents descriptive statistics for these variables.

3 Plant closures and socio-demographic changes: Regression analysis

We now present our empirical specification and baseline results.

3.1 Empirical specification

We are interested in the effect of big manufacturing plant closures and downsizing on city-level growth rates of total population and of specific population groups y: working age population, elderly population, migrants, couples, families with children, skilled people, and jobs by industries. Our baseline specification is the following:

$$\text{growth rate of } y_{c,r}^{2001-2016} = \alpha \times \text{job loss rate}_c^{2003-2017} + \beta \times X_c^{2001} + \theta_r + \varepsilon_c, \qquad (2)$$

where X_c^{2001} is a vector of initial city characteristics, θ_r are regional fixed effect (Western provinces, Ontario, Quebec, and the Atlantic provinces), and ε_c is an error term. The vector of initial city characteristics contains dummies indicating whether city c in 2001 is in the top quartile in terms of: (i) log population; (ii) share of residents aged 20-54 and share of residents with a university degree; (iii) share of manufacturing employment; and (iv) unemployment rate and participation rate.[11] Finally, we include as continuous variables: (v)

[11]We use dummies instead of the raw shares because some of the variables are highly correlated (e.g., total population and the share of 20–54 year old and the share of the highly skilled). We also use a discretized versions

January and July maximum temperatures; (vi) log distance to the closest coast; and (vii) log distance to the closest large urban center with at least $300,000$ inhabitants.

The variable of interest is the job loss rate between 2003 and 2017. As explained before, we measure it in our baseline using (1) and definition (ii), i.e., the share of manufacturing employment that has disappeared between 2003 and 2017 due to the closure or the massive downsizing of establishments with 50+ employees.[12] Our period of analysis spans about 15 years. There are four reasons for that choice. First, it corresponds to the period for which we have plant-level data. Second, the population censuses are conducted every five years, with a census in 2001 and in 2016 conveniently aligned with the other data. Third, city dynamics unfold slowly over time spanning several years or decades. Hence, choosing a short window would not allow us to see the effect of closures on the dynamics of population groups. It is difficult to know a priori how fast closures affect demographic changes. This may depend on the mobility of the population groups studied. For example, migrants may be more sensitive to economic opportunities and may be more likely to move quickly in the face of negative economic shocks than other groups such as families (with or without children) or the elderly. The 15 years window allows us to capture at least some, if not all, of the effects of big plant closures on the socio-economic composition of cities. Last, the study period 2003–2017 is one of massive shocks affecting manufacturing industries via the entry of China into the WTO.

3.2 Identification

Estimating the impact of plant closures on city-level demographic changes using OLS is likely to yield biased estimates of α. Indeed, it is likely that plant closures/downsizing and population changes are simultaneously determined by unobserved changes in other local factors. Even more, as explained in the introduction, it is likely that equation (2) suffers from reverse causality: people may leave a city because firms close or downsize, but firms may also close because people leave the city. Finally, a higher job loss rate might hide a higher turnover of establishments, so that differences in job loss rates across cities might not reflect

of the manufacturing share and of the unemployment rate and participation rate to be consistent.

[12] We check the robustness of the main results when considering only big plant closures, i.e., ignoring downsizing.

differences in net job creation.

To address these concerns, we build a standard shift-share (Bartik) instrument to predict the city-level job loss rate in local manufacturing employment. More precisely, we interact the initial sectoral composition of manufacturing employment in each city with sectoral employment growth rates in the U.S. between 2003 and 2017.[13] We thus construct the following IV for each city c:

$$\text{IV}_c = \sum_s \frac{\text{Emp}_{c,s}^{2003}}{\text{Emp}_c^{2003}} \frac{\Delta \text{Emp}_{US,s}^{2003-2017}}{\text{Emp}_{US,s}^{2003}} \tag{3}$$

where s denotes 4-digit NAICS industries.

For each city, our IV is the weighted average of the growth rates of the number of jobs at the 4-digit level in the U.S. between 2003 and 2017, weighted by the initial share of each sector in the manufacturing employment of the city. We believe this instrument is relevant since it captures global shocks that affect manufacturing industries both in the U.S. and in Canada. Offshoring and import competition from low-wage countries, for example, have severely hit the textile, clothing, and computer and electronic industries in many developed economies around the world, including the U.S. and Canada. Observe that since Canada is small compared to the U.S., it is unlikely that sectoral growth rates in the U.S. are directly affected by sectoral growth rates in Canada. This point is important for identification since sectoral growth rates in Canada could themselves be directly affected by factors that affect city-level demographic evolutions (especially since Canada's three largest cities make up close to one-third of the total population).

Identification based on Bartik instruments implicitly assumes the exogeneity of the shocks and/or of the shares used to build the instruments (see Borusyak et al., 2020; Goldsmith-Pinkham et al., 2020). We think we can safely consider that the shares are exogenous in our context: it is highly unlikely that changes in demography or amenities in some Canadian cities are directly related to the initial share in their manufacturing employment of the

[13] We use the County Business Patterns database of the U.S. Census Bureau that provides information on the total number of employees in the U.S. by 4-digit NAICS industry in 2003 and 2017. This information allows us to compute the employment growth rate between these two dates for each sector. As in Canada, the vast majority of U.S. manufacturing sectors experienced a decline in employment between 2003 and 2017, particularly in the clothing, textile and computer equipment sectors (see Table B.4 in the Appendix B).

industries that shrunk the most in the U.S., especially at the 4-digit level of the industrial nomenclature and controlling for the various covariates we include in the regression. Still, we will provide some checks to verify the validity of our IV strategy.

Finally, we cluster standard errors at the level of Canadian provinces to account for potential correlation of unobserved city-level shocks within provinces.

3.3 Results

Columns (1)–(5) of Table 4 show results for OLS and IV estimations of equation (2), both for total population and by age groups. Four outcome variables are considered: the growth rate of the total population, the growth of the young population (ages 0–19), the growth of the working-age population (ages 20–54), and the growth of the older population (ages 55+). The explanatory variable of interest is the manufacturing job loss rate related to big plant closures and downsizing. As shown in column (1), manufacturing job losses are negatively correlated with population growth at the city-level, with a semi-elasticity of -0.088.[14] The IV regression in columns (2) of Table 4 provides a somewhat different picture. Although the coefficient on the manufacturing job loss rate remains negative—and is larger in absolute value than the OLS estimate—it is not precisely estimated so that we cannot reject the null hypothesis that it is different from zero.[15] Note that the Kleinbergen-Paap statistic that we report in the table shows that the instrument has enough power to consider the IV estimates as reliable.

Columns (3)–(5) of Table 4 show IV estimates of the impact of big manufacturing plant closures and downsizing on population dynamics across age groups. The share of the young (0–19) and the working age population (20–54) in cities are negatively affected by big plant closures, with a semi-elasticity of -0.052 and -0.060 respectively (columns (3) and (4)). This

[14]Regarding the signs of the coefficients for the controls, the results are as expected. Cities with an initially larger working-age population in 2001 experienced more population growth between 2001 and 2016, as did cities with a higher average January temperature. On the contrary, cities with a high initial unemployment rate in 2001 saw less population growth. The remaining controls are not statistically significant.

[15]The finding that the coefficient on the job loss rate gets more negative with the IV for total population growth suggests that—beyond the circular relationship between population growth and economic growth we mentioned before (and which should bias downward our OLS estimates)—cities that are demographically more dynamic also have both higher job destruction and job creation rates. This could explain why the OLS estimates are smaller than the IV estimates.

implies, as shown in column (5), that manufacturing job losses have a positive effect on the share of the older population, with a coefficient of 0.112.[16] These results demonstrate that working-age residents are definitely those within the overall population that are more likely to leave a city following big plant closures. Since it is generally among the 20–54 year old residents that we find households with kids, big plant closures and downsizing also negatively impact the share of residents aged 0–19. On the opposite, big plant closures cause an increase in the share of the elderly in the overall population.

Table 4: Big plant closures and downsizing and changes in population by age groups

Dependent variable	(1) Population growth OLS	(2) Population growth IV	(3) Δ share 0-19 IV	(4) Δ share 20-54 IV	(5) Δ share 55+ IV
Job loss rate (Closures and downsizing)	-0.088[b]	-0.345	-0.052[b]	-0.060[a]	0.112[a]
	(0.035)	(0.309)	(0.021)	(0.020)	(0.032)
Observations	154	154	154	154	154
R-squared	0.436	n.a.	n.a.	n.a.	n.a.
Kleinbergen-Paap statistic		12.43	12.43	12.43	12.43

Notes: All regressions include the following controls: Dummies indicating whether city c is in the top quartile in terms of: (i) log population in 2001; (ii) share of residents aged 20-54 and share of residents with a university degree in 2001; (iii) share of manufacturing employment in 2001; (iv) unemployment rate and participation rate in 200. Continuous variables: (v) January and July maximum temperatures; (vi) log distance to the closest coast; and (vii) log distance to the closest urban center with at least 300,000 inhabitants. We also include regional fixed effect (Western provinces, Ontario, Quebec, and the Atlantic provinces) and the standard errors are clustered by province.

Our results show that the closures and downsizing of big manufacturing plants have led to some population declines in Canadian urban areas, with the demographic decline being concentrated among the working-age population and the young. The effect is quantitatively sizable. A one percentage point increase in the manufacturing job loss rate causes a 0.06% decrease of the population aged 20–54. Based on the descriptive statistics provided in Table A.1, a one-standard deviation in the job loss rate due to big plant closures and downsizing induces a decrease in the working-age population growth rate by 0.6 standard deviations.[17] Big plant closures have thus been an economically significant driver of the city-level dynamics of the working age population in Canada over the period 2003–2017.

Table 5 reports the effects of big plant closures on various demographic groups in Canada. Column (1) , shows the effects of job losses in the manufacturing sector on the growth of more skilled residents (those with at least a bachelor degree). As shown, there is no significant effect of manufacturing job losses on the growth of the share of skilled residents. The literature on the polarization of labor markets shows that medium-skilled jobs have declined

[16]Note that since population shares sum to one, the coefficients we estimate on the three age groups sum to zero.

[17]The calculation is as follows: $\frac{0.212\times 0.6}{0.212} \simeq 0.6$.

over the past 30 years, whereas the share of high- and low-skilled jobs has increased. This 'hollowing out' partly stems from deindustrialization since medium-skilled jobs are more prominent in the manufacturing sector than in the economy as a whole (Goos et al., 2009; Autor and Dorn, 2013). Since we examine the closure of big manufacturing plants—which mainly employ low- and medium- skilled workers—this explains why we do not see a decline in the number and share of high-skilled residents, even though the latter are generally more responsive to local labor demand shocks in terms of labor supply than less educated workers (see, e.g., Topel, 1986; Bound and Holzer, 2000; Albouy et al., 2019).

Table 5: Big plant closures and downsizing and changes in specific demographic groups

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	Δ share university	Δ share male	Δ share married	Δ share family	Δ share migrant	Δ activity rate	Δ unempl. rate
	IV	IV	IV	IV	IV	IV	IV
Job loss rate (closures and downsizing)	0.052	0.009	0.033	0.259[a]	-0.074[b]	-0.043	-0.054
	(0.035)	(0.026)	(0.022)	(0.076)	(0.037)	(0.038)	(0.042)
Observations	154	154	154	154	153	154	154
Kleinbergen-Paap statistic	12.43	12.43	12.43	12.43	11.58	12.43	12.43

Notes: All regressions include the following controls: Dummies indicating whether city c is in the top quartile in terms of: (i) log population in 2001; (ii) share of residents aged 20-54 and share of residents with a university degree in 2001; (iii) share of manufacturing employment in 2001; (iv) unemployment rate and participation rate in 200. Continuous variables: (v) January and July maximum temperatures; (vi) log distance to the closest coast; and (vii) log distance to the closest urban center with at least 300,000 inhabitants. We also include regional fixed effect (Western provinces, Ontario, Quebec, and the Atlantic provinces) and the standard errors are clustered by province.

In columns (2)–(5), we further analyze changes in different population groups in terms of gender, family status, and birthplace. The IV results show that big plant closures and downsizing have gender-neutral effects in terms of population: the male-to-female ratio is unaffected. They also do not have a statistically significant effect on the share of residents with a partner (married or in a common law union). However, having a family with at least one child substantially reduces the probability of leaving the city following a negative local labor-demand shock. This is consistent with the fact that people with family commitments have higher mobility costs than others (due to joint location decisions and school enrollment, in particular). The results also show that immigrants are more likely to leave cities that face negative local labor demand shocks: their share in the population decreases following manufacturing job losses. This is coherent with previous studies showing that immigrants are more sensitive to local economic opportunities (Cadena and Kovak, 2016; Albouy et al., 2019; Autor et al., 2023) and often work in manufacturing jobs.

Last, columns (6) and (7) show that there is no specific effect of big plant closures on the change in the activity and unemployment rates. This suggests that, on average in Canada, the adjustment of local economies to the closure and downsizing of big manufacturing plants has happened through migration rather than exit from the labor force or entry into unemployment.

4 Robustness checks and heterogeneous patterns

In this section, we check the robustness of the benchmark results and discuss some factors that may favor the resilience of cities after big plant closures and mass layoffs.

4.1 Robustness checks

Relevance and validity of the Bartik instrument. Several recent contributions discuss the conditions under which Bartik instruments are valid and suggest procedures to verify if they can be safely used. Following the suggestions made by Borusyak et al. (2020), we investigate three aspects.

First, we check that the Bartik IV exhibits enough variation to be relevant. With mean and median values of -0.16, a standard deviation of 0.08, and a difference between the first and the fourth quintiles of 18 p.p., we believe it does. Another way to assess the relevance of the instrument is to measure the inverse of the Herfindahl index of the sectoral shares at the national level. In the case where a few specific industries represent the lion's share of national manufacturing employment, it is unlikely that sectoral shares vary enough across locations to provide a good IV. In our case, the value of the index equals 42.8 (the largest industry share at the national level being no larger than 0.06), which suggests there is a reasonable degree of variation in the industry shares. All in all, these statistics confirm the above-10 Kleinbergen-Paap tests of the regressions: the Bartik IV can be considered relevant in our case.

Second, regarding the validity of the instrument, in unreported investigations, we run placebo tests where the dependent variable is the change in the city-level share of a given population age group between 1991 and 2001 (instead of 2001 and 2016). This placebo resembles a test of the parallel trends assumption. The coefficients we obtain in the IV regressions are close to 0 and statistically insignificant.

Finally, another concern with the benchmark IV regressions is that if some industries are highly concentrated in urban areas with specific unobserved trends, there could be a correlation between the instrument and the error term in the IV regressions. To take care of that issue, we build an alternative Bartik instrument from which we remove the industries that are the most highly geographically concentrated.[18] The results (available upon request) are very stable.

Overall, these robustness checks suggest that the Bartik instrument is relevant and valid in the context of our study.

Alternative definitions of the treatment and control variables. In Table C.1 in Appendix C, we reproduce the analysis by age groups considering the job loss rate due to big plant closures only (and not to downsizing anymore). The results are both qualitatively and quantitatively very similar to the benchmark results in Table 4. Also, the control variables in the benchmark analysis are based on dummies identifying cities in the top quartile for various initial characteristics. In Table C.2, we use instead dummies identifying cities above the median, and results are again both qualitatively and quantitatively similar.

We are thus confident that the benchmark results are not driven by the specification of the treatment and control variables.

4.2 City-level resilience to big plant closures and mass layoffs: heterogeneity

We now examine whether initial city characteristics can mitigate the negative effects of significant closures on demographic changes. To this end, we investigate successively three dimensions: (i) the initial share of the manufacturing sector in overall employment to ensure we are not simply capturing the decline of formerly industrial cities; (ii) the initial population size of the urban area, as large cities may be more resilient due to the larger market they represent and a more diversified economy (for more on urban resilience, see Glaeser, 2022) ; and (iii) the provision of cultural and recreational amenities. Although their role in local

[18] We define them as the industries for which the inverse of the Herfindahl index of the CMA-level shares in the overall industry-level employment is below 5 (i.e., a Herfindahl index of geographic concentration above 0.2).

economies is relatively understudied, recent works show that they participate to make central neighborhoods particularly attractive (see, e.g. Couture and Handbury, 2020; Behrens et al., 2022). Since these three dimensions are only weakly correlated in the data, we capture different mechanisms when studying each of them.

The results in Table 6 reveal interesting patterns.[19] First, the benchmark results we highlighted are not the mere reflection of the decline of former industrial cities. Indeed, the impact of the job loss rate in the manufacturing sector on demographic changes is not significantly different for the cities in the top quartile of the distribution in terms of the initial share of manufacturing employment, whatever the subgroup we consider. Second, on the contrary, large cities appear more resilient than smaller ones. Given the coefficients in Table 6, their demographic structure is not significantly affected by the closure and downsizing of big manufacturing plants as for each age group, the coefficient on the interaction term is of the opposite sign and similar in magnitude compared to the coefficient on the job loss rate. Finally, the presence of cultural and recreational services helps to retain working-age residents in the wake of big plant closures and downsizing, especially those without kids as no heterogeneous pattern is observed for the share of residents aged 0-19.

In the end, both city size and the presence of cultural and recreational amenities seem to favor the resilience of cities, allowing them to retain their younger residents when their labor market is hit by negative shocks.

5 Conclusion

We have analyzed the effect of big manufacturing plant closures and mass layoffs on demographic changes in Canadian cities. We have shown that job losses due to big plant closures and mass layoffs significantly affect the composition of cities' population. Generally, younger (working age) residents and immigrants disproportionately leave cities that experi-

[19]The Kleinbergen-Paap statistic is lower than in the benchmark regressions, but this is not unusual when the endogenous variable also appears in an interaction term, and we still pass the Stock-Yogo critical values at the 20% level at least (*vs* 10% in the benchmark results).

Table 6: Heterogeneous changes across cities depending on initial characteristics in 2001.

	(1)	(2)	(3)	(4)
Dependent variable	Population growth	Δ share 0-19	Δ share 20-54	Δ share 55+
Job loss rate (closures and downsizing)	-0.349	-0.051^{b}	-0.041^{c}	0.091^{a}
	(0.346)	(0.020)	(0.023)	(0.034)
Job loss rate × Large mfg share in 2001	0.021	-0.009	-0.091	0.101
	(0.547)	(0.041)	(0.095)	(0.121)
Observations	154	154	154	154
Kleinbergen-Paap statistic	4.489	4.489	4.489	4.489
	(5)	(6)	(7)	(8)
	Population growth	Δ share 0-19	Δ share 20-54	Δ share 55+
Job loss rate (closures and downsizing)	-0.348	-0.053^{a}	-0.070^{a}	0.123^{a}
	(0.299)	(0.019)	(0.018)	(0.028)
Job loss rate × Large population in 2001	0.161	0.062^{a}	0.077^{b}	-0.140^{a}
	(0.272)	(0.024)	(0.032)	(0.039)
Observations	154	154	154	154
Kleinbergen-Paap statistic	7.688	7.688	7.688	7.688
	(9)	(10)	(11)	(12)
	Population growth	Δ share 0-19	Δ share 20-54	Δ share 55+
Job loss rate (closures and downsizing)	-0.555	-0.052^{c}	-0.075^{b}	0.128^{a}
	(0.390)	(0.027)	(0.029)	(0.048)
Job loss rate × Large share in arts and recreation in 2001	0.765^{a}	0.004	0.058^{b}	-0.061
	(0.287)	(0.028)	(0.028)	(0.051)
Observations	154	154	154	154
Kleinbergen-Paap statistic	5.964	5.964	5.964	5.964

Notes: All regressions include the following controls: Dummies indicating whether city c is in the top quartile in terms of: (i) log population in 2001; (ii) share of residents aged 20-54 and share of residents with a university degree in 2001; (iii) share of manufacturing employment in 2001; (iv) unemployment rate and participation rate in 200. Continuous variables: (v) January and July maximum temperatures; (vi) log distance to the closest coast; and (vii) log distance to the closest urban center with at least 300,000 inhabitants. We also include regional fixed effect (Western provinces, Ontario, Quebec, and the Atlantic provinces) and the standard errors are clustered by province.

ence more negative shocks, in line with the well-documented fact that they are more mobile and their location decisions more driven by job opportunities. Less mobile groups, such as households with kids and older residents see their shares in the local population increase in cities where job losses are the highest. We find that some initial city characteristics—such as city size in terms of overall population and the presence of cultural and recreational services—may help to mitigate the negative effect of plant closures on subsequent demographic changes.

One implication of our results is that cultural and recreational services, that have been severely hit by the pandemic and whose role in the economy is relatively understudied, might have long-run effects by fostering the ability of cities to maintain demographic dynamism in case of bad shocks.

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Appendix material

This set of appendices is organized as follows. Appendix A describes the data used in the analysis and provides descriptive statistics. Appendix B provides additional descriptive statistics and figures. Last, Appendix C shows additional results.

Appendix A Data

Census data. The Census data released by the Computing in the Humanities and Social Sciences (CHASS) data center at the University of Toronto contain a great deal of information on the socio-demographic characteristics of the residents as well as on the jobs they occupy. We use them to construct several of the dependent and control variables used throughout the analysis.

The literature has shown that certain initial socio-economic characteristics of the population affect city-level population growth. Among them, the level of schooling—of human capital—of the population is strongly correlated with subsequent city growth (see, e.g., Glaeser et al., 1995; Moretti, 2004). Our proxy for the initial human capital is the share of residents holding at least a bachelor degree in 2001. We are also interested in which factors make cities more resilient. We focus more specifically on the presence of cultural and recreational activities. Based on the census data we thus compute the share of residents employed in these specific industries in 2001.[20]

Table A.1 presents descriptive statistics on the variables used in this study. The average population growth rate observed across Canadian urban areas is equal to 14.3%. In 2001, in Canadian urban areas, on average, half of the population was part of the working age population defined as 20-54 year-old residents, 12% had a university degree on average, and 14.1% of employment was in manufacturing. In addition, 2% of the residents worked in cultural and recreational services. However, as the table illustrates, there is a great deal of variation across urban areas for all of these initial characteristics that are helpful for our estimations.

Geographic data. We control in the regression analysis for several relevant geographic characteristics that may influence city-level population growth.

Distance Data: Proximity to the coast, which contributes to moderating extreme temperatures, is strongly positively correlated with population growth in the U.S. (see Rappaport and Sachs, 2003). We thus measure the distance between the centroid of each city and the nearest maritime coast. It

[20] We focus on the "Arts, entertainment and recreation" sector (NAICS 71, see more details here: https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=307532).

Table A.1: Descriptive statistics, urban area variables.

Variable	Obs	Sample Mean	Std. Dev.	Minimum	Maximum	Population Mean
Growth rate						
Total Population	154	0.143	0.181	-0.184	0.953	0.172
People aged between 20-54 years	154	0.012	0.212	-0.333	0.902	0.063
People aged over 55 years	154	0.633	0.257	0.153	1.934	0.606
People with university degree at bachelor or above	154	0.765	0.436	0.010	2.721	0.813
People with non-university degree at bachelor or above	154	0.222	0.184	-0.094	1.179	0.213
Changes in shares						
Male to female ratio	154	0.005	0.021	-0.067	0.059	0.004
Couple families (married and common-law couples)	154	0.040	0.027	-0.016	0.108	0.038
People with one or more children	154	0.007	0.112	-0.262	0.463	-0.078
Immigrant people	153	0.019	0.035	-0.037	0.156	0.044
Job losses rate						
% job losses of big and downzised plants	154	0.358	0.212	0	0.921	0.389
% job losses of big plants closed	154	0.304	0.214	0	0.921	0.327
Closures rate						
% big plants closed	154	0.070	0.050	0	0.263	0.075
% Closures and downsizing closed	154	0.091	0.062	0	0.333	0.098
Initial level						
Initial population (2001)	154	158,226	510,705	7,720	4,677,175	30,000,000
% Initial working age population	154	0.498	0.038	0.343	0.608	0.516
% Initial people with university degree	154	0.118	0.044	0.054	0.309	0.169
Labor force (industry)						
% Initial share of employment in manufacturing	154	0.141	0.080	0.016	0.342	0.140
% Arts and recreational employment	154	0.019	0.011	0.005	0.097	0.019
Geographic variables						
Maximum January temperature (C)	154	7	3	-2	14	7
Maximum July temperature (C)	154	31	2	21	38	31
Distance to nearest coast (m)	154	206,044	199,927	0	858,863	206,044
Distance to nearest big urban area (m)	154	202,455	285,300	0	990,837	202,455

Notes: A big urban area is a city with at least 300,000 residents.

has also been shown that cities that are close to the top metropolises in the urban hierarchy are more attractive to firms and workers (see Partridge et al., 2009). We thus calculate the distance separating each urban area from the largest urban area of at least 300,000 inhabitants.

Weather Data: Climatic conditions, as proxied by temperatures, are also among the amenities identified in the literature as a determinant of the residential attractiveness of cities (see Glaeser et al., 2001; Rappaport, 2007). We use the monthly climate summaries from the Canadian Centre for Climate Services of Environment and Climate Change to measure, for each city, the average daily warmest temperatures attained in January and July from 2001 to 2016.[21]

Regions: Regional Development Agencies support manufacturers across Canada.[22] Specific

[21] These data are available from stations that produce daily data from 2001 to 2016.

[22] These agencies are Atlantic Canada Opportunities Agency for Atlantic regions, Federal Economic Development Initiative and Federal Economic Development Agency for Ontario, Canada Economic Development for Quebec, and Western Economic Diversification Canada for Western region.

regional public policies might also influence city-level population growth; we can think of Quebec, which has its own immigration policy, partly determined by its needs in terms of workforce. We thus build specific dummy variables for the Atlantic regions (New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island), the West (Alberta, British Columbia, Manitoba, Saskatchewan), Quebec and Ontario.

Appendix B Additional tables describing the data

B.1 Tables on data

Table B.1: Comparing the Scott's National All database to the Annual Survey of Manufacturing (ASM).

	2001		2003		2005		2007		2009		2011	
Province	ASM	Scott's	ASM	Scott's	ASM	Scott's	ASM	Scott's	ASM	Scott's	ASM	Scott's
Alberta	4,843	3,935	4,882	3,650	7,750	3,482	8,091	3,723	7,852	3,597	7,003	3,477
British Columbia	7,085	6,212	6,933	5,923	11,942	5,400	12,179	5,267	11,605	5,031	11,552	4,946
Manitoba	1,465	1,654	1,481	1,556	2,307	1,489	2,351	1,405	2,323	1,280	1,918	1,302
New Brunswick	986	1,392	963	1,376	1,533	1,262	1,496	1,167	1,412	1,181	1,381	1,030
Newfoundland	525	576	522	578	706	544	738	517	657	482	660	432
Nova Scotia	1,097	1,677	1,106	1,576	1,944	1,506	1,904	1,354	1,817	1,312	1,760	1,184
Ontario	21,514	21,289	21,470	21,758	34,184	20,996	33,634	20,301	31,991	19,670	29,046	18,721
Prince Edward Island	233	328	211	303	299	327	369	309	358	282	342	260
Quebec	15,191	15,933	15,251	14,773	23,042	14,200	22,324	12,992	21,149	12,660	19,272	12,091
Saskatchewan	1,044	1,348	1,008	1,291	1,664	1,318	1,845	1,203	1,861	1,109	1,410	1,140
Territories		0		0		40		50		45		41
Canada	53,983	54,344	53,827	52,784	85,371	50,564	84,931	48,288	81,025	46,649	74,344	44,624
Cross-industry correlation	***0.973***		***0.972***		***0.945***		***0.935***		***0.932***		***0.881***	

Notes: Data are from the Scott's databases and Statistics Canada Annual Survey of Manufacturing (and Logging Industries) Table 16-10-0054-01 and Table 16-10-0038-01. The 2001 and 2003 ASMs report only employer plants with sales exceeding C$30,000 whereas the 2005 to 2009 ASMs report information for manufacturing plants (including logging industries, which is absent in the 2001 and 2003 ASMs) for all plants. The descriptive statistics reported as "cross-industry" in the bottom panel of the table are computed across all 3 digits manufacturing industries (NAICS 311–339).

Table B.2: Comparing the Scott's National All database to the Canadian business counts (CBC).

	2001		2005		2009		2013		2017	
Province	CBC	Scott's	CBC	Scott's	CBC	Scott's	CBC	Scott's	CBC	Scott's
Alberta	5,843	3,935	5,416	3,482	5,351	3,597	4,882	3,144	4,095	2,891
British Columbia	8,797	6,212	8,261	5,400	7,697	5,031	6,933	4,148	5,984	3,966
Manitoba	1,883	1,654	1,741	1,489	1,605	1,280	1,481	1,108	1,049	1,061
New Brunswick	1,446	1,392	1,195	1,262	1,018	1,181	963	873	431	740
Newfoundland	757	576	629	544	508	482	522	364	244	320
Nova Scotia	1,832	1,677	1,483	1,506	1,225	1,312	1,106	970	666	816
Ontario	25,006	21,289	23,220	20,996	21,673	19,670	21,470	15,933	16,722	14,277
Prince Edward Island	354	328	292	327	256	282	211	199	114	154
Quebec	18,349	15,933	17,026	14,200	15,238	12,660	15,251	10,378	9,939	8,980
Saskatchewan	1,378	1,348	1,259	1,318	1,151	1,109	1,008	948	877	895
Territories		0		40		45		36		35
Canada	65,645	54,344	60,522	50,564	55,722	46,649	53,827	38,101	40,121	34,135
Cross-industry correlation	***0.908***		***0.939***		***0.937***		***0.931***		***0.773***	

Notes: Data are from Scott's National All databases and CBP (Table 33-10-0028-01 ,Table 33-10-0035-01). The descriptive statistics reported as "cross-industry" in the bottom panel of the table are computed across all 3 manufacturing digits industries (NAICS 311–339).

Table B.3: Comparing the Scott's National All databases to the Labor Force Survey (LFS) by Cities (>100K).

	2001		2003		2005		2007		2009		2011		2013		2017	
Census Metropolitan Area	LFS	Scott's	LFS	Scott's	LFS	Scott's	LFS	Scott's	LFS	Scott's	LFS	Scott's	LFS	Scott's	LFS	Scott's
Abbotsford - Mission	10.6	6.7	9.9	6.7	9.9	7	10.4	6.7	8.5	6.3	7.5	5.8	8.2	4.9	9.7	5.1
Barrie	13.1	6.5	14.8	6.5	17.4	7.3	15.4	7.9	10.4	6.9	14.4	5.7	14.8	5.7	15.5	5.3
Brantford	15.8	9.6	17.4	10.2	17.7	15.2	15.8	14.1	14.5	13.4	13.6	10.8	13.8	10.5	14.4	9.5
Calgary	51.2	47.9	53.4	46.9	42.6	46.5	47.3	52	42.5	50	46.1	46.3	46.2	40.2	39	36.1
Edmonton	48.4	40.9	50.2	43.4	48.8	47.8	53.5	55.2	44.2	52.6	51.4	51.1	58.7	47.2	41.5	45.6
Gatineau	6.8	3.8	6.7	4.6	8	5	7.5	4.4	6.7	3.6	7	3.4	6.3	3	7	3.2
Greater Sudbury	3.6	3.6	4.3	4	4.4	4	3.7	3.7	3.5	3.6	3.9	3.5	3.3	3.4	3.1	3
Guelph	19.7	18	19.8	19.5	20.2	18.7	19.2	16.2	15.3	16.6	15.6	15.7	14.7	15.2	16.8	16.8
Halifax	11.5	11.1	10.8	12.1	9.9	10.9	12.5	12.2	11.8	12.9	11.4	12.7	10	10.6	10.5	8.7
Hamilton	73.7	37.4	76.2	38.5	69.2	39	58.1	37.5	51.1	35.3	49.3	34.4	46.6	31.8	49.8	29.3
Kelowna	6.5	5	7.8	5.4	6.4	6	8.3	5.9	6.6	5.4	6.3	5	4.4	5.9	5	4.7
Kingston	6.6	4.2	6	3.7	6.1	3.2	5.2	2.9	4.1	3	4.4	2.9	4	2.4	3.9	3.4
London	36	21.5	41.7	24	39.4	25.4	35.1	25.8	29.9	24.7	29.2	19.9	27.4	19.2	29.8	15.6
Moncton	6	5.2	5	6	4.4	6.1	4.3	5.6	5.9	6	5.4	5	4.6	5.2	4.2	4.1
Montreal	314.4	271.5	291.4	253.7	286.9	242	246.2	219.6	242.8	218.9	224.2	205.7	225.7	171.6	226	156.2
Oshawa	32.1	9.7	33.6	11	32.5	10.8	26.8	9.8	20.5	8.6	19.4	7.4	20.5	6.2	17.1	6.2
Ottawa	35.8	18.7	28.2	18.5	30.3	18.1	36	19.7	29.2	20.5	20.3	21.9	17	17.8	17.7	16.7
Peterborough	7.1	5	7.6	4.7	7.2	4.4	8.2	4.8	6	4.8	5.9	4.4	4.8	4.7	3.8	5.3
Quebec	32.4	29.5	33	29.6	40.7	34.9	39.3	34.4	32.3	34.8	32.2	32.4	28.4	32.1	32.1	28.4
Regina	5	6.5	5.5	5.9	6.4	6.1	6.5	6.8	7.5	6.3	6.8	7	7	5.4	8.3	5.5
Saguenay	11.2	7.5	10.2	7.5	10.6	8.3	11	8.6	9.1	8.8	8.6	9.2	9.3	6.8	7.8	6
Saint John	5.1	5.9	5.1	5.6	4.1	5.5	6	5.2	5.4	5.6	5.5	3.4	4.4	3.7	5.9	3.3
Saskatoon	10.1	11.8	9.2	12.5	11.8	11.2	11.3	10	11.1	9.7	9.1	10	11.4	8.8	8.8	8.4
Sherbrooke	19.7	16.7	23.1	15.7	17.6	14.8	14	11.6	12.4	11.9	13.3	11.8	11.9	10.9	14.8	11.1
St John's	3.5	6.8	3.4	5.9	3.9	5.4	5.2	6	4.4	6	3.8	5.7	5.1	6	3.7	4.5
St. Catharines - Niagara	32.4	22.1	30.5	21.8	26.9	20.7	25.6	18.7	20.6	16.6	21	15	21.8	12.8	21.6	12.6
Thunder Bay	7	3.6	6.7	3.7	5	3.7	4.4	3.4	2.9	2.8	2.9	3.5	4.2	2.5	3.2	2.1
Toronto	452.3	359.8	466.6	382.8	457.1	372	397.6	353.8	328.4	340.6	331.9	308.1	334.1	278.2	336.8	251.7
Trois-Rivieres	11.7	7.5	11	8.2	11.4	7.8	10.5	7.8	9.7	8.3	8.3	7.7	8.3	6.5	9.6	5.9
Vancouver	104.2	97.6	112.7	96.5	101.2	93	105.6	96.9	86.1	94.3	85.1	91.4	84.7	75.8	99.9	75.3
Victoria	6.3	5.3	8.5	6.1	7.7	5.7	6.7	5.7	6.2	5.9	5.9	5.7	5.8	5.4	7.2	4.8
Waterloo	63.2	42.6	63	46.1	63.7	46.8	59	43.6	49.8	40.9	49.3	35.9	52.3	30.3	51.3	30.5
Windsor	46.3	25.1	48.2	27.3	48	26.5	35.5	27.7	29.6	25.5	30.7	21.5	31.4	19	38.4	18.6
Winnipeg	50.5	37.9	47	38.2	45.7	38.4	48	35.6	40.5	33.1	37.5	33.6	41.3	29.7	42.8	25.2
Cross-employment correlation	***0.995***		***0.996***		***0.996***		***0.997***		***0.995***		***0.997***		***0.996***		***0.995***	

Notes: Distribution of Census Metropolitan Areas' employment (x1000) of manufacturing plants (NAICS 311–339). Data are from Scott's National All databases and Labor Force Survey Statistic Canada (Table 14-10-0098-01). The descriptive statistics reported as "cross-industry" in the bottom panel of the table are computed across all 3 digits industries.

Table B.4: Growth rates of U.S employment by NAICS 4-digits industries.

NAICS4	U.S manufacturing sector	Growth rate	NAICS4	U.S manufacturing sector	Growth rate
3346	Reproducing magnetic and optical media	-78.24%	3359	Other electrical equipment and component	-17.99%
3341	Computer and peripheral equipment	-77.27%	3274	Lime and gypsum product	-17.73%
3151	Clothing knitting mills	-75.06%	3272	Glass and glass product	-16.78%
3159	Clothing accessories and other clothing	-68.91%	3273	Cement and concrete product	-16.35%
3152	Cut and sew clothing	-68.60%	3334	Ventilation, heating, air-conditioning and refrigeration	-15.86%
3132	Fabric mills	-66.03%	3363	Motor vehicle parts	-15.13%
3343	Audio and video equipment	-64.12%	3261	Plastic product	-14.32%
3131	Fibre, yarn and thread mills	-60.91%	3321	Forging and stamping	-14.05%
3161	Leather and hide tanning and finishing	-57.56%	3313	Alumina and aluminum production and processing	-13.33%
3133	Textile and fabric finishing and fabric coating	-53.88%	3312	Steel product from purchased steel	-11.82%
3141	Textile furnishings mills	-51.77%	3314	Non-ferrous metal production and processing	-9.41%
3325	Hardware manufacturing	-49.57%	3391	Medical equipment and supplies	-9.03%
3342	Communications equipment	-48.63%	3251	Basic chemical	-8.33%
3352	Household appliance	-43.28%	3118	Bakeries and tortilla	-8.21%
3322	Cutlery and hand tool	-43.13%	3329	Other fabricated metal product	-8.17%
3271	Clay product and refractory	-43.01%	3256	Soap, cleaning compound and toilet preparation	-7.72%
3122	Tobacco manufacturing	-41.88%	3255	Paint, coating and adhesive	-7.25%
3371	Household and institutional furniture	-39.73%	3328	Coating, engraving, cold and heat treating	-5.70%
3231	Printing and related support activities	-36.56%	3324	Boiler, tank and shipping container	-4.00%
3326	Spring and wire product	-35.08%	3345	Navigational, measuring, medical and control instruments	-2.90%
3221	Pulp, paper and paperboard mills	-34.74%	3114	Fruit and vegetable preserving and specialty food	-2.19%
3169	Other leather and allied product	-34.47%	3323	Architectural and structural metals	-2.02%
3399	Other miscellaneous	-33.46%	3361	Motor vehicle	-1.46%
3344	Semiconductor and other electronic component	-33.15%	3253	Pesticide, fertilizer and other agricultural chemical	-1.08%
3162	Footwear manufacturing	-32.71%	3254	Pharmaceutical and medicine	-0.76%
3315	Foundries	-32.50%	3252	Resin, synthetic rubber, and artificial and synthetic fibres	-0.46%
3333	Commercial and service industry machinery	-31.97%	3113	Sugar and confectionery product	2.02%
3149	Other textile product mills	-29.95%	3112	Grain and oilseed milling	2.84%
3351	Electric lighting equipment	-29.02%	3366	Ship and boat building	2.93%
3379	Other furniture-related product	-27.51%	3116	Meat product	3.05%
3212	Veneer, plywood and engineered wood product	-27.45%	3327	Machine shops, turned product, and screw, nut and bolt	3.57%
3332	Industrial machinery	-25.99%	3339	Other general-purpose machinery	4.42%
3372	Office furniture (including fixtures)	-25.78%	3364	Aerospace product and parts	4.60%
3311	Iron and steel mills and ferro-alloy	-25.68%	3111	Animal food	6.17%
3222	Converted paper product	-25.32%	3331	Agricultural, construction and mining machinery	6.24%
3262	Rubber product	-24.39%	3336	Engine, turbine and power transmission equipment	7.46%
3259	Other chemical product	-24.00%	3241	Petroleum and coal product	7.52%
3353	Electrical equipment	-22.71%	3279	Other non-metallic mineral product	8.36%
3211	Sawmills and wood preservation	-21.81%	3115	Dairy product	10.77%
3219	Other wood product	-20.57%	3362	Motor vehicle body and trailer	14.02%
3117	Seafood product preparation and packaging	-19.65%	3365	Railroad rolling stock	19.29%
3369	Other transportation equipment	-19.65%	3119	Other food manufacturing	31.30%
3335	Metalworking machinery	-18.46%	3121	Beverage manufacturing	57.40%

Notes: Growth rates are between 2003 and 2017 for 4-digit sectors employment. Data are from U.S Bureau County Business Patterns.

Appendix C Additional results

Table C.1: Big plant closures and changes in population by age groups

Dependent variable	(1) Population growth OLS	(2) Population growth IV	(3) Δ share 0-19 IV	(4) Δ share 20-54 IV	(5) Δ share 55+ IV
Job loss rate (Closures)	-0.141[a]	-0.315	-0.048[a]	-0.054[a]	0.102[a]
	(0.036)	(0.244)	(0.014)	(0.020)	(0.025)
Observations	154	154	154	154	154
R-squared	0.436	n.a.	n.a.	n.a.	n.a.
Kleinbergen-Paap statistic		15.58	15.58	15.58	15.58

Notes: All regressions include the following controls: Dummies indicating whether city c is in the top quartile in terms of: (i) log population in 2001; (ii) share of residents aged 20-54 and share of residents with a university degree in 2001; (iii) share of manufacturing employment in 2001; (iv) unemployment rate and participation rate in 200. Continuous variables: (v) January and July maximum temperatures; (vi) log distance to the closest coast; and (vii) log distance to the closest urban center with at least 300,000 inhabitants. We also include regional fixed effect (Western provinces, Ontario, Quebec, and the Atlantic provinces) and the standard errors are clustered by province.

Table C.2: Big plant closures and downsizing and changes in population by age groups - Alternative controls

Dependent variable	(1) Population growth OLS	(2) Population growth IV	(3) Δ share 0-19 IV	(4) Δ share 20-54 IV	(5) Δ share 55+ IV
Job loss rate (Big and downsized plants)	-0.094[a]	-0.266	-0.053[a]	-0.068[a]	0.121[a]
	(0.026)	(0.257)	(0.013)	(0.018)	(0.025)
Observations	154	154	154	154	154
R-squared	0.436	n.a.	n.a.	n.a.	n.a.
Kleinbergen-Paap statistic		10.12	10.12	10.12	10.12

Notes: All regressions include the following controls: Dummies indicating whether city c is above the median in terms of: (i) log population in 2001; (ii) share of residents aged 20-54 and share of residents with a university degree in 2001; (iii) share of manufacturing employment in 2001; (iv) unemployment rate and participation rate in 200. Continuous variables: (v) January and July maximum temperatures; (vi) log distance to the closest coast; and (vii) log distance to the closest urban center with at least 300,000 inhabitants. We also include regional fixed effect (Western provinces, Ontario, Quebec, and the Atlantic provinces) and the standard errors are clustered by province.