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PRODUCTIVITY COMMISSION
Te Kōmihana Whai Hua o Aotearoa

New jobs, old jobs: the evolution of work in New Zealand's cities and towns

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The New Zealand Productivity Commission
Te Kōmihana Whai Hua o Aotearoa[1]

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[1] The Commission that pursues abundance for New Zealand.

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Overview

This paper uses census data to document and analyse the changing nature of jobs in regional New Zealand between 1976 and 2013. While the material is largely descriptive, its aim is to unravel the effects of several different forces on the evolution of jobs, towns and cities. This paper is not designed to make predictions about either the future of work or the future of regions. Rather, by documenting the evolution of regional employment patterns in New Zealand over the last 40 years, it aims to help understand how New Zealand has got to its current situation.

The changing nature of jobs has disproportionately favoured large "super cities", which in the New Zealand context means Auckland. In New Zealand, and in other developed countries, much new work has emerged in information-intensive sectors such as finance and professional and business services where productivity is enhanced if firms cluster in a small number of centres. For example, two thirds of the national increase in employment in the finance sector between 1976 and 2013 took place in Auckland, even though Auckland started with just over a third of the financial sector workforce at the start of this period.

While smaller urban areas have also increased the share of their workers in these growth sectors, the growth of these jobs in these areas was less than in Auckland. So far there is no evidence that small urban areas can compete with large cities in these sectors, so if these sectors keep growing as a fraction of the economy, Auckland is likely to continue to benefit from the sectoral transformation of the economy.

As manufacturing declined and service sectors expanded, the economies of most cities and towns have become more diversified. In this paper we show there are only a few examples of urban areas that have become more reliant on specialist industries since 1976. Rather, most areas became more diversified and more like each other. Small and medium sized urban areas with distinctive employment patterns are less common than they were. As migration between areas is easier when all areas have similar jobs, the reducing importance of city-specific industries may have catalysed the shift of jobs from slow-growing areas to climate-favoured fast-growing ones.

1 Motivation and method

1.1 Introduction

Over the last forty years New Zealanders, along with people in most other developed countries, have experienced big changes in the jobs they do and the places they live and work. These changes include:

- a decline in the number of manufacturing jobs;
- an increase in the quantity and renumeration of information-intensive work, often requiring tertiary education training;
- increased participation of females in the paid workforce;
- the rapid growth of large "super cities"; and
- internal migration to locations with desirable amenities, especially a favourable climate.

These trends have simultaneously changed the nature of work and the location of workers. Some urban areas have transformed themselves and thrived in the new environment, while others have found the transition difficult and have stagnated. Moreover, the transition has been accompanied by changes in income inequality as the relative importance of different skills and talents has changed and as the returns to those skills have varied across regions.

This paper uses census data to document and analyse the changing nature of jobs in regional New Zealand between 1976 and 2013. While the material is largely descriptive, its aim is to unravel the effects of several different forces on the evolution of jobs, towns and cities. This paper is not designed to make predictions about either the future of work or the future of regions. Rather, by documenting the evolution of regional employment patterns in New Zealand over the last forty years it aims to help understand how New Zealand has got to its current situation.

The way people adapted to the loss of manufacturing work is one of the issues we examine. In 1976, manufacturing accounted for 25% of jobs in New Zealand, and more than 15% of the workforce were employed in the manufacturing sector in all urban areas except for two small towns. By 2013 manufacturing accounted for less than 10% of national employment, and only a handful of small towns had more than 15% of their workforce employed in manufacturing industries. The changes induced by the loss of manufacturing jobs provide a prime example of how people have responded to widespread job changes in the recent past.

1.2 Themes and insights from the international literature

Many aspects of New Zealand's economic experience during the last forty years are similar to those experienced in other OECD countries. There is now a large international literature analysing the employment experiences of people in different sectors and different cities in various countries. This literature provides a useful context for understanding what has happened in New Zealand.

The decline of manufacturing

Manufacturing employment has declined as a share of total employment in most developed countries since the 1950s. In the United States, manufacturing employment declined steadily from 32% of the workforce in 1950 to 9% of the workforce in 2010 (Autor, Dorn and Hanson 2016). This decline has reflected three different factors:

- an increase in the efficiency of production, which means fewer workers have been needed for any level of production;
- an increase in manufactured imports, which has reduced demand for locally produced manufactures; and

- the outsourcing of some types of work, such as marketing, that were previously done within a manufacturing firm but are now done by specialists outside the firm and classified differently (Autor, Dorn and Hanson 2016).

A decline in manufacturing employment can have positive or negative effects on local employment in other industries. Local employment in other industries could increase if people move into new jobs to offset the decline in manufacturing jobs. Alternatively, the loss of local manufacturing jobs could reduce total employment as the initial reduction in local income reduces the demand for other locally produced goods and services. This is a negative multiplier effect. The extent that employment declines and the speed of any recovery depend on the relative strength of different equilibrating mechanisms (Notowidigdo 2011). In some places there may need to be a decline in wages to increase employment in other sectors. In other places the loss of manufacturing employment may lead to a permanent loss in employment, as some working people leave the town for jobs elsewhere and others decide to leave the workforce, perhaps taking earlier retirement. Even in this case a town's total population may not fall, as real estate prices may fall, and this attracts people who do not work to the town despite the poor employment opportunities.

Several recent studies have analysed the effects of an increase in Chinese manufactured imports on employment markets in the US (for example Bernard, Jensen and Schott 2006; Autor, Dorn and Hanson 2013, 2016; Acemoglu et al 2016). These results show (i) places that experienced greater competition from Chinese imports lost more manufacturing jobs than other places, and (ii) these job losses were not offset by an increase in other local employment. Wages declined in the affected regions. The wage declines were more pronounced in non-manufacturing sectors than manufacturing sectors, presumably in response to an additional supply of workers seeking new jobs. Similar results have been found in Spain and Norway (see the review by Autor, Dorn and Hanson 2016).

Other studies have attempted to trace the effect of technological change in the manufacturing sector on city-level employment. Acemoglu and Restrepo (2017) examined how employment was affected when there was an increase in the number of robots used by firms. They found that these robots had negative effects on local employment, on employment/population ratios, and on wages. Approximately half of the effect could be traced to local multiplier effects, as the reduction in manufacturing employment reduced demand for local goods and services. The impact was concentrated in the bottom half of the income distribution.

Overall, the international literature suggests that it can take a long time for regions to adjust to manufacturing employment losses and that the adjustment may never be full. There is a limited transfer of work from manufacturing to non-tradeable sectors. Moreover, part of the adjustment takes place through changing employment/population ratios, because many people who lose jobs leave the workforce or leave to places where they can find jobs and are replaced by people with less attachment to the workforce.

The location of new work

Beginning with Lin (2011), several authors have analysed the evolution of new work in the United States – jobs that never previously existed or only existed in tiny numbers. Lin (2011) examined the titles of approximately 30 000 jobs described in U.S. census records in 1965, 1977, 1990, and 2000 and examined the type, location, and number of jobs that were new each year. In 1977 and 1990 about 8% of jobs (not job titles) were new; in 2000 the figure was 4%. However, there were big differences in the types of new work before and after 1980. In the 1970s much of the new work was related to engineering. In the 1980s and 1990s much of the new work was computer related or related to management and finance.

These differences were important because the new jobs developed prior to 1980 employed different types of people and appeared in different locations than those developed after 1980. Prior to 1980 the jobs occurred all over the US. After 1980 they were disproportionately located in a few large urban areas that increasingly specialised in knowledge-intensive work, particularly those with large university-educated workforces such as New York, San Francisco, Seattle, and Washington. These cities initially had a large fraction of college educated workers and relatively diversified economies. The concentration of these new types of jobs in a few locations suggests that agglomeration economies were more important in these knowledge-intensive industries than in other industries.[2]

Not only were these new types of jobs disproportionally located in US cities with large numbers of university-educated people, but some of the fastest expanding sectors such as finance also increasingly hired university-educated workers and shifted to large urban areas where these workers were concentrated. The result has been a bifurcated labour market and rising income inequality. Income inequality increased between large and small cities as high paying work increasingly moved to the former locations, but it also increased within cities, particularly large cities. Wage inequality increased faster in big cities than small cities because the wage premium for college workers increased more rapidly in big cities and because the renumeration of people without tertiary education disproportionately declined in large cities (Berger and Frey 2016).

As a result of these trends, there has been a rising incentive for college educated people to locate in large urban areas, a reduction in the flow of less-educated workers to big cities, and a rising incentive for less educated workers to leave these places (Schleicher 2017; Autor 2019). Workers with middle levels of education increasingly found less skilled work in smaller cities (Lin 2011; Autor 2019). Between 1980 and 2000 the fraction of college educated workers in large cities increased from 23% to 47%, but only from 17% to 27% in smaller towns (Baum-Snow and Pavan 2013).

The growing inequality across regions also reflects differences in the wages paid to ostensibly similar people by different firms operating in an industry. These differences reflected growing dispersion in the productivity levels of different firms, which in turn is reflected in the wages they pay. The key studies documenting these trends examined wages in the United States and Germany. These studies show that it is increasingly important for individuals to work in the best firms as well as to have the right skills. In the United States, Barth et al (2016) showed that more than two thirds of the increase in wage inequality was due to an increase in the dispersion of the average wages paid by firms, rather than the distribution of wages within firms. Part of this change reflects an increase in the earnings and wages paid in the finance, software, and the oil and gas sectors, which are increasingly regionally specialised. In Germany, Card et al (2013) estimated that the increase in the dispersion of firm earnings accounted for over half of the increase in wage dispersion between 1985 and 2010. Over half of this increase in firm wage dispersion reflected a steady increase in assortative matching, whereby the most talented workers ended up working in the highest paying firms. Again, this study indicated that the premium for working in the best firms has been rising, particularly for the most talented workers.

The increasing levels of inequality across firms and across regions is linked. A small number of "super firms" increasingly locate in a small number of "super cities" (Rodríguez-Pose and Crescenzi 2008; McKinsey Global Institute 2018). These firms pay particularly high wages and employ routines and technologies that other firms have found difficult to copy (Syverson 2011). The increase in the size of large cities has been occurring for over a century and it has long been argued that the growth of very large cities reflects their productivity advantages (for example Black and Henderson 1999; Kaldor 1970). There may be some exceptions, as there seems to be a resurgence in some medium sized cities in Europe (Dijkstra, Garcilazo, and McCann 2013); but even this case refers to the performance of cities considerably larger than what we are describing as medium sized cities in New Zealand.

Fast growing and slow growing locations

Are the fastest growing urban areas those that specialise in highly paid new work? Not necessarily. Many rapidly growing locations do not specialise in rapidly growing sectors or even offer particularly high wages but have expanded because they offer favourable amenities. According to Fodor (2010) average income in the 25 US cities with the fastest population growth between 2000 and 2009 was only $34 500, compared to $42 900 in the 25 cities with the slowest population growth. Furthermore, 23 of the 50 cities with the fastest population growth between 1990 and 1998 had lower than median income

[2] A city has agglomeration economies when companies enjoy lower costs and obtain gains in efficiency because they are located near large numbers of other firms. Firms gain from localisation benefits if locating near firms in the same or similar industries reduces their costs. Firms gain from urbanisation benefits if locating near firms in other industries reduces their costs, perhaps by lowering the costs of the goods and services they use.

growth and 27 of the 50 cities with the slowest population growth had higher than median income growth (Gottlieb 2002).

The low correlation between population and wage growth suggests intercity-migration is driven by a variety of factors in addition to income. As Graves (1980) first documented for the United States, people have been attracted to amenity-rich locations despite the low wages these areas offer since the 1950s, particularly sunny, warmer locations near the coast. As consumption amenities tend to be luxury goods, the migrants to cities with desirable natural amenities tend to be disproportionately older people with the necessary level of wealth. In contrast, many younger and well-educated people migrate to large growing cities with good business environments since firms are also attracted to these locations as they are highly productive. When Chen and Rosenthal (2008) measured the quality of consumption amenities and business amenities of different US cities they also found college-educated people were attracted to cities with good business environments and older people were attracted to the centres with good consumer amenities. These different motives go some way to explaining why cities with high population growth have disparate income levels and income growth.

These results suggest it is useful to classify urban areas into at least three categories:

- fast-growing, higher-income locations that are centres for new work and expanding sectors;
- fast-growing, lower-income locations that have good amenities; and
- slow-growing locations, including those with static populations.

The latter are locations with low employment growth, and low or medium wage levels. These urban areas rarely disappear but tend to have static populations. Many of these places have manufacturing employment based on the processing of locally produced and costly-to-ship commodities, along with essential non-traded services such as retailing and education.

Polèse and Shearmur (2006) examined declining towns and regions in Canada and argued that in addition to remoteness and unattractive climate, failing towns have been dominated by a single resource extraction industry, often with one or two firms. While Chen and Rosenthal (2008) do not address this issue directly, their amenity indices can be used to identify the US cities that have low consumer and business desirability. They estimate that 19% of US cities have below median consumer-amenity indices and below median business-amenity indices. Three quarters of these cities lie in two regions that are widely considered to be in decline – the Midwest from upstate New York to southern Illinois; and the rural south, from north west Texas to Georgia. Declining cities can last a long time, eking out an existence from the momentum provided by long-lived capital assets (including residential housing) and the inertia generated by social contacts.

While the three types of urban areas differ in terms of the work opportunities they offer, they all offer some types of jobs that are very similar. Industries can be analysed in terms of the extent that they produce goods and services for the local market and the extent that they produce for an external market. The “non-tradeable” sectors that largely produce for a local market are found in all urban areas. However, tradeable sectors differ across locations, and are typically the characteristic economic feature of an urban area. One way of measuring an area’s industrial structure is to measure each industry’s “locational quotient” (Coulson 2006). This is simply the fraction of people employed in an industry in the area relative to the fraction of people employed in the industry nationwide. Since an area that specialises in a particular industry will have a location quotient for that industry above one, an area’s characteristic industries will be those with high location quotients.

Duranton and Puga (2000, 2001) observe that secondary cities tend to be more specialised than large cities. They frequently have a single dominant tradeable sector, often manufacturing, which makes them relatively exposed to shocks. Other authors have offered similar analysis. For example, Hildreth (2006) noted that the performance of secondary cities in England often depends on their leading industries. Using six categories of cities (manufacturing or industrial cities; tourism or heritage cities; university cities; regional service cities; gateway cities (transport hubs); or satellite cities (essentially cities whose inhabitants commute to a nearby large city)) he showed industrial and gateway cities typically have the lowest incomes and the least diverse markets. Tourism and heritage cities also have little ability to diversify in the face of economic shocks.

For an urban area to thrive it needs relatively efficient non-tradeable sectors to produce goods and services wanted by resident consumers and resident firms. It also needs relatively efficient tradeable sectors to earn sufficient income to purchase goods and services not produced locally. These two requirements mean a location can do poorly if:

- it has relatively unproductive tradeable sectors, or tradeable sectors that only generate low incomes, and for one reason or another it is not an efficient location to produce alternative tradeable goods; or
- it has relatively unproductive non-tradeable sectors producing intermediate inputs for other businesses that cannot be readily and cheaply obtained from other cities, as this makes it an unattractive place to locate a business; or
- it has poor natural consumption amenities, making it unattractive as a place to live; or
- it has relatively unproductive non-tradeable sectors producing consumption goods and services, and this makes it an unattractive place to live.

To paraphrase Tolstoy, successful urban areas have many similar characteristics, but unsuccessful ones can be unsuccessful in quite different ways.

The response to employment shocks

The way urban areas evolve through time depends on the shocks they receive and the way they respond to these shocks. Both the susceptibility to shocks, and the response to them, may depend on the industrial structure of these areas. Polèse (2010) defines cities in terms of their resilience to different types of shocks.

- a-resilience refers to the ability to survive temporary shocks. Most cities have A-resilience, even to catastrophic shocks such as earthquakes or war damage.
- b-resilience refers the ability to respond to permanent shocks to a city's economic base. Polèse (2010) argues it is less common to find cities that respond well to these types of shocks. It requires a city to have an ability to transform itself when it experiences a major decline in a traditional industry. Montreal, Boston, New York and, to a lesser extent, Minneapolis are cited as examples of major cities with such resilience; Detroit, New Orleans, Nagasaki, and Manchester as cities which have found the transformation more difficult.

One of the determinants of a city's resilience to shocks is the extent of inter-regional migration. If people are quick to move out in response to the decline of a traditional industry, an urban area may have a hard job reinventing itself. This is one of the major differences between Europe and the U.S., and part of the reason for different regional policy in the two continents. City-level populations change much less in Europe than in the U.S. in response to shocks, as migration between cities is more rapid in the U.S. than Europe (van Dijk, Folmer, and Oosterhaven 2010).

When outward migration is easy, cities may find it difficult to respond positively in the face of negative shocks as many of their skilled workers choose to leave rather than start new businesses. A feature of B-resilient cities is that they tend to keep their skilled workforce when shocks occur. For this reason, cities with attractive natural amenities, or with attractive cultural environments, tend to be more resilient. Commercial and mercantile cities have historically proved more adaptable to negative shocks than cities based upon extractive industries or heavy manufacturing, partly because the industrial culture associated with the latter industries appears to deter the emergence of new industries (Glaeser et al 2016). Cities that lack business service sectors are often troubled (Hansen 1990). In contrast, there does not seem to be an obvious common factor behind cities that successfully respond to shocks to their main industries. Hansen (1990) cites New Orleans and Manchester as cautionary tales of cities with vibrant culture or technological leadership that failed to transform themselves to maintain a dominant position.

1.3 The New Zealand context

Between 1976 and 2013 employment in New Zealand's thirty largest cities and towns increased by 48% or by an average of 1.1% per year.[3] However, this average masks considerable variation (see Table 1-1 and Table 1-2). Employment increased by more than 65% in nine urban areas, including Auckland, Hamilton and Tauranga. In contrast, employment increased by less than 15% in eight other urban areas, and it decreased by a small amount (less than 10%) in three more. Employment in one urban area, Tokoroa, decreased by nearly half.

Table 1-1 Mean and standard deviation of population growth rates across cities and towns, 1976-2013

	1976–1996	1996–2013	1976–2013
	All 30 towns and cities		
Weighted mean	17%	26%	48%
Unweighted mean	20%	19%	48%
Unweighted SD	41%	19%	76%
	17 larger urban areas		
Unweighted mean	18%	21%	45%
Unweighted SD	22%	16%	49%
	13 smaller urban areas		
Unweighted mean	24%	16%	52%
Unweighted SD	58%	22%	104%

Source: Authors' calculations based on Stats NZ Census data, 1976-2013

What explains this variation? It does not appear to be the initial size of the cities for some small cities grew rapidly and some large cities grew slowly (see Table 1-1). Nonetheless, there are some obvious patterns. Five of the twelve slowest growing urban areas are in the south or west coast of the South Island (New Zealand's least sunny region) while the remaining seven are small regional towns in the North Island. In contrast, the fastest growing urban areas include three areas in the climate-favoured upper North Island, two sunny areas in the South Island, and two satellite areas on the outskirts of major cities. As Grimes et al (2016) indicated in their study of population trends in New Zealand, a simple explanation for why some urban areas in New Zealand have grown faster than others is that there has been an increasing willingness of people to live in locations that have desirable amenities such as a good climate or scenery.

Is there more to population growth in cities and towns than sun, skiing, and surf? Do other factors explain the variation in employment growth rates? For instance, do urban areas grow or shrink according to the nationwide performance of the industries in which they specialise?[4]

Even a limited knowledge of the New Zealand economy gives this idea some plausibility. In 1976, for example, 50% of Tokoroa's workforce or 3 700 workers were employed in the wood-processing and pulp and paper industries. By 2006 only 650 people were employed in these industries and total employment in the town had decreased from 7 500 to 4 750.

[3] For ease of reference this paper largely uses the terms "cities" and "urban areas" to refer to these largest 30 cities and town.

[4] The empirical work in the paper is based on employment in 65 different industries. For some purposes we aggregate the results into groups of related industries, which we call sectors. Sometimes we aggregate the industries into fifteen sectors on other occasions five sectors. We try to use the word "sector" only in reference to these groupings.

Table 1-2 Employment growth in New Zealand's 30 largest cities and towns (ranked by employment growth)

	Employment level 1976	Employment rank 1976	Growth 1976–1996	Growth 1996–2013	Growth 1976–2013
Tokoroa	7 479	19	-30%	-20%	-44%
Greymouth	4 845	26	-11%	5%	-7%
Wanganui	15 558	13	-7%	2%	-5%
Oamaru	5 601	24	-7%	6%	-2%
Levin	6 768	21	1%	-1%	0%
Invercargill	22 305	8	-4%	6%	1%
Masterton	8 352	18	-9%	14%	3%
Dunedin	48 249	5	-6%	10%	3%
Timaru	11 721	16	-5%	14%	8%
Gisborne	11 784	15	-1%	10%	8%
Hawera	4 590	28	6%	4%	10%
Rotorua	18 540	10	13%	1%	14%
Whangarei	15 228	14	9%	11%	20%
Wellington	155 316	2	0%	20%	20%
Palmerston North	28 110	7	14%	10%	25%
Napier-Hast	41 319	6	10%	14%	26%
New Plymouth	18 321	11	11%	21%	34%
Christchurch	127 896	3	12%	21%	36%
Feilding	4 659	27	25%	9%	37%
Whakatane	5 274	25	24%	13%	40%
Ashburton	6 129	22	12%	32%	47%
Blenheim	8 472	17	35%	22%	65%
Hamilton	54 516	4	25%	34%	67%
Nelson	16 731	12	34%	26%	69%
Auckland	326 847	1	31%	36%	79%
Taupo	5 634	23	50%	20%	81%
Kapiti	7 116	20	57%	46%	129%
Rangiora	2 832	29	54%	61%	147%
Tauranga	18 630	9	72%	60%	176%
Queenstown	1 548	30	198%	54%	361%
Total	1 010 370		17%	26%	48%

Source: Authors' calculations based on Stats NZ Census data, 1976-2013

At the other end of the spectrum, between 1976 and 2006 employment in the accommodation, hospitality and recreation industries in Queenstown increased from 550 to 1 950 as the town transformed itself into one of the key centres of New Zealand's tourism industry.

These two examples show that large shocks to urban areas' key industries can have large effects on employment. One purpose of the paper is to see how typical these effects are. We do this by examining how employment levels in New Zealand's cities and towns respond to *city-specific* employment shocks and whether the response depends on the characteristics of an urban area, such as its size or its initial industrial structure. After a negative shock strikes one of its industries, for example, it may be the case that most people find jobs in other industries, resulting in little change in total city-level employment. Alternatively, some urban areas or industries may have characteristics that amplify shocks, so that total employment declines by a larger amount than the initial shock.

The analysis focuses on the response to city-specific shocks. As indicated above, urban areas produce goods and services that are mainly consumed locally and goods and services that are sold to people outside the area. All areas produce very similar goods and services for local consumption, such as construction, retailing, or schooling, and these industries typically comprise most of their employment. Most urban areas also have specialist industries that produce goods and services sold elsewhere. These industries are found in different proportions in different areas and thus tend to characterise the area's production and employment. Because external shocks to these industries differentially affect employment levels in different areas, they have the potential to lead to large changes in total population and employment levels. When we examine how city-specific shocks affect employment, we concentrate on these sectors. For example, Hawera is known for its dairy-processing industry, but an expansion of this industry in Hawera could be expected to lead to an increase in employment in other occupations, such as teachers, construction workers, and dentists.

1.4 Method and data

To explore these issues, the paper uses census data covering employment in 30 urban areas and 65 separate industries between 1976 and 2013. Using the Stats NZ classification (based on UA13), we identified three large cities, 14 medium sized urban area ranging in size from Blenheim (2013 population of 29 298) to Hamilton (203 448), and 13 small urban areas ranging from Greymouth (9660) to Timaru (27 051). The total population of the medium sized areas in 2013 was 1 039 000, while the population of the small areas was 213 000. The population of Auckland, Wellington, and Christchurch were 1 335 000, 377 000 and 353 000 respectively.

City-industry employment data are available at five-year intervals from census returns for the years 1976-2013.[5] We aggregate these data into 65 industries representing two- or three-digit industry codes (based on ANZSIC06), for example dairy product manufacturing (5 061 employees nationwide in 2013); supermarket and grocery stores (37 704 employees); banking and finance (35 793 employees); or education (129 324 employees). The employment numbers include working proprietors. One of our main results traces the effect of employment shocks to two-digit industries over five-year periods from 1976 to 2013. The most interesting findings concern the effect of employment changes in the primary and manufacturing sectors, which employed 25% of workers nationally in 1976.

A key part of our methodology is to identify the industries that are ubiquitous to all urban areas and the industries that are concentrated in certain locations and can be considered city-specific. To do this, we use employment census data from 1976 to 2013 to calculate location quotients for each industry in each urban area. A location quotient is the fraction of a location's workers employed in a certain industry relative to fraction of national employment in that industry. The location quotients for the "ubiquitous" industries that are found in all urban areas are near one, and consequently the cross-city variance of the location quotients of these ubiquitous industries is low. In contrast, the cross-city variance of the location quotients of tradeable industries that are concentrated in certain urban areas is large. By

[5] The 2011 Census was delayed until 2013.

ordering industries according to their cross-city variances, industries that are concentrated in a few areas but absent from others can be systematically identified.

We used a methodology based on Bartik (1991) to trace the effect of employment shocks on city-level employment. The Bartik methodology defines a city-industry employment shock as the amount of employment a city would lose or gain in a particular industry if that industry contracted or expanded at the national average rate. This approach automatically adjusts a city's employment change for the over- or under-representation of an industry in that city. We focus on the effects of employment shocks to tradeable industries (identified as industries with high location quotient variances) on total employment and on employment in other industries. Much of the focus concerns shocks to manufacturing industries as these comprise a large fraction of the industries in the tradeable sectors.

The detailed location and industry data are used in several other ways. In section 2.3, they are used to trace the location of jobs in expanding sectors. In section 2.4, they are used to estimate employment churn, the extent that people switch jobs from one industry to another, in different sized cities. In section 3.1 the data are used to see how city-level employment in different industries is affected by local demand, to examine the extent non-tradeable goods are in fact more affected by local demand conditions than tradeable goods. In section 3.2 the employment data are used to analyse how nationwide shocks to manufacturing and primary industries affected employment in other sectors, to ascertain if the way cities responded to the largely negative manufacturing employment shocks depended on the characteristics of the industries. In section 3.3 the data are used to see whether employment growth in different cities was significantly affected by their initial industrial specialisations, or whether other factors were more important. Lastly, in section 3.4 we use the data to examine the extent that urban areas are becoming more or less industrially diversified through time.

2 Employment patterns in New Zealand cities

This chapter describes how the spatial evolution of the economy may be related to the changing pattern of goods and services produced in New Zealand.

2.1 Location quotients as a measure of industrial specialisation

City-industry employment data can be arranged to examine employment across industries in an urban area. Let:

E_t^{ic} = employment in industry *i* in city *c* at time *t*

E_t^{c} = total employment in city *c* at time *t*

E_t^{i} = total employment in industry *i* at time *t*

E_t = total employment in all cities and industries at time *t*

The *location quotient* for a city-industry pair is the ratio of a city's employment share in a particular industry relative to the national employment share in that industry:

$$LQ_t^{ic} = \left(\frac{E_t^{ic}/E_t^{c}}{E_t^{i}/E_t}\right) \qquad (1)$$

A location quotient measures the extent to which an industry is over-represented or under-represented in an urban area. A high location quotient for a city-industry pair means the area specialises in the activity while a low location quotient for a city-industry pair means it undertakes little of the activity relative to the national average. Gilmer (1990) provides a discussion of how location quotients can be used to classify industries and urban areas.

Industries differ significantly according to the variability of the location quotients across urban areas. Some industries are found everywhere, and thus the variance of the location quotient across urban areas is low. Typically, these are non-traded industries that all cities and towns need such as retailing, construction, or education. Other industries are found in a small number of locations and their products are exported to areas elsewhere in the country or around the world. The variance of these industries across areas is high.

Table A.1 in Appendix A shows 65 industries ranked by the cross-city standard deviation of their location quotients. For each industry the cross-city standard deviation of the location quotient is calculated for each census year and the average of the eight standard deviations is reported. The cross-city standard deviations range from 0.17 to 5.86, with a median of 0.45.

The industries with below median cross-city standard deviations are found in all locations as they are difficult to trade across space and require local suppliers. These industries account for approximately 70% of total employment. In contrast, 30% of employment takes place in industries whose location quotients have above median standard deviations. These industries do not need to be located in all areas as they can be easily traded.

It is convenient to aggregate these 65 industries into 15 industrial sectors. Most of these aggregates, such as retailing or transport, are self-explanatory. Manufacturing is split into two branches – Manufacturing RS (Regionally Specialised) and Manufacturing WD (Widely Distributed) – based on the size of the standard deviation of their location quotients:

Table 2-1 Employment by sector, 1976-2013

	1976	2013	Change	Percentage change
1. Construction	8.9%	7.8%	-1.1%	-12.0%
2. General Government	5.2%	5.5%	0.3%	6.7%
3. Health and Education	12.5%	19.3%	6.8%	54.1%
4. Retail	11.5%	10.3%	-1.2%	-10.4%
5. Accommodation and hospitality	3.1%	6.0%	2.9%	92.1%
6. Personal services	4.6%	6.1%	1.5%	33.6%
7. Wholesale	5.1%	5.5%	0.4%	7.5%
8. Transport	8.0%	4.4%	-3.6%	-45.4%
9. Finance and real estate	4.9%	6.7%	1.8%	36.0%
10. Professional services	2.6%	9.7%	7.2%	279.2%
11. Administrative/ business services	2.1%	3.6%	1.5%	72.8%
12. Utilities and telecommunications	3.3%	2.9%	-0.5%	-14.1%
13. Manufacturing WD	17.6%	6.8%	-10.8%	-61.2%
14. Manufacturing RS	7.7%	3.0%	-4.7%	-60.9%
15. Primary industry	3.0%	2.4%	-0.6%	-19.4%

Source: Authors' calculations based on Stats NZ Census data, 1976-2013

- Manufacturing RS: this is a group that comprises the seven manufacturing industries that have location-quotient standard deviations that are in the top quartile of the 65 industries. Many of these manufacturing industries are disproportionately located in smaller cities and towns and process primary commodities such as milk, meat, or wood.
- Manufacturing WD: this is a group comprising ten manufacturing industries that have cross-city location quotient standard deviations that are in the second and third quartiles. These industries, such as printing or clothing manufacture are found to some extent in most urban areas.

The 17 manufacturing industries are listed in Table A.2 in Appendix A. The table also contains a description of eight primary industries (such as horticulture) that have location quotient standard deviations that are in the top quartile. These industries are also regionally specialised and employment in these primary industries is also overwhelmingly located in smaller urban areas.

2.2 What do urban areas do?

Table 2-1 shows the national share of employment in the fifteen main sectors in 1976 and 2013. Table 2-2 and Table 2-3 show the average amount of employment in these sectors in different sized urban areas for the periods 1976–1991 and 1996–2013. The dominant feature of the data is the decline in the fraction of employment in manufacturing over the period, from 25% to 10% of the workforce. This decline was offset by a significant expansion in the professional services sector and in the health and education sector, each of which increased by 7% of the workforce. The accommodation and hospitality sector and the financial service sector also increased significantly.

Table 2-2 Employment by sector in different sized urban areas, 1976-1991

	National average	Difference with national average				
	National average	Auckland	Wellington	Christchurch	Medium areas	Small areas
1. Construction	7.1%	-0.2%	-0.6%	-1.1%	0.8%**	0.6%**
2. General Government	6.0%	-1.1%	4.6%	-0.6%	-0.2%	-1.7%**
3. Health and Education	13.5%	-1.5%	-1.4%	1.1%	1.2%**	-0.2%
4. Retail	11.7%	-0.3%	-2.3%	-0.2%	1.0%**	2.5%**
5. Accommodation and hospitality	3.8%	-0.6%	-0.6%	0.4%	0.3%**	1.1%**
6. Personal services	4.5%	-0.2%	0.2%	0.1%	0.1%	0.1%
7. Wholesale	5.6%	0.9%	0.6%	0.4%	-0.9%**	-1.8%**
8. Transport	5.7%	0.3%	1.0%	0.3%	-0.6%**	-1.2%**
9. Finance and real estate	5.5%	0.2%	2.6%	-0.5%	-0.8%**	-1.9%**
10. Professional services	3.4%	0.0%	1.2%	-0.4%	-0.2%*	-0.7%**
11. Administrative/ business services	2.6%	0.4%	0.7%	-0.1%	-0.6%**	-0.7%**
12. Utilities and telecommunications	5.0%	-0.5%	2.4%	-0.6%	-0.3%	-0.1%
13. Manufacturing WD	15.4%	5.0%	-1.8%	2.9%	-4.1%**	-5.6%**
14. Manufacturing RS	6.8%	-0.9%	-4.0%	-0.5%	1.1%**	5.4%**
15. Primary industry	3.2%	-1.5%	-2.7%	-1.3%	2.4%*	3.8%**

Source: Authors' calculations based on Stats NZ Census data, 1976-2013

Notes:

1. Medium areas: Whangarei, Hamilton, Tauranga, Rotorua, Gisborne, Napier-Hastings, New Plymouth, Wanganui, Palmerston North, Kapiti, Nelson, Blenheim, Dunedin, Invercargill
2. Small areas: Whakatane, Taupo, Hawera, Fielding, Levin, Masterton, Greymouth, Rangiora, Ashburton, Timaru, Oamaru
3. *,** Indicates that the difference with the mean level of Auckland, Wellington and Christchurch is statistically different from zero at a 5% (*) or 1% level (**). The statistical significance is calculated by regressing the labour share of each city against dummy variables for small and medium sized areas as well as time fixed-effects. The standard errors of the regression were calculated using the Huber-White method

Table 2-3 Employment by sector in different sized urban areas, 1996-2013

	National average	Difference with national average				
	National average	Auckland	Wellington	Christchurch	Medium areas	Small areas
1. Construction	7.1%	-0.3%	-1.3%	0.7%	0.4%*	1.1%**
2. General Government	5.3%	-1.3%	6.2%	-1.1%	-0.2%	-1.3%*
3. Health and Education	16.9%	-1.9%	-1.2%	0.5%	2.7%**	-0.3%
4. Retail	10.9%	-0.7%	-1.8%	0.3%	0.9%**	2.5%**
5. Accommodation and hospitality	5.8%	-0.6%	-0.4%	0.5%	0.3%	0.6%*
6. Personal services	6.0%	-0.2%	0.4%	0.1%	0.1%	-0.2%
7. Wholesale	6.1%	2.0%	-1.3%	-0.1%	-1.3%**	-2.2%**
8. Transport	4.6%	0.4%	-0.4%	0.5%	-0.4%**	-0.8%**
9. Finance and real estate	6.6%	1.1%	2.2%	-0.6%	-1.6%**	-2.3%**
10. Professional services	8.3%	1.6%	3.5%	-1.1%	-2.2%**	-3.7%**
11. Administrative/ business services	3.7%	0.6%	0.4%	-0.2%	-0.7%**	-1.1%**
12. Utilities and telecommunications	3.1%	0.4%	1.5%	-0.4%	-0.8%**	-0.6%**
13. Manufacturing WD	8.9%	1.7%	-3.1%	2.0%	-1.1%*	-1.4%*
14. Manufacturing RS	3.7%	-1.0%	-2.3%	-0.1%	1.1%**	5.6%**
15. Primary industry	2.9%	-1.8%	-2.4%	-1.1%	2.7%**	4.0%**

Source: Authors' calculations based on Stats NZ Census data, 1976-2013

Notes:

1. Medium areas: Whangarei, Hamilton, Tauranga, Rotorua, Gisborne, Napier-Hastings, New Plymouth, Wanganui, Palmerston North, Kapiti, Nelson, Blenheim, Dunedin, Invercargill.
2. Small areas: Whakatane, Taupo, Hawera, Fielding, Levin, Masterton, Greymouth, Rangiora, Ashburton, Timaru, Oamaru.
3. *,** Indicates that the difference with the mean level of Auckland, Wellington and Christchurch is statistically different from zero at a 5% (*) or 1% level (**). The statistical significance is calculated by regressing the labour share of each city against dummy variables for small and medium sized areas as well as time fixed-effects. The standard errors of the regression were calculated using the Huber-White method.

There are significant differences in the employment composition of small, medium and large urban areas. (A small urban area has population less than 29 000 in 2013, a medium urban area has population 29 000 – 250 000 and each of the three large urban areas has a population in excess of 250 000.) Small urban areas have considerably more employment in the primary and manufacturing sectors than medium or large ones, and they also specialise in different types of manufacturing. On average, between 1996 and 2013, 17% of employment in small urban areas was in the manufacturing RS and primary sectors such as horticulture, dairy or pulp and paper manufacturing, compared to 4% in Auckland. In contrast, 8% was in Manufacturing WD sectors such as printing or fabricated metal manufacturing compared to 11% in Auckland.

These differences in the size of the primary and manufacturing RS sectors in small and large urban areas have become larger over time. Small urban areas also have disproportionately large retail sectors. In contrast, small urban areas have much smaller professional services and financial services sectors than Auckland or Wellington, and the difference has been increasing over time. The gap is most noticeable in the financial service sector, as the expansion of financial service employment in large urban areas appears to have been at the expense of employment in small urban areas.

Employment in medium sized urban areas has similar characteristics to that in small urban areas but, with one exception, the differences with large areas are less marked. There is more employment in the retail, primary and manufacturing RS sectors in medium sized urban areas than in large urban areas, and less employment in the professional service, financial service and wholesale sectors, although employment in these services has increased faster than in small urban areas. Medium sized cities also have disproportionately large health and education sectors, partly because three medium sized urban areas have universities.

In Table 2-4 and Table 2-5 the employment figures for small and medium sized urban areas are rearranged by the population growth rate rather than the size of the area.[6] Irrespective of the speed of growth, all small and medium areas have larger primary, manufacturing RS and retail sectors than the large areas, but the differences are biggest for the slow growing urban areas. The slowest growing small areas also have the largest education and health sectors while the fastest growing small areas have larger than average construction sectors. Slow growing small locations, therefore, are characterised by large primary, manufacturing, retail and health and education sectors, but small professional service, finance and wholesale sectors.

Table 2-4 Employment by sector in urban areas that differ by growth rate, 1976-1991

	National average	Difference with national average		
		Slow	Medium	Fast
1. Construction	7.1%	0.1%*	0.9%**	1.5%**
2. General Government	6.0%	-0.9%**	-1.0%*	0.1%
3. Health and Education	13.5%	1.7%**	-0.2%	-1.1%
4. Retail	11.7%	1.8%**	1.0%**	1.9%**
5. Accommodation and hospitality	3.8%	0.9%**	0.4%*	1.0%**
6. Personal services	4.5%	0.1%	0.2%	0.2%*
7. Wholesale	5.6%	-1.4%**	-0.9%**	-1.6%**
8. Transport	5.7%	-0.9%**	-1.4%**	0.1%
9. Finance and real estate	5.5%	-1.6%**	-1.6%**	-0.8%**
10. Professional services	3.4%	-0.6%**	-0.1%*	-0.4%*
11. Administrative/ business services	2.6%	-0.8%**	0.0%**	-0.6%**
12. Utilities and telecommunications	5.0%	-0.3%*	-0.1%	0.1%
13. Manufacturing WD	15.4%	-5.2%**	-5.4%**	-4.9%**
14. Manufacturing RS	6.8%	4.4%**	3.0%**	0.0%
15. Primary industry	3.2%	2.6%**	2.3%**	4.6%**

Source: Authors' calculations based on Stats NZ Census data, 1976 – 2013

Notes:

1. Slow-growing areas: Rotorua, Gisborne, Hawera, Wanganui, Levin, Masterton, Greymouth, Timaru, Oamaru, Dunedin, Invercargill.
2. Medium-growing areas: Whangarei, Whakatane, Napier-Hastings, New Plymouth, Palmerston North, Feilding, Ashburton.
3. Fast-growing areas: Hamilton, Tauranga, Taupo, Kapiti, Nelson, Blenheim, Rangiora.
4. *,** Indicates that the difference with the mean level of Auckland, Wellington and Christchurch is statistically different from zero at a 5% (*) or 1% level (**). The statistical significance is calculated by regressing the labour share of each city against dummy variables for small and medium sized areas as well as time fixed-effects. The standard errors of the regression were calculated using the Huber-White method.

[6] Auckland, Wellington and Christchurch are excluded from this exercise because they have different employment profiles than the smaller towns and cities.

Table 2-5 Employment by sector in urban areas that differ by growth rate, 1996-2013

	National average	Difference with national average		
		Slow	Medium	Fast
1. Construction	7.1%	-0.1%	0.1%	1.4%**
2. General Government	5.3%	-0.9%*	-0.1%	-0.3%
3. Health and Education	16.9%	2.2%**	-0.4%**	-0.7%
4. Retail	10.9%	1.8%**	0.6%**	1.5%**
5. Accommodation and hospitality	5.8%	0.6%	-0.9%	0.9%*
6. Personal services	6.0%	-0.1%	-0.3%*	0.1%
7. Wholesale	6.1%	-2.3%**	-1.2%**	-1.6%**
8. Transport	4.6%	-0.9%**	-0.4%**	-0.1%
9. Finance and real estate	6.6%	-2.4%**	-2.0%**	-1.1%**
10. Professional services	8.3%	-3.5%**	-3.3%**	-2.2%**
11. Administrative/ business services	3.7%	-1.1%**	-1.2%**	-0.7%*
12. Utilities and telecommunications	3.1%	-0.8%**	-1.1%**	-0.6%**
13. Manufacturing WD	8.9%	-1.6%*	-1.9%	-1.7%**
14. Manufacturing RS	3.7%	5.1%**	2.3%**	1.1%**
15. Primary industry	2.9%	3.7%**	2.5%**	3.5%**

Source: Authors' calculations based on Stats NZ Census data, 1976–2013

Notes:

1. Slow-growing areas: Rotorua, Gisborne, Hawera, Wanganui, Levin, Masterton, Greymouth, Timaru, Oamaru, Dunedin, Invercargill.
2. Medium-growing areas: Whangarei, Whakatane, Napier-Hastings, New Plymouth, Palmerston North, Feilding, Ashburton.
3. Fast-growing areas: Hamilton, Tauranga, Taupo, Kapiti, Nelson, Blenheim, Rangiora.
4. *,** Indicates that the difference with the mean level of Auckland, Wellington and Christchurch is statistically different from zero at a 5% (*) or 1% level (**). The statistical significance is calculated by regressing the labour share of each city against dummy variables for small and medium sized areas as well as time fixed-effects. The standard errors of the regression were calculated using the Huber-White method.

2.3 Implications of the shift to the service sector economy

The decline of manufacturing and the rise of service sectors since 1976 has had important regional implications. This is because some of the fastest growing service industries disproportionally favoured larger urban areas. The effect was most noticeable in the financial services, wholesale, utility, and the professional services sectors, but it also occurred in the transport sector. While workers in large and smaller areas alike suffered job losses as manufacturing declined, reemployment opportunities in new growth industries opened up fastest in large urban areas.

One method of documenting this effect is to compare how much employment changed in each industry-city combination relative to the increase that could have been expected if employment in each industry-city combination had grown at the national rate, adjusted for each city's population growth and the area's under-or over-representation in that industry. If employment in particular industry grows much faster than the national rate in a particular class of urban areas, it shows that the industry has increasingly favoured that class of urban areas.

Formally, we define the predicted number of jobs in an industry *i* in city *c* at time *t+1*, $\hat{E}^{ic}_{t+1}$, as:

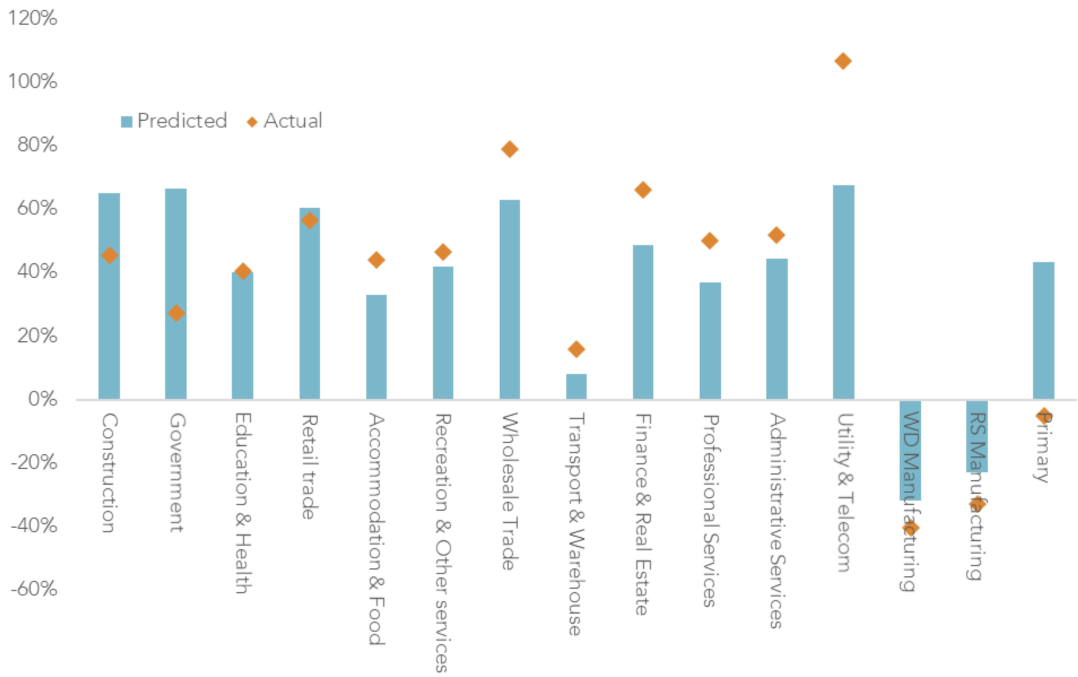
$$\hat{E}^{ic}_{t+1} = LQ^{ic}_t \times \left(\frac{E^i_{t+1}}{E^i_t} \times \frac{E^i_t}{E_t}\right) \times \left(\frac{E^c_{t+1}}{E^c_t} \times E^c_{t+1}\right) \quad (2)$$

The first term measures the extent that an urban area is under- or over-represented in a particular industry, the second term measures the extent that an industry increased nationally between *t* and *t+1*, and the third term shows total employment in the area in period *t+1*. The predicted increase in the number of jobs between periods t and t+1 is found by subtracting the actual number of jobs at time t. We then compare the actual change in employment with the predicted change in employment and express this amount as a fraction of the nationwide urban change in employment for that industry.

To give an example, between 1976 and 2013 employment in the wholesale sector expanded by 30 354 jobs, from 5.1% of total employment to 5.4% of total employment. Auckland initially was slightly over-represented in the wholesale sector, accounting for 36% of national-level employment in that sector relative to its overall 32% share of national employment. In addition, Auckland grew rapidly between 1976 and 2013 and accounted for 53% of the increase in total national employment.

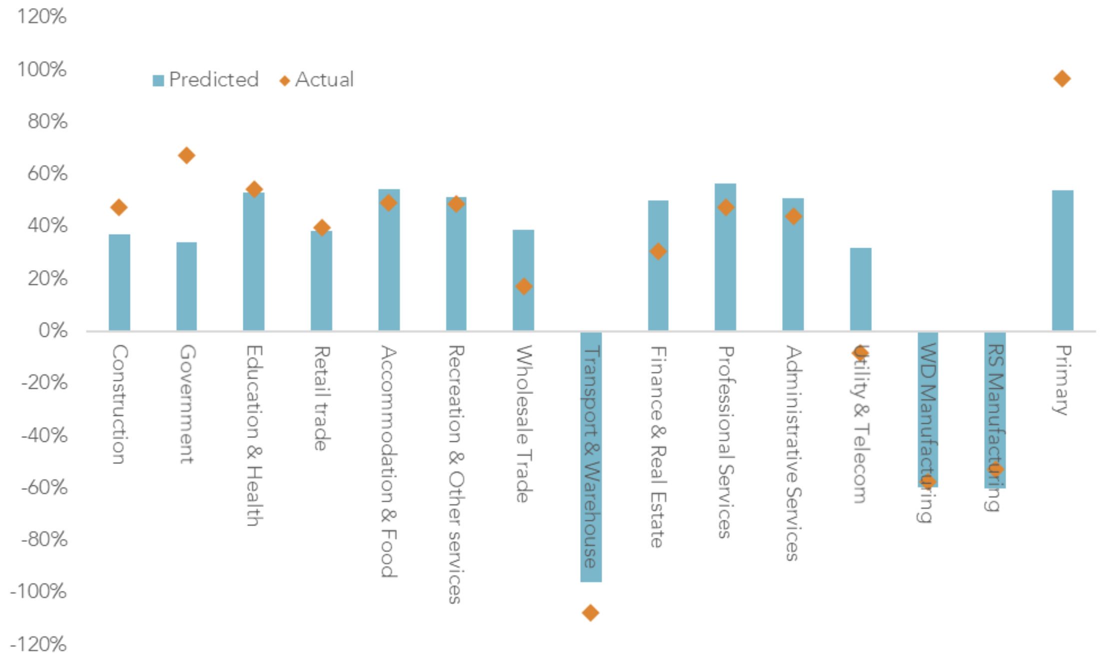
Putting these trends together, Auckland could have been expected to get 56% of the national increase in wholesale sector employment – essentially the average of the increase that occurred because Auckland got more people and the increase that occurred because the sector grew relative to other sectors. In reality, Auckland gained 79% of the national increase in wholesale sector employment. This means wholesale sector employment increased 42% faster in Auckland than could have been expected, as these jobs increasingly shifted to New Zealand's biggest city. In contrast, only 16% of the additional wholesale sector jobs were located in medium sized urban areas rather than the 25% that could be expected from their population increase and the national increase in wholesale sector employment.

Figure 2-1 Predicted and actual employment growth in Auckland



Source: Authors' calculations based on Stats NZ Census data, 1976–2013

Figure 2-2 Predicted and actual employment growth in medium cities



Source: Authors' calculations based on Stats NZ Census data, 1976–2013

The results of this comparison for Auckland and for all medium sized urban areas are shown in Figure 2-1 and Figure 2-2. The industries are aggregated into 15 sectors. There are three main findings. First, the figures show employment in Auckland and medium sized urban areas increased by the expected amount in the education and health, retail, accommodation and recreation and personal services sectors – sectors where the variance of the location quotients across urban areas is low because production is necessarily local and because the services are purchased in similar amounts in different places. Nationally, the fraction of employment in these sectors steadily increased from 32% to 42% between 1976 and 2013, and employment in these sectors in each type of city increased in proportion to its population growth.

Secondly, employment in the wholesale, financial services, professional services and utility sectors increased much faster in Auckland than in medium or small sized urban areas. Between 1976 and 2013, employment in these sectors increased from 16% to 31% of total employment in Auckland but only from 15% to 18% in medium sized areas.[7] The biggest increases in the size of these sectors occurred between 1976 and 1996, but Auckland has continued to increase its relative performance in these sectors since 1996. Auckland also had more rapid than expected employment in the transport and administrative services sectors.

Thirdly, manufacturing shrank much faster than could have been expected in Auckland, whereas it shrank less rapidly than expected in medium sized urban areas. Both Auckland and medium sized urban areas experienced significant absolute decline in manufacturing employment over the period, but they were relatively larger in Auckland than what could have been expected given its rapid population increase. In principle, Auckland's growing population could have offset some of its manufacturing job loss, but it did not.

These trends help explain the rapid expansion of big cities relative to smaller urban areas. The agglomeration benefits that favour a big-city location appear to be much greater for firms in the wholesale, financial services, and professional services sectors than they are for manufacturing firms. The rapid expansion of the wholesale, financial services, and professional services sectors that has taken place in all modern economies including New Zealand, combined with the preference of firms in

[7] Christchurch and Wellington are intermediate cases. Total employment in these four sectors increased from 22% to 29% in Wellington and from 15% to 22% in Christchurch over the period. In the 13 smallest urban areas, employment in these four sectors increased from 12% to 16%.

these sectors to locate in large cities, mean there has been a reallocation of employment away from smaller centres to Auckland and to a lesser extent to Wellington and Christchurch.

While agglomeration externalities may explain the growth of Auckland, differences in agglomeration externalities do not explain the different population growth rates among small and medium sized urban areas. Fast-growing service industries, such as banking and finance, did slightly better in the fast-growing small and medium urban areas than the slow-growing small and medium urban areas, but none of the small and medium urban areas did better than Auckland and all had a smaller share of jobs in the fast-growing service industries than would be expected given their population growth.

The rising importance of the education and health, retail, accommodation, and personal services sectors do not explain differential growth rates of small and medium sized urban areas either. These sectors do not appear to have strong agglomeration externalities or, if these externalities exist, they cannot be utilised as the services have to be produced locally. Rather, employment growth in these sectors is closely tied to population growth.

If the changing sectoral pattern of the economy does not explain the diversity of employment growth within medium sized cities, is there an alternative explanation? As we explore further below, it does not seem to be their initial industrial structure. Rather, a large fraction of the employment growth in medium sized urban areas reflects the exogenous population growth of each area. As Grimes et al (2016) argue, much of the difference in the growth rates of medium sized urban areas appears to stem from the rising importance of consumption amenities, such as a good climate and attractive scenery rather than their industrial structure.

2.4 Implications for employment churn

The interplay of the changing sectoral structure of employment and the changing regional location of employment can be analysed through a different lens – that of employment churn (Duranton 2007). Employment churn measures the extent people switch jobs from one industry to another and is usually compared to the overall change in employment in the city. Churn, $Churn_t^c = \frac{\sum_{i=1}^{65}|E_t^{ic}-E_{t-1}^{ic}|}{E_{t-1}^c}$, is calculated by adding up the (absolute) net employment change in each industry in a city and dividing by the initial employment in that city. The difference between employment churn and the change in total employment is excess churn, $XSC_t^c = \frac{\sum_{i=1}^{65}|E_t^{ic}-E_{t-1}^{ic}|-|E_t^c-E_{t-1}^c|}{E_{t-1}^c}$. For example, if a city lost 1,000 jobs in three industries and gained 500 jobs in ten industries, employment churn would be 8 000 (the total sum of the losses and gains experienced in all sectors), total employment would increase by 2 000 jobs and excess churn would be 6 000. The excess churn is the difference between the total number of new jobs in expanding industries and the net increase in new jobs (5 000 – 2 000) plus the 3 000 jobs lost in contracting industries. Excess churn is high when there is little net increase in the number of jobs in a city but a lot of job expansion and contraction in different industries.[8]

Excess churn should be lower in fast growing cities than slow growing cities, because industries that are contracting on a national basis may not contract locally if the increase in local demand stemming from an expanding local city population offsets the decline stemming a reduction in per capita demand. For example, the employment of car mechanics in a city may not decline if the city doubles in size even if there is a nationwide per capita decline in the demand for car mechanic services.

But churn can also be affected by city size. One reason why small urban areas may have higher excess churn than large urban areas is that employment can be quite "lumpy" if it depends on a few medium sized or large plants. If there are only one or two plants in a small city, people who lose their jobs when a firm contracts may find it more difficult to find employment in the same industry than if they lived in a large urban area. In this case they will either have to find employment in a different industry, leave the workforce, or move to another location (Coleman & Zheng forthcoming). The result may be a decline in the quality of the matching between the skills that an employee has and the skills that are required on a job. Poor matching may also occur if, in response to the rapid expansion of a sector, firms in a small city

[8] In each case, the number would have to be divided the total level of employment in the starting year to convert the numbers into percentages.

have to find employees from quite different industrial backgrounds to fill their vacancies. Using French and US data, Duranton (2007) showed excess churn declined with city size. Their evidence shows, in these two countries at least, people in small cities may adjust to economic change by moving between industries more frequently than they do in large cities, even if this leads to less efficient employment matching.

We use census data from 1976 to 2013 to estimate the employment churn rate for each city in New Zealand. The measure of churn depends on how finely industries are disaggregated. When industries are aggregated into broad sectors, measures of churn decrease because employment flows between different industries within the same sector are no longer picked up. We use two different aggregation levels: across 65 different industries; and across 15 sectors.

To analyse how churn depends on city size and city growth rates, we estimated two sets of regressions. In the first, the 37 years between 1976 and 2013 are treated as a single period, and each city's excess churn is regressed against its initial employment level and its average employment growth rate:

$$XSC^c = \alpha_0 + \beta_1 ln\left(\frac{E^c_{2013}}{E^c_{1976}}\right) + \beta_2\, ln(E^c_{1976}) + e^c \quad (3)$$

In the second, the excess churn measure is split into seven five-yearly components and each observation is regressed this measure against each city's beginning period employment level and employment growth rate plus a set of time dummy variables:

$$XSC^c_t = \alpha_0 + \sum_{\tau=1}^{6} \alpha_\tau D_\tau + \beta_1 ln\left(\frac{E^c_t}{E^c_{t-1}}\right) + \beta_2\, ln(E^c_{t-1}) + e^c_t \quad (4)$$

The coefficient estimates of the two sets of equations are presented in Table 8.

The estimated coefficients of equation 3 and equation 4 are very similar. In both cases there was a strong negative relationship between excess churn and the city growth rate and between excess churn and city size when the equations are estimated using data from 65 sectors. The effects are large and strongly statistically significant.

Table 2-6 The effect of city size and city growth rate on excess churn

	Constant	Ln(city growth)		
		Excess churn – whole period, 1976-2013		
Excess churn 65	0.32	-0.27	-0.017	N= 30
	(0.02)	(0.046)	(0.0020)	R^2 = 0.80
Excess churn 15	0.14	-0.16	-0.0068	N= 30
	(0.017)	(0.04)	(0.0018)	R^2 = 0.54
Excess churn 65	0.11	0.097	-0.0067	N= 30
Positive components	(0.02)	(0.050)	(0.0022)	R^2 = 0.32
Excess churn 65	0.20	-0.36	-0.010	N= 30
Negative components	(0.016)	(0.039)	(0.0017)	R^2 = 0.82
		Excess churn – separate 5 year periods with time dummies 1976-2013		
Excess churn 65	0.25	-0.23	-0.017	N= 210
	(0.02)	(0.081)	(0.0021)	R^2 = 0.67
Excess churn 15	0.12	-0.17	-0.0072	N= 210
	(0.019)	(0.063)	(0.0020)	R^2 = 0.48

Source: Authors calculations based on Stats NZ Census data, 1976–2013

These results mean that not only do slowly growing cities have higher excess churn than other cities, but small cities have higher excess churn than large cities. This indicates that small cities have more expansion and contraction in different industries for any level of net job change. The reasons for this difference are not clear, but it may reflect a greater propensity for people to change industries in small cities.[9]

When equations are estimated using data aggregated into 15 sectors, both coefficients are still negative and statistically significant, but the coefficients are only half as big. This suggests that half of the excess churn in small and slowly growing cities reflects people moving from one industry in a sector to a closely related industry within the same sector, while half reflects a movement from one sector to a completely different sector.

To explore why fast growing cities have less excess churn than slow growing cities, we decomposed the excess churn measure into two subcomponents corresponding to the sectors which had increases in employment and sectors that had decreases in employment. The results are also shown in Table 2-6. The coefficient indicating how the rate of city employment growth affects employment in expanding sectors ('positive components') is positive, and the coefficient indicating how the rate of city employment growth affects employment in contracting sectors ('negative components') is negative. This is to be expected as it indicates slowly growing cities experience worse employment shrinkage in contracting sectors and less rapid employment expansion in expanding industries. The size of the coefficient on contracting sectors is over three times as large as the size of the coefficient on expanding sectors, however, indicating the effect of city growth rate on employment churn is driven by sector-specific job contraction. These results make intuitive sense: for sectors that are facing national-level job losses, cities with rapidly increasing population will have lower overall job losses than slowly growing cities because the population increase provides them with additional demand. The smaller job loss reduces the need for people to move from one sector to another and so excess churn is less. The coefficients on city size are more equal, indicating the larger employment losses small cities experience in contracting industries are matched by larger gains in expanding industries.

The relationship between city size and job churn provides an additional perspective on the economic issues facing small urban areas. Small urban areas have been less able to partake in the expansion of several of the fastest growing service sectors than fast growing cities because they do not provide the agglomeration benefits these sectors enjoy from large cities. They also have larger cross-industry employment shifts, possibly because of the difficulty of finding employment in the same industry when a particular firm contracts. As Artuc, Chaudhuri and McLaren (2010) emphasise, people shift jobs for a large number of reasons, many which are not related to income. It appears that people in smaller urban areas are more likely to switch from one industry to another when they switch jobs. By definition such employment changes entail a loss of industry-specific skills, and while we do not investigate whether this leads to a reduction in productivity, there is evidence from New Zealand that it is associated with a slower increase in incomes than could otherwise be expected (Hyslop and Maré 2009).

[9] For a given level of employment change, higher excess churn means there are more job losses in sectors (either because there are more sectors with job losses or the average size of a job loss is bigger) and more job increases in other sectors (either because there are more sectors with job increases or the average size of a job increase is bigger). However, this does not necessarily mean people initially in the city are switching sectors. People in job-losing sectors could move to a different city but stay in the same sector, while people in job-increasing cities could be moving from similar sector jobs in other cities.

3 National versus city-level effects

The patterns in the previous section suggested that employment growth in the most rapidly growing service industries disproportionately favoured Auckland. The rapid growth of Auckland could thus be related to the global shift from manufacturing to service industries. In this chapter we tease out this story by asking three questions.

- How did employment shocks to different industries affect city-level employment levels? Did urban areas find it easier to adjust to some types of shocks than others?
- To what extent did the disparate employment growth across urban areas reflect differences in the shocks they received, particularly to the industries in which they were disproportionately specialised? Did some urban areas have good luck or bad luck by being over-exposed to industries that grew particularly fast or particularly slowly?
- To what extent have cities diversified their employment patterns since the 1970s. Were fast growing cities becoming more diversified across industries, or did they increase employment in the industries in which they were initially specialised?

We answer these questions in a series of steps. To examine how cities respond to employment shocks, it is first necessary to identify these shocks. We use the approach adopted by Bartik (1991), which defines a city-industry employment shock as the amount of employment a city would lose or gain in a particular industry if that industry contracted or expanded at the national average rate. However, for reasons explained below, we only focus on shocks to tradeable rather than non-tradeable industries. As explained in section 2.1 we distinguish tradeable and non-tradeable industries sectors on the basis of the size of their cross-city location quotient variances. To ensure this approach is valid, in section 3.1 we examine the extent that employment in each industry responds to changes in local demand, proxied by total employment in a city. If an industry is non-tradeable local employment in that industry should depend on local demand, whereas if it is tradeable local demand should be a less important factor. The evidence supports this contention, although the extent that widely distributed manufacturing is dependent on local demand is surprising.

The way employment shocks to a city's industries affect total employment is discussed in section 3.2, although many of the technical details are relegated to Appendix B. The results from this section, which are based on the Bartik methodology, suggest that cities that initially specialised in widely distributed manufacturing, such as clothing manufacture, adjusted to shocks to these industries much more easily than cities that initially specialised in regional-specialised manufacturing, particularly the processing of primary produce. The results are not as clear as we would like, but it appears cities that specialised in widely-distributed manufacturing found it much easier to make the transition to service sectors and as a result they have suffered less from the negative shocks to manufacturing experienced since the 1970s.

Section 3.3 adopts a different approach, although one that is related to the Bartik methodology employed in section 3.2. In this case, rather than examining how cities responded to employment shocks hitting particular industries, it examines the extent that these shocks explain how much employment increased in different cities. In broad terms, the answer is "not much"; rapidly growing cities expanded for reasons largely unrelated to their initial industrial composition, but grew for other reasons.

Lastly, section 3.4 examines the pattern of industrial diversification in different cities. The results from this section clearly show that employment in most cities has become a lot more diversified over time. Furthermore, it is largely possible to reject the contention that the fastest growing cities have become more specialised in their initial speciality over time, although a couple of small urban areas are counterexamples.

3.1 National and city-level effects on city-industry employment

The analysis in section 2.4 indicates that employment in several non-tradeable sectors, such as education or retailing, is found in similar proportions in all urban areas, suggesting that the change in employment in these sectors in an urban area is related to the change in the size of that urban area. Employment growth in other (tradeable) sectors is likely to be less dependent on the changes in the size of a city, as the goods and services can be produced elsewhere. Nonetheless, the local production of tradeable goods and services could be related to the size of the city if people had a strong preference for locally produced goods and services (even though other goods and services were available) or because an industry attracted a constant fraction of the workforce in all cities, even if this required significant adjustments in incomes in regions where there was relatively little demand for the locally produced product. In this section we ascertain if there is in fact significant difference in the importance of local demand for local employment in non-tradeable and tradeable sectors. As previously, we use the cross-city variance of location quotients to classify industries as tradeable or non-tradeable.

We use a statistical approach that is related to the well-known Bartik (1991) methodology that is used to estimate how shocks to employment in particular industries affect overall employment. The Bartik measure calculates the employment change that would occur in a city-industry pair if employment in the industry grew at the national average rate. It is often used as a proxy for the employment shocks that hit a local industry which can be attributed to nationwide factors. It is calculated as the expected change in the number of jobs in industry *i* in city *c* that would occur if employment in the industry grew at the national-average growth rate for that industry between time *t* and *t+k*:

$$B_{t+k}^{ic} = E_t^{ic} \times \left(\frac{E_{t+k}^{i}}{E_t^{i}}\right) = E_t^{ic} \times \left(1 + g_{t+k}^{i}\right) \qquad (5)$$

In practice, the Bartik employment growth measure in industry *i* and city *c*, g_{t+k}^{i}, can have very large values if the starting employment value is zero or very small. To sidestep this problem, we calculate a growth index by dividing the *t+k* value by the average value over the two periods:

$$d_{t+k}^{i} = \frac{E_{t+k}^{i} - E_t^{i}}{(E_{t+k}^{i} + E_t^{i})/2} = \frac{2g_{t+k}^{i}}{(2 + g_{t+k}^{i})} \qquad (6)$$

The Bartik measure for an industry-city pair can be further refined by excluding each area's contribution to the national-average growth rate:

$$B_{t+k}^{i\tilde{c}} = E_t^{ic} \times \left(\frac{E_{t+k}^{i} - E_{t+k}^{ic}}{E_t^{i} - E_t^{ic}}\right) = E_t^{ic} \times \left(1 + g_{t+k}^{i\tilde{c}}\right) \qquad (7)$$

$$d_{t+k}^{i\tilde{c}} = \frac{(E_{t+k}^{i} - E_{t+k}^{ic}) - (E_t^{i} - E_t^{ic})}{\left((E_{t+k}^{i} - E_{t+k}^{ic}) + (E_t^{i} - E_t^{ic})\right)/2} \qquad (8)$$

In a typical regression, the change in employment in an industry i in a particular city c (d_{t+k}^{ic}) is regressed against the change in employment that is predicted from the national change in employment in industry i, where the latter is calculated exclusive of any change in employment in industry i in city c. This regression estimates how much of the variation in city-industry employment growth rates is explained by national factors affecting the industry.

In this section we adopt a different approach. We regress the change in employment in an industry i in a particular city c (d_{t+k}^{ic}) against the change in total employment in that city, again excluding any change in employment in industry i in city c. This regression examines how much local demand, proxied by the growth of employment in the city in other industries, affects employment in a particular industry.

Formally, if the growth rate of city employment (excluding employment in industry i) is…

$d_{t+k}^{\tilde{ic}} = \frac{(E_{t+k}^{c}-E_{t+k}^{ic})-(E_{t}^{c}-E_{t}^{ic})}{\left((E_{t+k}^{c}-E_{t+k}^{ic})+(E_{t}^{c}-E_{t}^{ic})\right)/2}$ and $\{D_k\}$ is a set of year indicator variables

we estimate that…

$$d_{t+k}^{ic} = \alpha_i^0 + \sum_{k=2}^{T} \delta_i^k D_k + \beta_i d_{t+k}^{\tilde{ic}} + e_{t+k}^{ic} \qquad c = 1,\dots,N \quad k = 1,\dots,T \tag{9}$$

The time indicator variables allow the average growth of an industry to vary through time. The coefficient β_i is the main coefficient of interest and measures the extent that employment growth in a city affects employment in the i^{th} industry in that city. For non-tradeable sectors we expect $\beta_i = 1$, whereas if production is largely sold outside an urban area we expect $\beta_i = 0$. The equation is estimated using weighted least squares, where the weights are employment in each area.

In addition to the coefficient β_i we also report the R^2 and the marginal R^2 of the regression. The R^2 of the regression indicates how much of the variation in city level employment growth in an industry can be explained by the time indicator variables (that is, variation in the average industry growth rate through time) and overall city employment growth. The marginal R^2 indicates the fraction of the variation in city growth rates that is not explained by differences in the average growth rate over time that is explained by city employment growth.

Table A.3 (in Appendix A) shows the results of the regressions for each industry arranged by the standard deviation of the cross-city location quotients. Table 3-1 shows the average coefficient for the 16 industries in each of the quartiles, from the quartile with the lowest cross-city standard deviations to the quartile with the highest cross-city standard deviations. It also provides a summary for five aggregate sectors.[10] These sectors are: the widely distributed and regionally specialised manufacturing sectors; the primary sector; and the remaining service industries, divided into the Other-WD (widely distributed) sector (comprising service industries with location quotient variances in the lowest two quartiles) and the Other-RS (regionally specialised) sector (comprising service industries with location quotient variances in the upper two quartiles).

Table 3-1 Effects of industry and city employment changes on city-industry employment patterns (quartile and sector means)

	Number of industries	LQ std deviation	β_i (city employment)	R^2	Marginal R^2
		Quartiles			
Q1	17	0.25	0.91	0.66	0.15
Q2	16	0.37	0.88	0.62	0.10
Q3	16	0.68	0.68	0.55	0.07
Q4	16	2.75	0.09	0.38	0.02
		5-Sector split			
Other WD	30	0.30	0.89	0.65	0.13
Other RS	11	0.77	0.60	0.61	0.08
Manufacturing WD	9	0.53	0.91	0.51	0.06
Manufacturing RS	7	2.78	0.20	0.33	0.03
Primary	8	2.92	-0.10	0.36	0.02

Source: Authors' calculations based on Stats NZ Census data, 1976–2013

Note:

1. The regression R^2 is the fraction of city-industry employment growth explained by time effects and city employment growth. The marginal R^2 is the fraction of city-industry employment growth not explained by time effects that is explained by city employment growth.

[10] A set of regressions was estimated when the variables were expressed in growth rates. The results are similar and are available on request.

The regressions show that industry-specific city-level employment changes are strongly correlated with city level employment changes in the non-tradeable industries with the lowest cross-city location quotient standard deviations. For most industries in the Other-WD and Manufacturing-WD sectors, the estimated coefficients β_i on the city-level employment growth variable are near 1, indicating that industry-specific city-level employment rises and falls in tandem with total city-level employment. This result is expected for industries in the Other-WD group as service sector employment should depend primarily on the size of the local market. For example, retail employment in Dunedin should rise and fall with changes in Dunedin's total employment.

The results for industries in the Manufacturing-WD sector suggest that a large fraction of the output of this sector is also sold locally. In contrast, the average coefficients of the Other-RS, Manufacturing-RS and Primary Sectors are 0.60, 0.20, and -0.10 respectively. These coefficients indicate local demand is much less important for these industries, particularly in the regionally specialised manufacturing and primary sectors. Moreover, in these last two sectors the amount of the variation in employment that is explained by city level employment changes is very small, as shown by the very low marginal-R^2 statistics.

Perhaps the most interesting result of these regressions is the extent that widespread manufacturing industries are affected by local demand. While the result is perhaps not surprising, since these manufacturing sectors are widespread, it sits somewhat uneasily with the results in Table 2-3 and Table 2-4 that show there was little difference in the growth rates of widespread manufacturing employment in small and medium towns that grew at quite different rates. The difference may reflect the importance given to Auckland, Wellington, and Christchurch in the weighted regressions, particularly as the manufacturing-WD sector is overweight in these centres.

These results have another somewhat arcane implication. In the next section, we use the Bartik methodology to explore how nationwide industry shocks after employment in local markets. It would be nice to be able to explore these effects for all industries. The results of this section suggest it may not be sensible to use this methodology to examine employment in non-tradeable sectors. This is because when local demand is a large determinant of local employment in a particular industry, nationwide shocks to the industry will reflect nationwide growth in employment, which in turn reflects nationwide growth in population. Yet there is no reason why the growth of a non-tradeable sector such as retailing in a slow growing city should reflect national growth in the retailing sector, if the latter largely responds to national population growth. If retailing in New Zealand has expanded by 50 percent because of the national population increase, it does not mean retailing in Dunedin should increase by 50 percent since the latter city has had much less population growth. For this reason, in the next section we focus on the way that employment shocks to the manufacturing and primary sectors have affected employment in other markets.

3.2 The employment effects of shocks to manufacturing and primary industries

In this section we report estimates of how shocks to manufacturing and primary industries affected city-level employment between 1976 and 2013. For reasons explained in the next paragraph, the details of the estimates are presented in Appendix B, and we provide a summary in this section. While our focus is the manufacturing and primary sectors, we use the same method to investigate shocks to other industries on city level employment. We are much less confident about these results, however, because the measure of employment shocks in these industries is likely to be much less accurate than in the primary and manufacturing industries. This is because employment in many service sectors is dominated by local demand factors, and our measure of nationwide shocks for these industries may not be very good.

The methodological basis for the regressions presented in this section has been frequently used by researchers. In principle it is similar to the approach used to understand the effects of manufacturing employment shocks that occurred in U.S. cities because of Chinese competition that was reviewed in the introduction. Unfortunately, our attempt to estimate how declines in manufacturing employment affected city-level employment in other sectors have proved particularly problematic. Part of the issue is the relatively small number of cities in New Zealand. Part of the issue is also some misplaced ambition, in which we attempted to use the technique to explore how employment shocks to non-manufacturing sectors affected city level employment. After some time we lost confidence in these results. For these and other reasons, the authors do not wish to overplay the results reported in this section and Appendix B. In the course of preparing this section we estimated a very large number of regressions involving a large number of combinations of dependent variables, independent variables, period lengths, aggregation levels, dummy variables and fixed effects. There were choices to make about whether the Bartik measures should or should not include Auckland's employment changes, and whether each city's employment changes should be included or excluded in its own Bartik measure. We estimated but have not reported regressions which included city size as an additional variable, which produced different results because of multicollinearity. We have redone regressions when the results indicated obvious programming errors but may have been less vigilant about programming errors when the regression results conformed to our expectations. We have estimated the equations using ordinary least squares, weighted least squares, and with and without two potential outliers, Queenstown and Tokoroa. We have had long arguments about the meaning of the Bartik measure for non-tradeable sectors. We have entertained doubts whether the equations have serious omitted variable bias. In short, while we are not unhappy with the final specifications we have chosen, we are not sure about their statistical significance and would not wish to base important policy decisions upon their results. This is not a satisfactory result, but given how this part of the project evolved, it would be remiss for us to pretend otherwise. Sometimes research does not proceed smoothly, and this was one of those occasions.

The basic issue we wish to investigate is the way urban areas responded to exogenous employment shocks in their key industries. Given the large size of the manufacturing industry in most cities in 1976, the key shocks concern the loss of manufacturing jobs. Did the response to these largely negative employment shocks depend on the type of industry that received the shocks or the characteristics of the city in which the industry was located? To examine this issue properly it is necessary to have a way of identifying shocks that occurred for reasons that were exogenous to the characteristics of the city. To discover that a particular city did not respond to the loss of manufacturing jobs would not be particularly helpful, for example, if the manufacturing jobs were lost for reasons to do with deep-seated problems in the city's economy, problems that prevented the successful development of other sectors. The Bartik methodology is a popular way to identify shocks to a city's manufacturing employment that can be plausibly attributed to exogenous reasons.

The Bartik shock to employment in a particular industry and city is calculated by estimating how employment would have changed in the city if the industry grew at the same rate as the industry in *other* cities. The reasoning is that if an industry is contracting or expanding nationwide, it is unlikely that local changes in employment in that industry are due to the economic climate of the city. The size of the shock is adjusted for the size of the industry in the city (using location quotients), so if a city has a large initial exposure to a particular industry, it is assumed to receive a particularly large shock. The shock to a city's total employment in a sector is calculated by adding up the shock to each of the industries in the sector: In the analysis below we convert the growth rate into a growth index: This measure was first used by Bartik (1991) and is now widely used as a measure of a shock to a city's employment that reflects national-industry rather than firm-specific or city-specific factors.

The Bartik identification strategy is best in circumstances where there is an obvious nationwide shock, such as the increase in Chinese import competition or a reduction in protective tariffs. It is less appropriate where average nationwide changes in employment in an industry are not likely to be representative of employment in an individual city's employment in that industry. If employment in some industries primarily depends on the size and income of the local population (as was established above), nationwide employment in the industry will partly reflect population changes in the rest of the country as well as changes in the industry's share of total employment. However, there is no reason why local population growth is strongly correlated with national population growth. If local population growth is not highly correlated with national population growth, which it is not, changes in national employment growth in a service sector will not be a good proxy for local employment demand in this sector. For this reason, employment shocks to tradeable industries are likely to be better proxied by the Bartik measure than employment shocks to non-tradeable sectors.

We examine the effect of national employment shocks on local employment levels by splitting the data into five basic sectors: the primary sector, two manufacturing sectors, and two service sectors. We estimate the effect of the sector shock on local same-sector employment, on local employment in other sectors (each of the four other sectors separately plus the four sectors combined), and total employment in the city. Consider a manufacturing sector. The first estimate examines the extent that local employment in the manufacturing sector is correlated with the national employment in that sector. The second estimate examines the extent that a shock to manufacturing leads to changes in jobs in other sectors. The third estimate measures the total change in employment in the city in response to the nationwide employment shock. The effects are estimated over successive five-year periods. In the appendix we report the results of the regressions for each of the five sectors.

For each of the sector shocks, there are three key issues, each measured by a regression coefficient. The first is the size of the own-sector coefficients β^{ii} (for example, the effect of a nationwide manufacturing shock on local manufacturing employment.) These coefficients measure the extent that sector-specific employment is correlated across the country. If actual sector-specific city-level employment levels change by the amount predicted by sector-specific employment trends in the rest of the country, the own-shock coefficient β^{ii} will equal 1.

The second issue is the extent that a shock to employment in one sector affects employment in other sectors. This is represented by the coefficients $\beta^{\tilde{\imath}i}$ (for example, the effect of a shock to manufacturing on employment in all other sectors). If $\beta^{\tilde{\imath}i} < 0$, employment changes in other sectors *offset* employment changes in the sector receiving the shock, whereas if $\beta^{\tilde{\imath}i} > 0$ a change in employment stemming from a shock in one sector is *intensified* by a gain or loss of jobs in other sectors. The latter is a multiplier effect, which might occur, for example, because a reduction in employment in one sector reduces the demand for goods and services in other sectors.

The third issue is the extent that a shock to one sector affects total employment in the urban area. This is represented by the coefficients β^{Ei} (for example, the effect of a shock to manufacturing on total employment). There are a range of possibilities for the coefficients β^{Ei}. If $\beta^{Ei} > 1$, multiplier effects dominate. If $\beta^{Ei} = 0$, total employment in a city does not change in response to the shocks affecting individual industries as workers switch between sectors. Lastly, β^{Ei} may be negative if employment is increasingly concentrated in a few cities as some cities systematically increase their size at the expense of others.

There are various ways the regressions can be estimated. The first choice is the number of cities to include in the regression. If we include Auckland, there are 30 urban areas, or otherwise there are 29. We report regressions excluding Auckland because if employment in Auckland expanded at the expense of employment elsewhere then its employment changes will be different to those in the rest of the country.

The second choice is whether the measure of the Bartik shock includes or excludes Auckland employment growth. Our preferred choice is to include Auckland, as we believe this provides a better indication of the size of the shocks hitting each industry in the country, but we also estimated the model with Bartik shocks calculated with Auckland excluded. We found little difference in the two sets of estimates, although we would expect the coefficient on the Auckland-inclusive Bartik measure to be less positive if Auckland's employment growth occurred at the expense of smaller cities. The regressions were estimated using weighted least squares, with weights proportional to average city employment.

The results for manufacturing

The estimated own-shock coefficients β^{ii} for the two manufacturing sectors are each close to and insignificantly different from $\beta^{ii} = 1$. In both cases this means a city's manufacturing employment covaries fully with manufacturing employment in the rest of the country. Moreover, in both cases there are offsetting changes in employment in other industries (indicated by the coefficient $\beta^{\tilde{\imath}i}$) so that total employment in a city changes by much less than manufacturing employment. However, the size of the offsetting response seems to be a lot larger for widely distributed rather than regionally specialised manufacturing industries.

The evidence for the different size of the offsetting response is three-fold. The first evidence, which is weakest, is the size of the estimated cross-sector coefficients $\beta^{\bar{i}i}$ between the manufacturing shock and local employment in other sectors. These coefficients are -1.48 (with a 95% confidence interval of -0.3 to -2.7) for widely distributed manufacturing industries, and -0.60 (with a 95% confidence interval of 0.2 to -1.4) for regionally specialised manufacturing industries. While the difference in these estimates is large, the large standard errors mean it is not possible to reject the hypothesis that the aggregate employment responses to the shocks are the same.

More conclusive evidence comes from the regression in which the employment change in the widely distributed service sector is regressed against the shocks to the five different sectors. The coefficient estimates show negative shocks hitting widely distributed manufacturing industries were offset by a larger expansion of employment in the widely distributed service sectors than shocks hitting regionally specialised manufacturing industries. The coefficient estimates are -1.36 (standard error = 0.44) and -0.24 (standard error = 0.25) respectively and the hypothesis that the coefficients are the same can be rejected.

The third evidence comes from disaggregating the sector-specific employment changes into 15 sectors and estimating a new set of regressions linking employment change in each sector to the five different sector shocks (see Table B.1 in Appendix B). While most estimates of the coefficients are imprecisely estimated, all the coefficients between the ten private-sector service sectors and the widely distributed manufacturing shocks are negative and the coefficients for retail trade and banking and finance are both sizeable and statistically significant.[11] In contrast, only five of the coefficients between the ten private-sector service sectors and the regionally specialised manufacturing shocks and are negative, none are statistically significant and eight of them are larger than the corresponding coefficients for widely distributed manufacturing. This evidence is consistent with the evidence reported above that the shocks hitting widely distributed manufacturing industries were offset by increases in service sector employment by a much larger extent than the shocks hitting regionally specialised manufacturing industries.

The overall employment response to the different types of manufacturing industries are quite different in magnitude. Consider a shock that is forecast to reduce manufacturing employment by 100 jobs. The point estimates in the last row of Table B.1 indicate that total employment *reduced* by 36 jobs if the shock reduced a regionally specialised manufacturing industry, but total employment *increased* by 60 jobs if the shock hit a widely distributed manufacturing industry. This difference primarily reflects the difference in the amount of offsetting employment in the widely distributed service sectors.

The size of the positive estimate, which indicates negative employment shocks to widely distributed manufacturing industries were associated with rapid overall employment growth, is puzzling. The disproportionate growth of Auckland's service sectors since 1981 is not part of the explanation as these regression results do not include Auckland as a dependent variable. It is possible that the size of the coefficient reflects the effect of city size, because small towns have below average employment in widely distributed manufacturing sectors and below average employment growth in professional service and banking industries. Unfortunately, our ability to examine whether the responsiveness to manufacturing employment shocks systematically differed with the size of cities is undermined by the large degree of multicollinearity between the size of cities and the fraction of their employment in regionally specialised and widely distributed industries. Nonetheless, the statistical evidence that there is a much smaller increase in service sector jobs when 'regionally specialised' manufacturing plants shut down relative to when 'widely specialised' manufacturing plants shut down is consistent with the stories

[11] The ten service sectors are construction; retail trade; hospitality and accommodation; recreation services; wholesale trade; transport; banking and finance; professional services; administrative services; and utilities.

from small towns such as Greymouth and Tokoroa about the difficulties of creating new jobs following major job losses in their manufacturing industries

The results for the primary sector

The estimates of the effects of primary sector employment shocks are different. The estimated own-shock β coefficient is 0.63 (with a 95% confidence interval of 0.4 to 0.8) which indicates local primary sector employment does not fully covary with national level industry shocks. There is a positive correlation between primary sector employment shocks and employment in other sectors suggesting weak multiplier effects, although the coefficient is not significantly different from zero. In combination, total employment changes by the same amount as the predicted shock: that is if a city is forecast to lose 100 jobs due to a primary sector shock, our estimates suggest it loses 108 jobs of which 63 are in the primary sector and a further 45 in other sectors. These coefficients are not very precisely estimated, but, unlike the situation for manufacturing employment shocks, there is no evidence that jobs expand in other sectors to compensate for losses in the primary sector.

Summary

It is worth reminding the reader of some of the qualifications we have expressed regarding these estimates. Nonetheless, the results seem consistent with the other findings in the paper. In particular we estimate that there has been a considerable difference in the response to negative employment shocks hitting widely-distributed manufacturing sectors – the types of manufacturing that was previously found in New Zealand's larger cities – and negative shocks hitting the regionally specialised manufacturing sectors favoured by New Zealand's smaller towns. The employment shocks to widely distributed manufacturing employment tended to be offset by changes in other employment, so total employment changes by less than the shock. The negative employment shocks to the widely distributed manufacturing industries that were a feature of New Zealand's larger urban areas were absorbed by expanding specialist service industries. In contrast, the employment shocks to regionally specialised manufacturing industries were absorbed less well and were not associated with expansions in specialist service industries. Since these manufacturing industries are disproportionately located in smaller towns, smaller urban areas had a much more difficult transition to the decline in manufacturing than larger urban areas

These results are in line with overseas evidence that suggest cities have a more difficult time adjusting to regionally specialised manufacturing job loss than other types of job loss. Polèse and Shearmur (2006) discuss this phenomenon with respect to small cities that are dominated by a single firm, but Glaeser, Kerr and Kerr (2015) suggest that the problem may occur in large cities with a history of specialised manufacturing as well. Unfortunately, the high correlation between regionally specialised industries and the size of cities in our dataset have prevented us from untangling the extent to which the different rate at which manufacturing employment shocks were absorbed in New Zealand between 1976 and 2013 was primarily an industry effect or a small city effect. As emphasised in the disclaimer at the beginning of the Appendix, questions remain about the robustness and statistical significance of the results. Nevertheless, the results as presented here support the contention that small urban areas that were specialised in primary product manufacturing were less successful than larger urban areas in diversifying into other industries when they experienced negative employment shocks to their manufacturing industries.

3.3 Shift-share analysis

Shift-share analysis is used below to further decompose regional growth patterns into components that reflect national trends and components that reflect local factors. We use the shift-share technique developed by Esteban-Marquillas (1972) which decomposes urban area employment growth into two national-trend components and two local components. An urban area's growth is split into these four factors as follows:

$$g_t^c = \frac{\Delta E_t^c}{E_{t-1}^c} = \frac{\sum_i \Delta E_t^{ic}}{E_{t-1}^c} = \frac{\sum_i NG_t^{ic} + IM_t^{ic} + AL_t^{ic} + DM_t^{ic}}{E_{t-1}^c} \quad (10)$$

where E_{t-1}^{ic} is employment in industry *i* and city *c* at the previous period, g_t is the national average rate of total employment growth, g_t^i is the national average rate of employment growth in industry *i*, and g_t^{ic} is rate of employment growth in industry *i* and city *c*.

The national average growth rate component is a measure of the amount an urban area would grow if each industry was the average national size and it grew at the national average rate:

$$NG_t^{ic} = \left(E_{t-1}^c \times \frac{E_{t-1}^i}{E_{t-1}}\right) \times g_t^i \quad (11)$$

The effect is calculated for each industry separately and then added together. This term is the same for all cities. The term $\left(E_{t-1}^c \times \frac{E_{t-1}^i}{E_{t-1}}\right)$ in equation 11 is sometimes called the homothetic employment level or the level of employment a city would have if the industry employed the same fraction of people as the national average.[12]

The industry mix effect is a measure of the amount an industry grows in an urban area that takes into account the extent the area is overrepresented or underrepresented in a particular industry:

$$IM_t^{ic} = \left[E_{t-1}^{ic} - \left(E_{t-1}^c \times \frac{E_{t-1}^i}{E_{t-1}}\right)\right] \times g_t^i \quad (12)$$

This term is also calculated separately for each industry and then added together. This term is different for each city and measures the extent a city grows because it is initially specialised in sectors that grow either faster or more slowly than average.

These two terms reflect the extent that employment in an urban area is due to national industry trends. The term NG_t^{ic} captures average national growth and is equal for all areas. The industry mix term, IM_t^{ic}, captures the effect of local industry structure on regional employment growth and is conceptually close to the Bartik measure as the aggregate measure will be positive if an area is overrepresented in fast growing industries and negative if it is overrepresented in slow growing industries.

The first local component is the convergence factor AL_t^{ic} (also known as the allocative effect):

$$AL_t^{ic} = \left[E_{t-1}^{ic} - \left(E_{t-1}^c \times \frac{E_{t-1}^i}{E_{t-1}}\right)\right] \times \left(g_t^{ic} - g_t^i\right) \quad (13)$$

This is a measure of the extent that employment in an industry grows faster or slower than average because it is converging to the national employment rate.

The last term is the dynamic employment growth factor DM_t^{ic} (also known as the competitive effect)

$$DM_t^{ic} = \left(E_{t-1}^c \times \frac{E_{t-1}^i}{E_{t-1}}\right) \times \left(g_t^{ic} - g_t^i\right) \quad (14)$$

This is a measure of the extent that an industry grows faster in a particular urban area than the national average rate.

The two local terms capture the extent that an urban area's growth reflects local rather than national industry factors. The convergence effect, AL_t^{ic}, captures the extent that an urban area's industrial mix is diverging or converging to the national average. This term is negative if an urban area's employment in an industry is converging to national levels either because it is growing more quickly than average in industries in which it was initially under-represented, or it is growing more slowly in industries in which it was initially overrepresented. Conversely, this term will be positive if an urban area has above average growth in industries in which it was initially overrepresented, or if it is growing slowly in industries in which it was initially underrepresented. The dynamic employment growth factor, DM_t^{ic}, essentially

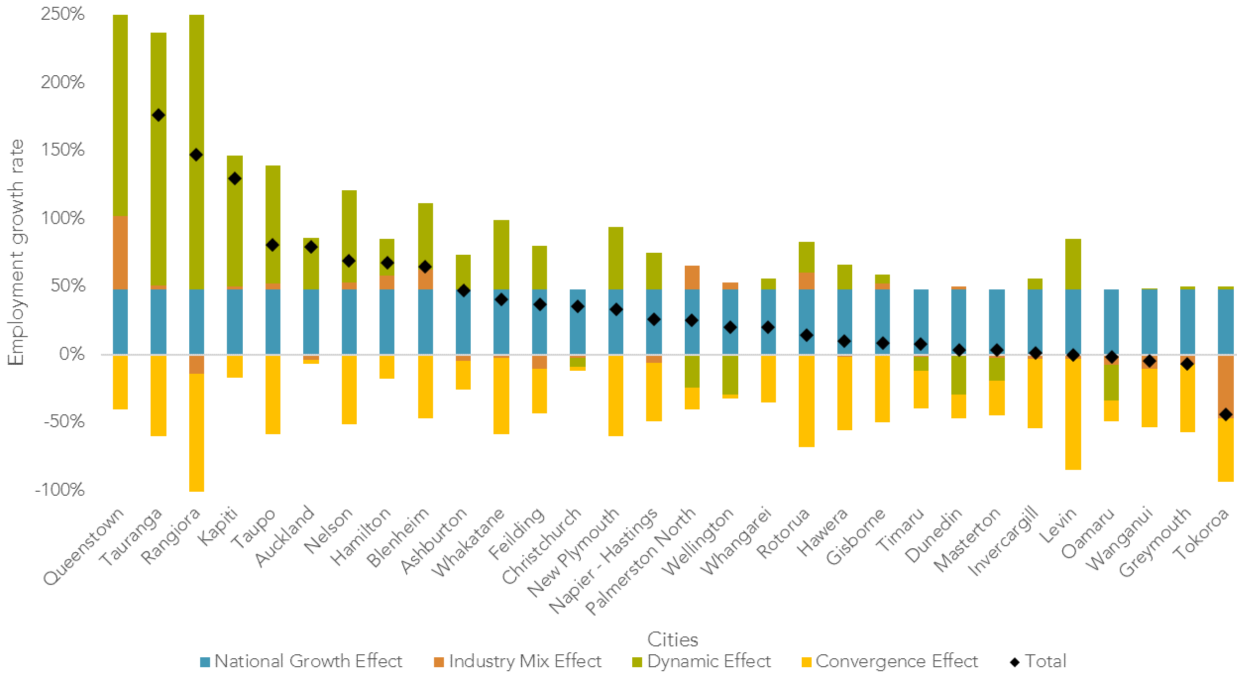
[12] This condition is equivalent to saying that the location quotient for the industry is equal to 1.

captures the extent city-industry employment growth exceeds average industry growth at the national level. It is positive if an area grows more rapidly than average for reasons other than the area's particular mix of industries and negative if the area grows at lower than average rates. In many ways it is best considered a residual term, for while it measures how much faster or slower employment in an urban area grows than the national average (adjusted for the urban area's particular industry mix) it does not explain why it is growing more rapidly or slowly than average.

We calculated these four shift-share components for all 65 industries and then aggregated the results for each urban area. The following analysis primarily refers to employment changes over the whole period (1976 to 2013) but we also undertook separate analyses for the 1976–1996 and 1996–2013 periods.

Figure 3-1 shows the shift-share decomposition for each urban area for 1976-2013, ordered by total growth rate. Each urban area is represented by a bar split into the four components, some negative and some positive, and the actual level of employment change shown as a dot in the bar. (Note that the total growth for Queenstown is not shown in the figure as to improve the clarity of the results the maximum growth is 250%.)

Figure 3-1 Shift-share analysis on city employment growth rate, 1976-2013



Source: Authors calculations based on Stats NZ Census data, 1976–2013

Note:

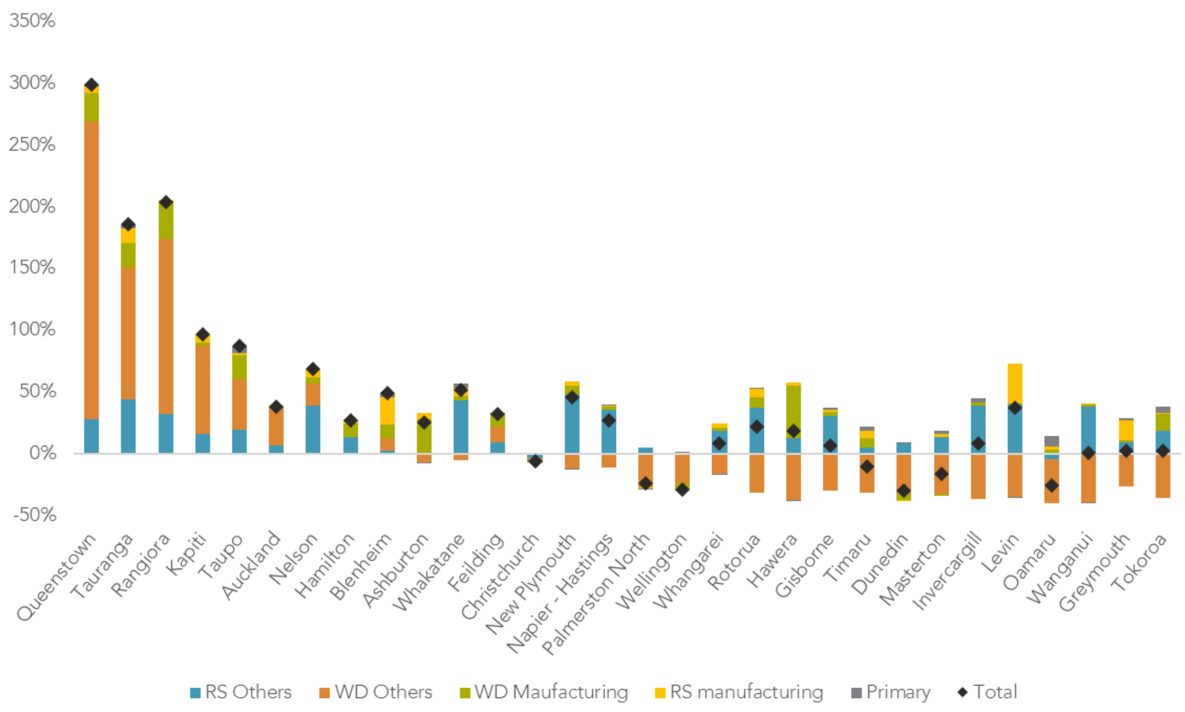
1. The total employment growth of Queenstown is not shown as the graph is truncated at 250%

First, the industry mix measure is very small relative to the other components. One way of measuring this is to compare the average (absolute) size of the different components. The average size of the dynamic effect is about the same size as the average size of the convergence effects, but the average size of the industry mix effect is only a quarter of either of these components. Quite simply, differences in the initial mix of industries do not explain much of the differences in cross-city growth rates, only about 10%. Secondly, since the industry mix effect is small, it follows that most of the variation in growth rates around the national average reflects idiosyncratic city-specific effects unrelated to the initial industrial mix – the convergence (AL) and dynamic employment growth (DM) terms.

Figure 3-1 shows that the convergence term is negative for all cities, indicating each urban area experienced some sort of industrial convergence. Figure 3-2, which splits the convergence term for each urban area into components associated with overrepresented industries and underrepresented industries, shows that industrial convergence occurred in most urban areas because employment in underrepresented industries increased faster than average, rather than because employment in overrepresented cities increased more slowly than average. (Queenstown is one of the few exceptions where employment in overrepresented tourism industries expanded faster than average, but even in this case there was convergence with other cities because employment in underrepresented industries also increased faster than average.)

Less apparent from Figure 3-2, there is a negative cross-city correlation between the dynamic employment growth and the allocation terms. As this means the fastest growing cities have the largest convergence effects, it suggests that fast growing cities are characterised by faster than average growth in their initially underrepresented industries and slow growing cities are characterised by slower than average growth in their overrepresented industries.

Figure 3-2 The dynamic effect by five broad sectors across 30 cities

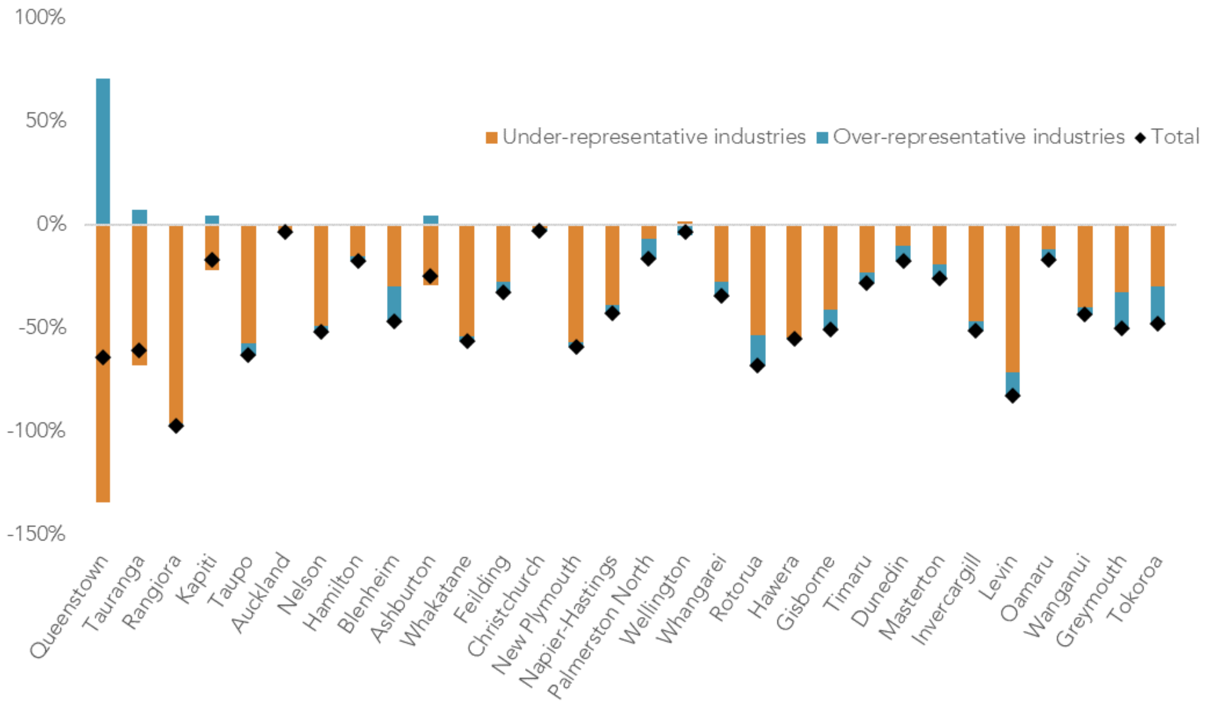


Source: Authors calculations based on Stats NZ Census data, 1976–2013

Note:

1. "RS Others" are non-manufacturing and non-primary industries in the quartile 2 and 3 of location quotient standard deviation Table A.1. "WD Others" include industries in the quartile 1 of location quotient standard deviation

Figure 3-3 The convergence effect by under- and over-representative industries across 30 cities



Source: Authors calculations based on Stats NZ Census data, 1976–2013

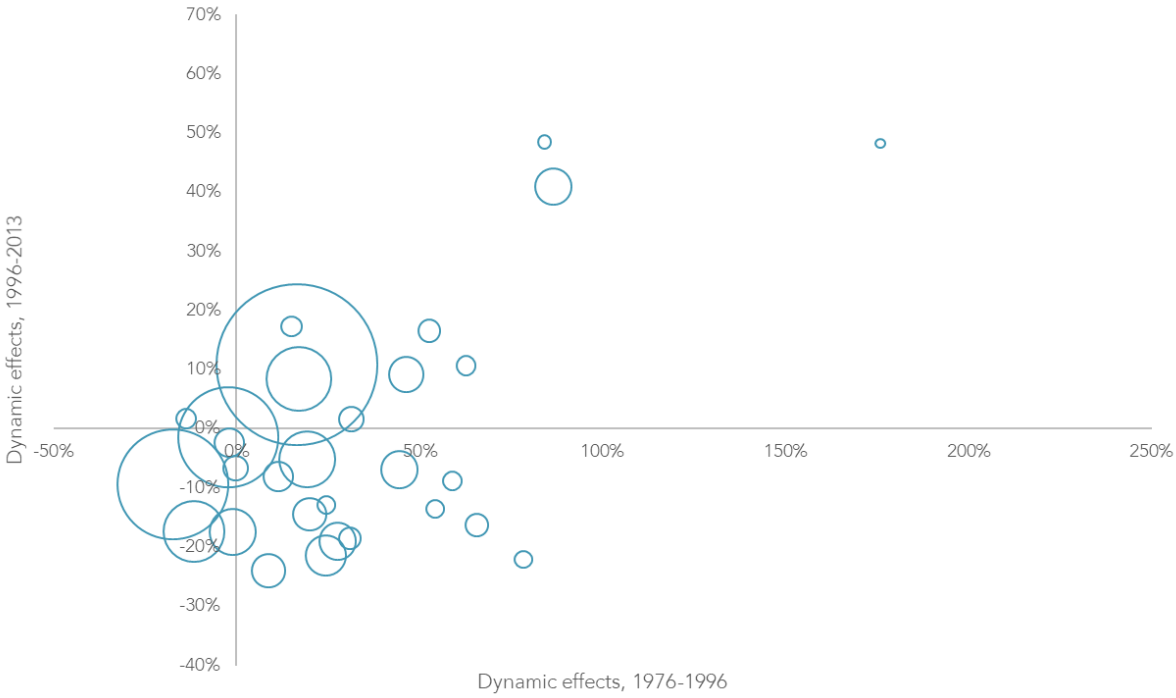
Note:

1. Industries with location quotients greater than 1 in 1976 are specialised industries. Otherwise, they are non-specialised industries.

The residual dynamic employment growth factor can be disaggregated into five broad industrial sectors (Figure 3-3). This indicates the widely distributed service sector, which comprises locally-traded industries such as residential construction and retailing, is the largest component of the dynamic employment component. This is particularly true for the four fastest growing urban areas (Queenstown, Tauranga, Rangiora and Kapiti) shown on the far left of the graph. In contrast, the dynamic employment growth factors of cities with slow population growth are much weaker. The result is consistent with the regression analysis in section 3.1, which showed that the widely distributed service sector industries are highly responsive to local population change. Unfortunately, however, even though this decomposition shows that the employment growth in the fastest growing cities reflects much faster growth in employment in widely distributed service sectors, it does not explain why this growth occurred in these cities and not others.

The residual dynamic employment factor is persistent over time. Figure 3-4, which shows the correlation between the size of the dynamic employment growth factors in the 1976-1996 and 1996-2013 sub-periods, indicates that the series are positively correlated. An implication of this strong correlation is that the initial industrial mix was not important in either 1976 or 1996. It This further suggests that the much of the strength of the persistence in employment growth rates can be traced to local factors other than a city's mix of industries.

Figure 3-4 Correlation of the dynamic effects, 1976-1996 and 1996-2013



Source: Authors calculations based on Stats NZ Census data, 1976–2013

Note:

1. Dot size is set to total city employment in 2013

To summarise, the shift-share analysis shows an urban area's initial industrial mix only explains a small component of its overall employment growth. Idiosyncratic factors unrelated to its initial specialisation are more important. While it is possible to trace the effect of shocks to particular industries on employment growth, they do not appear to be a major determinant of this growth. Other local factors are more important. The data also suggest that urban areas are converging in their industrial structure, as in most cases industries grow fastest where they are initially smallest. This suggests urban areas have been diversifying their industrial structure rather than relying on local specialist industries. This is explored in more detail in the following section.

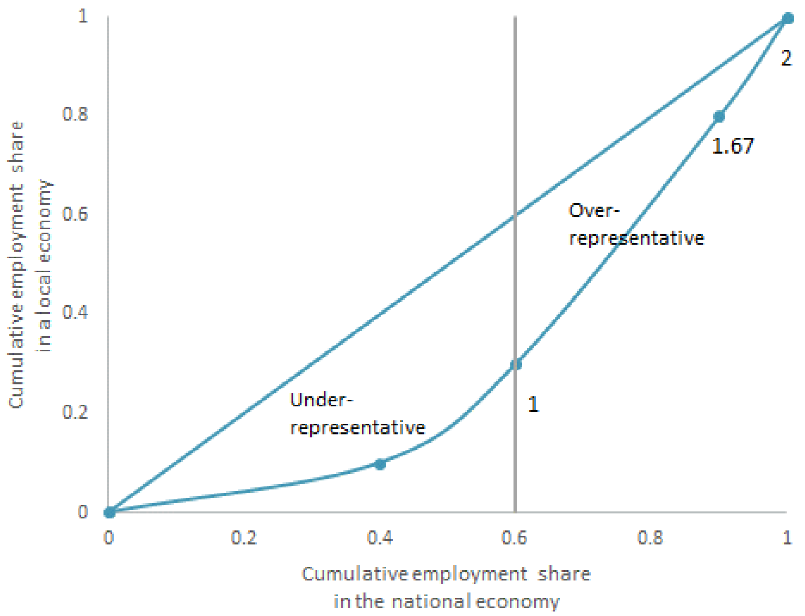
3.4 Regional specialisation

The decline in manufacturing and the growth of other industries suggests that most urban areas have developed more diversified economies over time. This raises the question: is there a systematic relationship between diversification, city size, and city growth rates? To investigate this issue we construct a regional specialisation index (RSI) that measures industrial diversification by comparing an urban area's industrial structure with the nationwide industrial structure.[13] We use the measure to see how industrial diversification has changed over time.

The regional specialisation index we construct is based on the same idea as the Gini coefficient that is used to measure inequality. In each urban area the location quotients for each industry are ranked from smallest to largest. The amount of employment in the smallest *n* industries is calculated and the cumulative total is compared to the cumulative amount of employment in the same *n* industries nationally. The result is a Lorenz curve (see Figure 3-5).

[13] The nationwide industrial structure is calculated across the 30 urban areas analysed in this paper and excludes rural areas and minor urban areas.

Figure 3-5 The regional specialisation index lorenz curve



Source: Authors

The Lorenz curve is used to calculate a Gini coefficient, which ranges from 0 (indicating a highly diversified economy) to 1 (indicating a highly specialized economy). For example, if all employment in a city was in a single industry, 64 industries would have zero location quotients and the Regional Specialisation Index would equal one. In contrast, if the industrial structure of the city was exactly the same as the national average, all location quotients would equal 1 and the city would have a Regional Specialization Index equal to zero.

Formally, the Regional Specialisation Index is calculated as:

$$RSI_c = 1 - \sum_{i=1}^{65}(LS_{c,i} + LS_{c,i-1})\,(NS_i - NS_{i-1}) \quad (15)$$

where

$LS_{c,i}$ are = the cumulative employment share of industry i in region k, where the industries for city c ranked from lowest to highest in terms of their location quotient.

$LS_{c,i-1}$ = the cumulative employment share of industry i-1 in region k.

NS_i ranked = the cumulative employment share of industry i in New Zealand, where the industries are in the same order as city c.

NS_{i-1} = the cumulative employment share of industry i-1 in New Zealand.

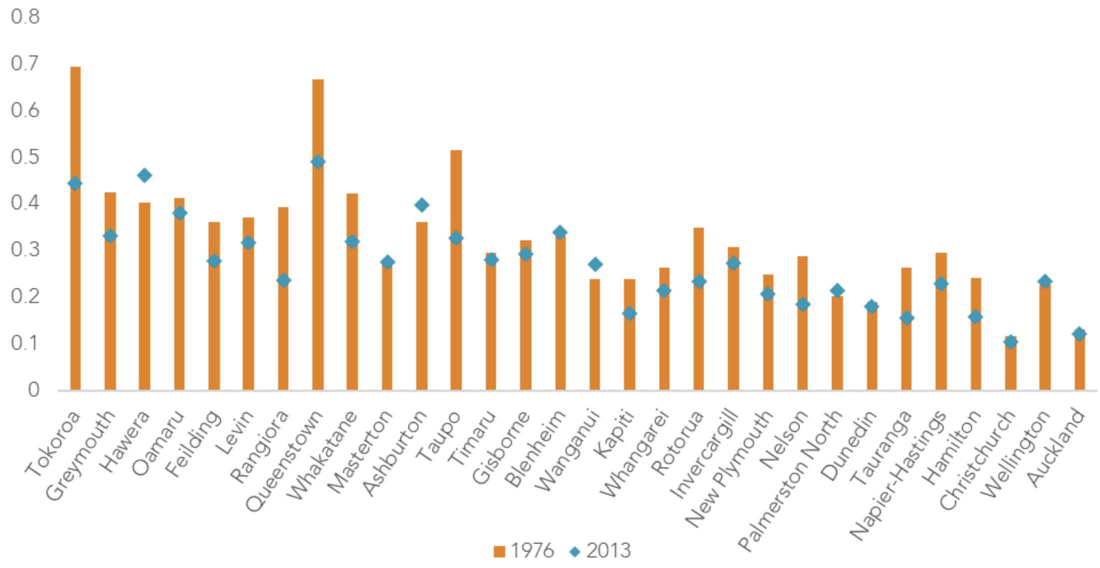
Results

Figure 3-6 shows the Regional Specialisation Index for the thirty urban areas in 1976 and 2013, ordered by population in 2013. Two results stand out.

First, regional specialization declined over time, with 23 of the 30 urban areas becoming more diversified between 1976 and 2013. The decrease in specialization took place throughout the period, with the index declining in 23 of the towns between 1976 and 1996 in 22 towns between 1996 and 2013. The largest declines in regional specialization occurred in the urban areas that were initially the most specialized, suggesting towns are becoming more similar to each other over time.\

Secondly, and unsurprisingly, smaller urban areas are less diversified than larger ones. This could occur because small towns lack industries that are common elsewhere or because they are disproportionately specialised in a small number of key industries.

Figure 3-6 Regional specialisation index in 1976 and 2013, all regions



Source: Authors' calculations based on Stats NZ Census data, 1976–2013

Note:

1. Regions are ordered from the smallest to the largest city employment in 2013

To unpick this difference, we split the regional specialisation index into two components. The first component measures the extent that an urban area is under-represented in some industries and the second component measures the extent the urban area is over-represented in some industries. The under-representative component is calculated by applying the Regional Specialisation Index (RSI) formula to industries that have location quotients less than or equal to one and the over-representative component is calculated by applying the formula to industries that have location quotients greater than one. The two components sum to the Regional Specialisation Index. If the under-representative component of the regional specialisation index is large, it means the city has little activity in many sectors – it is missing industries. Conversely, if the over-representative component of the regional specialisation index is large, an urban area has concentrated on a small number of industries.

Figure 3-7, which splits the Regional Specialisation Index into these two components for each urban area, shows both components decrease with city size. The data show small urban areas have more missing industries than large urban areas, and are considerably more specialized in the industries in which they specialise. We suspect the negative relationship between urban areas specialisation and population is related to the distinction between localisation and urbanisation agglomeration externalities (Rosenthal and Strange, 2006).[14] Smaller cities enjoy localization externalities from the industries in which they specialize but larger cities enjoy urbanization externalities that promote highly diversified economic activities. [15]

An examination of the way the two components of the regional specialization index have changed over time shows most places reduced their concentration on their initial specialist industries. There were only five urban areas that became more specialized in their initial specialist industries, all small and medium sized North Island towns.[16] In contrast, 24 urban areas that had a reduction in their over-representation indices. Of these, 17 including Tauranga, Hamilton and Christchurch also had a reduction in their under-representation index. These cities became more diversified by reducing their reliance on their initial specialist industries and by increasing their employment in industries in which

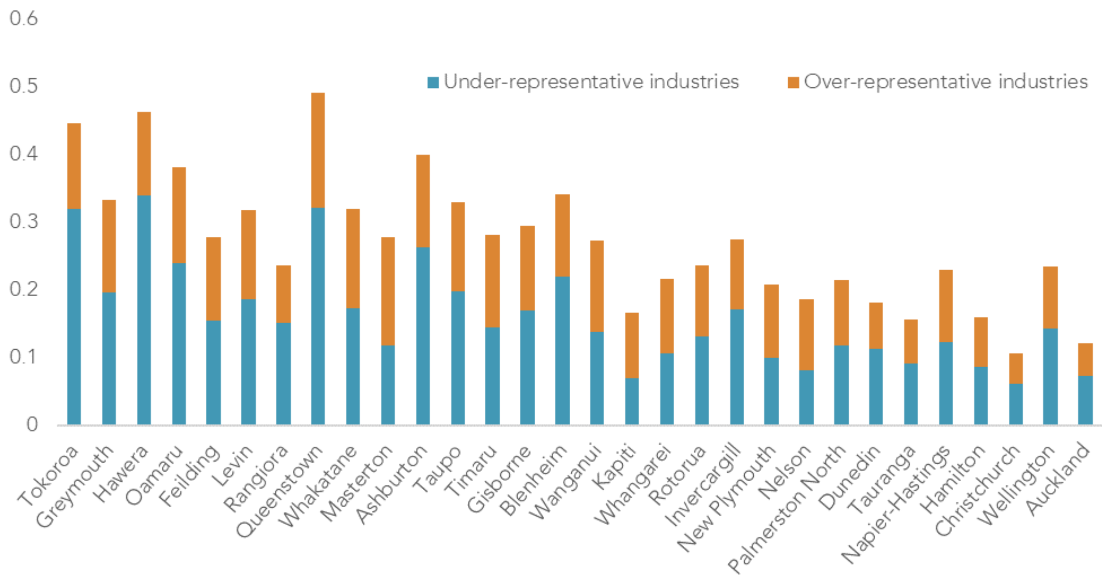
[14] Localisation externalities arise when productivity increases in a particular industry because many firms in the same industry are located close together enabling them to share common inputs, information, and workers. Urbanisation externalities arise when productivity increases in different industries because firms in these industries are located geographically close together. They can arise when firms use many different inputs, or can learn techniques used in different industries.

[15] In 2013 the mean of the under-representation indices for small urban areas, mediums sized urban areas, and Auckland Wellington and Christchurch were 0.21. 0.13, and 0.09 respectively. The mean of the over-representation indices was 0.13, 0.10, and 0.06.

[16] Tokoroa, Masterton, Kapiti, Palmerston North and Napier-Hastings.

they were initially under represented. A further five urban areas (out of the 24) including Auckland and Wellington had little change in the extent they were diversified, while two towns became less diversified in the industries where they were initially under-represented.

Figure 3-7 Decomposition of regional specialisation index, all regions, 2013



Source: Authors' calculations based on Stats NZ Census data, 1976–2013

Note:

1. Regions are ordered from the smallest to the largest population size in 2013

The change in the diversity of industrial output is related to the speed of overall employment and population growth. The fastest growing urban areas did not typically grow because of a boom in demand for the goods in which they were initially specialised. Rather the areas that grew the fastest between 1976 and 2013 had more rapid declines in their regional specialisation indices than the slowest growing cities, declining 0.10 points rather than 0.04 points.[17] The most rapidly growing areas did not become more specialised, but managed to diversify into new activities more quickly than other cities.

It is possible to split the specialisation index further, by decomposing the change in the index into three components:[18]

- the change that occurred because of changes in the national industry composition;
- the change that occurred because of overall employment growth in the urban area; and
- a residual component.

This split reveals three key results.

First, employment changes that stemmed from nationwide industrial changes during the period decreased the regional specialisation index. This result reflects the decline of manufacturing over the period, for this was a specialist industry for most urban areas. Our results suggest that if manufacturing had become more important, specialisation would have increased over the period, because manufacturing is spatially concentrated.

Secondly, population growth accelerated diversification in fast growing urban areas, but retarded it in slow growing ones. In fast growing urban areas, population growth both reduced the area's reliance on

[17] A t-test of the hypothesis that the decline in the RSI for the nine fastest growing urban areas is the same as the decline in the RSI of the remaining areas can be rejected at the 10% significance level if Tokoroa and Queenstown are included in the sample and rejected at the 5% significance level if these cities are excluded. Both Queenstown and Tokoroa experienced very rapid declines in their RSI over the period, which affects the variance of the test rather than mean difference between the two groups.

[18] The regression results are available from the authors on request.

its traditional specialities (as these did not grow as rapidly as overall employment) and increased employment in previously underweight sectors.

Thirdly, the predicted component of the change in the regional specialisation index accounted for 40% of the overall variance of the changes in regional specialisation, if Tokoroa and Queenstown are excluded.[19] It follows that most changes in city specialisation occur because of idiosyncratic factors unrelated to the city's initial industrial structure or its overall rate of population growth.

These results provide clear answers to questions concerning the way growth depends on specialisation. First, most urban areas reduced their specialisation over time, and few grew as a result of favourable shocks to their specialist industries. Secondly, the fastest growing urban areas became more diversified rather than more specialised. In this sense, Nelson or Tauranga rather than Blenheim are typical fast-growing urban areas. Both of these tendencies indicate that the ability to develop new industries and diversify out of declining industries has been a key feature of rapidly growing urban areas.

[19] If these cities are included, the fraction of variance explained by the predicted employment changes reduces to 10%. Queenstown and Tokoroa account for less than 1% of total employment but had larger employment changes than all other urban areas.

4 Conclusion

The results in this paper suggest that the employment dynamics of New Zealand's smaller urban areas are quite different to those of the larger ones. At the start of the period large and small urban areas had quite different types of manufacturing industries, with smaller areas disproportionately focussed on industries that processed rural products.

Almost all urban areas suffered from the long manufacturing downturn that started in the late 1970s, but when small areas lost jobs in their rural-processing manufacturing industries they found it much harder to create new jobs in different industries than when larger ones lost jobs in their manufacturing industries. Manufacturing job losses in most large and medium sized urban areas did not reduce employment overall because employment in other industries expanded, particularly in the personal and professional service sectors.

The different response to the loss of manufacturing jobs accentuated the differences in the employment patterns of different sized urban areas. Small and medium-size areas are now, relative to large areas, much more specialised in manufacturing than they used to be and undertake very different types of manufacturing than large areas.

They have also suffered because the sectors that have expanded nationally, such as the finance or the professional services sectors, have disproportionately expanded in Auckland. In theory, accountants could have displaced manufacturing workers in Wanganui, Invercargill, or Napier. In practice, they have not, because accounting firms prefer to be located in Auckland. Since the work of many of the new expanding industries is best done in big cities, the sectoral shift of the economy has made it difficult for many small and medium sized urban areas to expand.

The economies of most cities and towns became more diversified as manufacturing declined and service sectors expanded. In this paper we created a formal measure of the extent that cities and towns have diversified rather than specialised and show there are only a few examples of urban areas that have become more reliant on specialist industries since 1976. Rather, most areas became more diversified, and more like each other. Small and medium sized urban areas with distinctive employment patterns are less common than they were. As migration between areas is easier when all areas have similar jobs, the reducing importance of city-specific industries may have catalysed the shift of jobs from slow-growing areas to climate-favoured fast-growing areas.

The analysis in this paper leads to a number of policy-relevant conclusions. Three key ones stand out.

First, the decline of manufacturing and the increasing importance of several new service industries has tended to favour large cities, as there has been a rapid expansion in sectors such as the professional services sector that prefer to be located in big cities. New Zealand's experience is consistent with overseas trends. It is probable the disproportionate growth of large cities has occurred because these industries derive greater agglomeration benefits from locating in big centres than previously important industries such as manufacturing. Global trends like these are unlikely to be overcome by regional interventions aimed at encouraging the development of industries in locations where agglomeration benefits do not exist.

Second, the speed at which urban areas recover from negative employment shocks to their specialist industries depends on the type of industry receiving the shock. For instance, it seems to be much more difficult to recover from adverse shocks that hit rural processing industries than shocks that hit other types of manufacturing industries. If the government wishes to help regional economies recovering from employment downturns, it should recognize that the transition path out of some industries is harder than others.

Lastly, the paper has focussed attention on the similarities and differences of small and large urban economies. The most obvious similarity is that all towns produce similar non-tradeable goods – goods that have a low cross-city location quotient variance – whereas they produce different specialities. For this reason, government programmes aimed at enhancing the way non-tradeable businesses improve their productivity are likely to produce the widest regional benefits, as they have the potential to improve productivity in many sectors everywhere. There is growing recognition of this principle in regional development strategies around the globe.

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Appendix A Additional tables

Table A.1 Industrial sectors arranged by the standard deviation of location quotients

Industrial sector	Code	LQ std deviation	Industry weight
Quartile 1 (lowest location quotient standard deviations)			
Personal services; domestic household staff	RS210	0.17	1.4%
Repair and maintenance	RS211	0.21	1.4%
Construction	EE1_	0.21	4.6%
Supermarket and grocery stores	GH121	0.22	2.4%
Furniture, electrical and hardware retailing	GH131	0.23	2.0%
Banking and financing; financial asset investing	KK110	0.23	2.4%
Professional Services	MN11_	0.23	6.2%
Education	PP11_	0.25	7.1%
Support Services	MN21_	0.25	3.2%
Recreational, clothing, footwear and personal accessory retailing	GH132	0.26	1.8%
Publication and Broadcasting	JJ11_	0.26	1.4%
Other store based retailing; non-store and commission based wholesaling	GH130	0.27	1.6%
Specialised food retailing	GH122	0.27	0.8%
Religious services; civil, professional and other interest groups	RS219	0.27	1.1%
Property and Real estate	LL12_	0.28	1.5%
Other Wholesaling	FF11_	0.29	1.9%
Fuel retailing	GH112	0.30	0.7%
Total employment share			41.6%
Quartile 2 (Medium-low location quotient standard deviations)			
Medical and Other Health	QQ11_	0.30	8.3%
Other goods and commission based wholesaling	FF110	0.30	1.7%
Insurance and Financial Services	KK1_	0.32	1.6%
Road transport	II111	0.33	1.8%
Department stores	GH133	0.35	0.9%
Library and other information services	JJ123	0.35	0.2%
Fabricated metal product manufacturing	CC721	0.36	1.5%
Transport Support	II13_	0.37	1.9%
Residential building construction	EE110	0.38	1.8%
Grocery, liquor and tobacco product wholesaling	FF114	0.38	1.0%
Motor vehicle and parts retailing	GH111	0.39	1.2%

Industrial sector	Code	LQ std deviation	Industry weight
Telecommunications services including internet service providers	JJ120	0.40	1.4%
Printing	CC411	0.42	0.8%
Local government administration	OO111	0.43	0.9%
Other Manufacturing	CC91_	0.43	1.0%
Petrochemicals	CC5_	0.44	1.6%
Total employment share			27.7%
Quartile 3 (Medium- high location quotient standard deviations)			
Basic material wholesaling	FF111	0.45	1.2%
Non-residential building construction	EE113	0.46	0.7%
Electronic and electrical equipment manufacturing	CC821	0.46	1.1%
Central government administration and justice	OO211	0.47	3.0%
Transport equipment manufacturing	CC811	0.53	1.1%
Rental and hiring services (except real estate); non-financial asset leasing	LL110	0.55	0.6%
Non-metallic mineral product manufacturing	CC611	0.58	0.5%
Machinery manufacturing	CC822	0.58	1.2%
Recreational Services	RS11_	0.67	1.4%
Clothing, knitted products and footwear manufacturing	CC212	0.68	1.4%
Air and space transport	II123	0.69	0.6%
Electricity, Gas, and Water	DD1_	0.71	0.9%
Fruit, oil, cereal and other food product manufacturing	CC141	0.74	1.5%
Accommodation, Food, and Beverages	GH21_	1.06	4.9%
Safety and Defence	OO21_	1.06	1.6%
Rail transport	II121	1.14	0.4%
Total employment share			22.3%
Quartile 4 (Highest location quotient standard deviations)			
Other transport	II120	1.21	0.3%
Textile and leather manufacturing	CC211	1.44	0.8%
Poultry, deer and other livestock farming	AA141	1.47	0.2%
Beverage and tobacco product manufacturing	CC151	1.51	0.3%
Horticulture and fruit growing	AA111	1.60	1.0%
Sheep, beef cattle and grain farming	AA121	1.62	0.4%
Agriculture, forestry and fishing support services	AA320	1.78	0.5%
Primary metal and metal product manufacturing	CC711	2.08	0.4%
Wood product manufacturing	CC311	2.18	0.9%

Industrial sector	Code	LQ std deviation	Industry weight
Meat and Fish manufacturing	CC1_	2.31	1.7%
Fishing and aquaculture	AA310	3.06	0.1%
Dairy cattle farming	AA131	3.13	0.3%
Dairy product manufacturing	CC131	4.06	0.4%
Forestry and logging	AA211	5.11	0.3%
Mining	BB11_	5.59	0.2%
Pulp, paper and converted paper product manufacturing	CC321	5.86	0.6%
Total employment share			8.4%

Source: Authors calculations based on Stats NZ Census data, 1976 – 2013

Table A.2 Employment in manufacturing and primary goods sectors

		LQ std deviation	Work share 1976	Work share 2013	Change
	Primary production sectors (all 4th quartile location quotient standard deviation)				
Horticulture and fruit growing	AA111	1.60	0.85%	0.71%	-17%
Sheep, beef cattle and grain farming	AA121	1.62	0.45%	0.40%	-12%
Dairy cattle farming	AA131	3.13	0.44%	0.28%	-37%
Poultry, deer and other livestock farming	AA141	1.47	0.19%	0.16%	-18%
Forestry and logging	AA211	5.11	0.28%	0.18%	-36%
Fishing and aquaculture	AA310	3.06	0.11%	0.08%	-28%
Agriculture, forestry and fishing services	AA320	1.78	0.42%	0.41%	-1%
Mining	BB11_	5.59	0.23%	0.19%	-20%
Total: primary industries			2.97%	2.40%	-19%
		Highly regionally-specialised manufacturing sectors (all 4th quartile location quotient standard deviation)			
Meat and Fish manufacturing	CC1_	2.31	2.62%	0.99%	-62%
Dairy product manufacturing	CC131	4.06	0.48%	0.34%	-29%
Beverage and tobacco manufacturing	CC151	1.51	0.56%	0.28%	-51%
Textile and leather manufacturing	CC211	1.44	1.31%	0.34%	-74%
Wood product manufacturing	CC311	2.18	1.18%	0.62%	-47%
Pulp, and paper manufacturing	CC321	5.86	0.98%	0.22%	-77%
Primary metal and metal manufacturing	CC711	2.08	0.51%	0.20%	-61%
Total: specialist manufacturing			7.65%	2.99%	-61%
		Widespread manufacturing sectors (2nd-3rd quartile location quotient standard deviation)			
Fruit, oil, cereal and food manufacturing	CC141	0.74	1.48%	1.21%	-19%
Clothing and footwear manufacturing	CC212	0.68	3.04%	0.26%	-91%
Printing	CC411	0.42	0.80%	0.53%	-34%
Petrochemicals	CC5_	0.44	2.31%	0.95%	-59%
Non-metallic mineral manufacturing	CC611	0.58	0.95%	0.32%	-67%
Fabricated metal product manufacturing	CC721	0.36	1.88%	1.10%	-42%
Transport equipment manufacturing	CC811	0.53	2.06%	0.54%	-74%

		LQ std deviation	Work share 1976	Work share 2013	Change
Electronic and electrical manufacturing	CC821	0.46	1.59%	0.64%	-60%
Machinery manufacturing	CC822	0.58	2.08%	0.75%	-64%
Other Manufacturing	CC91_	0.43	1.38%	0.51%	-63%
Total: widespread export and intermediate goods			17.58%	6.82%	-61%

Source: Authors calculations based on Stats NZ Census data, 1976–2013

Table A.3 Effects of Industry and city employment changes on city-industry employment

Sector		LQ std deviation	βi (city)	R^2	Marginal R^2
		Quartile 1			
Personal services	RS210	0.17	0.80	0.82	0.17
Repair	RS211	0.21	0.74	0.92	0.16
Construction	EE1_	0.21	1.03	0.55	0.14
Supermarket/grocery	GH121	0.22	0.28	0.37	0.02
Furniture etc retailing	GH131	0.23	0.74	0.73	0.11
Banking etc	KK110	0.23	0.97	0.72	0.15
Professional services	MN11_	0.23	1.16	0.78	0.23
Education	PP11_	0.25	0.69	0.64	0.24
Support services	MN21_	0.25	1.27	0.52	0.18
clothing retailing	GH132	0.26	1.04	0.57	0.25
Publication/Broadcasting	JJ11_	0.26	1.30	0.33	0.15
Other store retailing	GH130	0.27	0.99	0.67	0.25
Specialised food retailing	GH122	0.27	0.93	0.43	0.08
Religious services	RS219	0.27	1.13	0.57	0.11
real estate	LL12_	0.28	0.71	0.83	0.07
Other Wholesaling	FF11_	0.29	1.28	0.75	0.16
Fuel retailing	GH112	0.30	0.48	0.93	0.04
Mean		0.25	0.91	0.66	0.15
		Quartile 2			
Health	QQ11_	0.30	0.50	0.70	0.17
Other goods wholesaling	FF110	0.30	1.34	0.59	0.15
Insurance etc	KK1_	0.32	1.32	0.52	0.23
Road transport	II111	0.33	0.74	0.51	0.13
Department stores	GH133	0.35	0.82	0.68	0.04
Library etc	JJ123	0.35	0.54	0.28	0.04
Fabricated metal Mfrg	CC721	0.36	0.85	0.68	0.07
Transport services	II13_	0.37	0.78	0.95	0.07
Residential construction	EE110	0.38	1.24	0.88	0.13
Grocery, wholesaling	FF114	0.38	0.80	0.27	0.04
Motor vehicle retailing	GH111	0.39	0.86	0.74	0.19
Telecommunications	JJ120	0.40	0.93	0.94	0.00
Printing	CC411	0.42	1.37	0.56	0.11
Local government	OO111	0.43	0.35	0.63	0.01
Other_Mfrg	CC91_	0.43	0.29	0.42	0.01
Petrochem	CC5_	0.44	1.41	0.50	0.11
Mean		0.37	0.88	0.62	0.10

Sector		LQ std deviation	βi (city)	R^2	Marginal R^2
			Quartile 3		
Basic wholesaling	FF111	0.45	1.43	0.58	0.12
Non-residential build	EE113	0.46	1.19	0.83	0.05
Electronic Mfrg	CC821	0.46	0.74	0.46	0.03
Central government	OO211	0.47	0.03	0.58	0.00
Transport equipment	CC811	0.53	1.24	0.49	0.05
Rental services	LL110	0.55	0.04	0.73	0.04
Non-metallic Mfrg	CC611	0.58	0.70	0.55	0.04
Machinery Mfrg	CC822	0.58	0.60	0.59	0.02
Recreation	RS11_	0.67	0.81	0.43	0.11
Clothing Mfrg	CC212	0.68	0.74	0.55	0.05
Air transport	II123	0.69	1.41	0.40	0.10
Electricity_Gas_Water	DD1_	0.71	0.97	0.55	0.06
Fruit, etc Mfrg	CC141	0.74	1.14	0.31	0.10
Accomodation etc	GH21_	1.06	0.78	0.72	0.21
Safety and Defence	OO21_	1.06	-1.10	0.35	0.06
Rail transport	II121	1.14	0.18	0.69	0.03
Mean		0.68	0.68	0.55	0.07
			Quartile 4		
Other transport	II120	1.21	0.89	0.82	0.04
Textile Mfrg	CC211	1.44	0.07	0.47	0.01
Poultry, deer farming	AA141	1.47	-0.31	0.25	0.00
Beverage and tobacco	CC151	1.51	1.51	0.35	0.05
Horticulture	AA111	1.60	0.07	0.50	0.00
Sheep, beef, grain	AA121	1.62	-0.24	0.35	0.00
Agriculture services	AA320	1.78	-0.09	0.47	0.00
Primary metal Mfrg	CC711	2.08	0.20	0.19	0.02
Wood Mfrg	CC311	2.18	0.16	0.48	0.00
Meat and Fish Mfrg	CC1_	2.31	-0.85	0.32	0.03
Fishing	AA310	3.06	0.76	0.23	0.02
Dairy farming	AA131	3.13	-1.18	0.24	0.06
Dairy Mfrg	CC131	4.06	-1.08	0.17	0.03
Forestry and logging	AA211	5.11	-0.03	0.57	0.00
Mining	BB11_	5.59	0.21	0.29	0.01
Pulp, paper Mfrg	CC321	5.86	1.37	0.33	0.06
Mean		2.75	0.09	0.38	0.02

Source: Authors calculations based on Stats NZ Census data, 1976–2013
Note:
The regression R^2 is the fraction of city-industry employment growth explained by time effects and city employment growth. The marginal R^2 is the fraction of city-industry employment growth not explained by time effects that is explained by city employment growth.

Appendix B The employment effects of shocks to manufacturing and primary industries

In this section we estimate how shocks to manufacturing and primary industries affected city-level employment between 1976 and 2013. While our focus is the manufacturing and primary sectors, we use the same method to investigate shocks to other industries on city level employment. We are much less confident about these results, however, because the measure of employment shocks in these industries is likely to be much less accurate than in the primary and manufacturing industries. This is because employment in many service sectors is dominated by local demand factors, and our measure of nationwide shocks for these industries may not be very good.

The authors do not wish to overplay the results of this section. In the course of this section we estimated a very large number of regressions involving a large number of combinations of dependent variables, independent variables, period lengths, aggregation levels, dummy variables and fixed effects. There were choices to make about whether the Bartik measures should or should not include Auckland's employment changes, and whether each city's employment changes should be included or excluded in its own Bartik measure. We estimated but have not reported regressions which included city size as an additional variable, which produced different results because of multicollinearity. We have redone regressions when the results indicated obvious programming errors but may have been less vigilant about these errors when the regression results conformed to our expectations. We have estimated the equations using ordinary least squares, weighted least squares, and with and without two potential outliers, Queenstown and Tokoroa. We have had long arguments about the meaning of the Bartik measure for non-tradeable sectors. We have entertained doubts whether the equations have serious omitted variable bias. In short, while we are not unhappy with the specifications we have chosen, we are not sure about their statistical significance and probably would not wish to base important policy decisions upon their results. This is not a satisfactory result, but given how this part of the project evolved, it would be remiss for us to pretend otherwise. Sometimes research does not proceed smoothly, and this was one of those occasions.

B.1 Methodology

Our measure of industry shocks uses the methodology established by Bartik (1991). The Bartik shock to employment in a particular industry and city is calculated by estimating how employment would have changed in the city if the industry grew at the same rate as the industry in *other* cities:

$$B_{t+k}^{i\tilde{c}} = E_t^{ic} \times \left(\frac{E_{t+k}^{i} - E_{t+k}^{ic}}{E_t^{i} - E_t^{ic}}\right) \tag{16}$$

The shock to a city's total employment in a sector is calculated by adding up the shock to each of the industries in the sector:

$$B_{t+k}^{S\tilde{c}} = \sum_{i \in S} E_t^{ic} \times \left(\frac{E_{t+k}^{i} - E_{t+k}^{ic}}{E_t^{i} - E_t^{ic}}\right) \qquad S = \{i_1, i_2, i_3 \dots i_S\} \tag{17}$$

This expression can be rearranged to show that the employment shock for a sector at time *t+k* is the change in employment that occurs if each industry in the city expands at the national average rate and the city maintains its time *t* location quotients and its share of the national population:

$$B_{t+k}^{S\tilde{c}} = \sum_{i \in S} E_t^{ic} \times \left(\frac{E_{t+k}^{i} - E_{t+k}^{ic}}{E_t^{i} - E_t^{ic}}\right) = \sum_{i \in S} LQ_t^{ic} \times \frac{E_t^{c}}{E_t} \times E_t^{i} \times \left(\frac{E_{t+k}^{i} - E_{t+k}^{ic}}{E_t^{i} - E_t^{ic}}\right) \tag{18}$$

When expressed as a fraction of the initial employment level in the city, the expected sectoral employment growth in a city is the sum of the location quotient of each industry in the city multiplied by the national industry weight multiplied by the national growth of the industry:

$$b^{S\tilde{c}}_{t+k} = \frac{B^{S\tilde{c}}_{t+k}}{E^{c}_{t}} \quad = \sum_{i\in S} LQ^{ic}_{t} \times \frac{E^{i}_{t}}{E_{t}} \times \left(\frac{E^{i}_{t+k}-E^{ic}_{t+k}}{E^{i}_{t}-E^{ic}_{t}}\right) \tag{19}$$

This quantity, the Bartik shock measure, is the change in employment a city could expect if each of the industries in a sector expanded at the same rate as the national average for that industry and the city remained as overweight or underweight in the industry as it did at the beginning of the period. For example, if a city had 50% more of an industry than the national average, and that industry was 2% of national employment, and the industry expanded nationally by 10%, the city could expect employment to increase by (1.5 x 2% x 10%) or 0.3%.

This measure was first used by Bartik (1991) and is now widely used as a measure of a shock to a city's employment that reflects national-industry rather than firm-specific or city-specific factors. In the analysis below we convert the growth rate into a growth index:

$$d^{S\tilde{c}}_{t+k} = \frac{b^{S\tilde{c}}_{t+k}-b^{S\tilde{c}}_{t}}{(b^{S\tilde{c}}_{t+k}+b^{S\tilde{c}}_{t})/2} \tag{20}$$

One issue with this measure occurs because employment in some industries depends on the local population. In these industries, the Bartik measure partly reflects population changes in the rest of the country as well as changes in the industry's share of total employment. For instance, if the retail industry's share of national employment drops by two percentage points it seems reasonable to expect the retail industry's share of employment in Oamaru (a town with slow population growth) and Tauranga (a town with very rapid population growth) to drop by two percentage points. However, if the number of retail workers in New Zealand increases by 15% because the national population increases by 15%, there is no obvious reason why the number of retail workers in either city should increase by 15%, as population growth across cities is very uneven. For this reason, we concentrate on the effects of shocks to tradeable industries, not just because cities vary significantly in their exposure to these industries but because these industries are less affected by local demand and thus the Bartik measure is less affected by changes in national employment levels.

B.2 National employment shocks and local employment levels

To examine the effect of national employment shocks on local employment levels we split the data into five basic sectors: the primary sector, two manufacturing sectors, and two service sectors. We estimate the effect of the sector shock on local same-sector employment, on local employment in other sectors (each of the four other sectors separately plus the four sectors combined), and total employment in the city. As we estimate these effects over successive five-year periods, the basic equations are:

$$d^{jc}_{t+k} = \alpha + \sum_{s} \beta^{js}\ d^{s\tilde{c}}_{t+k} + \sum_{c\in C} \delta^{jc} D^{c} + \sum_{\tau=2}^{7} \delta^{j\tau} D^{\tau} + u^{jc}_{t+k} \qquad k = 1,\ldots,7 \tag{21}$$

where the dependent variable d^{jc}_{t+k} is the actual change in employment in the city in a sector or collection of sectors S_j, measured as a growth index, and $d^{s\tilde{c}}_{t+k}$ is the Bartik shock for the s^{th} sector or collection of sectors in city c, also measured as a growth index. (The nomenclature is complicated because there are eleven choices (*j*) for the dependent variable and five choices (*s*) for the Bartik shocks.)

The regression includes city and time fixed effects, D^{c} and D^{τ}. We report the regressions when each of the five Bartik measures are included simultaneously in each regression, but the results are robust to including the Bartik measures one at a time.[20]

There are eleven different dependent variables. The dependent variables in the first five regressions are the sector-specific city-level employment changes and the main coefficients of interest are the own-sector coefficients β^{ii} (these are the diagonal entries in Table B.1). These coefficients measure the extent that sector-specific employment is correlated across the country. If actual sector-specific city-

[20] When the Bartik sector shocks are included one at a time, and the sector shocks are correlated with each other, the single-sector regression results could be biased because of omitted variable problems. The coefficients in the two sets of regressions are quite similar and the results are available on request.

level employment levels change by the amount predicted by sector-specific employment trends in the rest of the country, the own-shock coefficient β^{ii} will equal 1.

The dependent variables in the second set of five equations are the city-level employment changes in the complementary sectors $\tilde{i}$; for example, if sector *i* is the primary sector, we look at employment changes in all sectors excluding the primary sector in a city. The coefficients of interest in these equations are the coefficients $\beta^{\tilde{i}i}$, the effect of a shock to one sector on employment in other sectors. If $\beta^{\tilde{i}i} < 0$, employment changes in other sectors *offset* employment changes in the sector receiving the shock, whereas if $\beta^{\tilde{i}i} > 0$ a change in employment stemming from a shock in one sector is *intensified* by a gain or loss of jobs in other sectors. The latter is a multiplier effect, which might occur, for example, because a reduction in employment in one sector reduces the demand for goods and services in other sectors.

The eleventh equation analyses the effect of a sector-specific employment shock on total employment in the urban area. There are a range of possibilities for the coefficients on total employment, β^{Ei}. If $\beta^{Ei} > 1$, multiplier effects dominate. If $\beta^{Ei} = 0$, total employment in a city does not change in response to the shocks affecting individual industries as workers switch between sectors. Lastly, β^{Ei} may be negative if employment is increasingly concentrated in a few cities as some cities systematically increase their size at the expense of others.

There are various ways the regressions can be estimated. The first choice is the number of cities to include in the regression. If we include Auckland, there are 30 urban areas, or otherwise there are 29.[21] We report regressions excluding because if employment in Auckland expanded at the expense of employment elsewhere then its employment changes will be different to those in the rest of the country.[22]

The second choice is whether the measure of the Bartik shock includes or excludes Auckland employment growth. Our preferred choice is to include Auckland, as we believe this provides a better indication of the size of the shocks hitting each industry in the country, but we also estimated the model with Bartik shocks calculated with Auckland excluded. We found little difference in the two sets of estimates, although we would expect the coefficient on the Auckland-inclusive Bartik measure to be less positive if Auckland's employment growth occurred at the expense of smaller cities. The regressions were estimated using weighted least squares, with weights proportional to average city employment.

The results are displayed in Table B.1.

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[21] We also estimated regressions excluding two obvious outliers, Queenstown and Tokoroa. As the equations are estimated using weighted least squares, there was little effect on the estimated coefficients as these cities are very small and thus had little weight.

[22] To paraphrase Ross Perot, Auckland may have played the role of the "giant sucking sound" that extracts jobs from regional cities (2nd Presidential Debate, 19 October 1992). This would induce a negative bias to the coefficient as Auckland would have rising employment in an industry when the industry shifts from regional cities to Auckland. As Auckland has a weight of one third in the weighted least squares regressions, we decided to exclude Auckland from the regression to prevent the estimation of potentially misleading results.

Table B.1 The effect of employment shocks on local employment

Employment change↓↓	Bartik M_RS	Bartik M_WD	Bartik P4	Bartik O_WD	Bartik O_RS	N	R^2
			Auckland included in the Bartik shock measure				
M_RS	**0.96**	0.29	0.11	-0.01	-0.15	203	0.59
	(0.12)	(0.22)	(0.13)	(0.08)	(0.12)		
M_WD	-0.13	**0.88**	0.22	0.07	0.00	203	0.74
	(0.12)	**(0.21)**	(0.13)	(0.08)	(0.12)		
P4	-0.10	-0.23	**0.63**	0.02	0.00	203	0.51
	(0.09)	(0.16)	**(0.10)**	(0.06)	(0.09)		
O_WD	-0.24	-1.36	0.23	**-0.58**	0.82	203	0.83
	(0.25)	(0.44)	(0.27)	**(0.16)**	(0.24)		
O_RS	-0.13	-0.19	-0.11	-0.16	**0.25**	203	0.75
	(0.12)	(0.21)	(0.13)	(0.08)	**(0.11)**		
Non M_RS	**-0.6**	-0.89	0.98	-0.65	1.07	203	0.84
	(0.39)	(0.68)	(0.42)	(0.25)	(0.37)		
Non M_WD	0.49	**-1.48**	0.87	-0.73	0.92	203	0.85
	(0.34)	**(0.6)**	(0.37)	(0.22)	(0.32)		
Non P4	0.46	-0.38	**0.46**	-0.68	0.92	203	0.85
	(0.39)	(0.69)	**(0.42)**	(0.25)	(0.37)		
Non – O_WD	0.60	0.76	0.86	**-0.08**	0.10	203	0.80
	(0.25)	(0.44)	(0.27)	**(0.16)**	(0.24)		
Non O_RS	0.48	-0.41	1.20	-0.50	**0.67**	203	0.84
	(0.34)	(0.59)	(0.37)	(0.22)	**(0.32)**		
Total Employment	0.36	-0.60	1.09	-0.66	0.92	203	0.85
	(0.4)	(0.70)	(0.44)	(0.26)	(0.38)		
			Auckland excluded from the Bartik shock measure				
M_RS	**0.96**	0.16	0.12	0.00	-0.11	203	0.54
	(0.16)	(0.25)	(0.14)	(0.06)	(0.11)		
M_WD	-0.14	**0.85**	0.20	0.07	-0.02	203	0.73
	(0.14)	**(0.23)**	(0.13)	(0.06)	(0.10)		
P4	-0.17	-0.27	**0.60**	-0.02	0.02	203	0.51
	(0.11)	(0.17)	**(0.10)**	(0.04)	(0.08)		
O_WD	-0.41	-1.43	0.20	**-0.57**	0.85	203	0.83
	(0.30)	(0.47)	(0.26)	**(0.12)**	(0.22)		
O_RS	-0.13	-0.19	-0.11	-0.16	**0.25**	203	0.75
	(0.12)	(0.21)	(0.13)	(0.08)	**(0.11)**		
Non M_RS	**-0.87**	-1.12	0.88	-0.65	1.04	203	0.84
	(0.46)	(0.73)	(0.41)	(0.19)	(0.33)		
Non M_WD	0.22	**-1.80**	0.80	-0.72	0.95	203	0.85
	(0.41)	**(0.65)**	(0.36)	(0.17)	(0.30)		

Employment change↓↓	Bartik M_RS	Bartik M_WD	Bartik P4	Bartik O_WD	Bartik O_RS	N	R^2
Non P4	0.26	-0.69	**0.40**	-0.63	0.90	203	0.85
	(0.47)	(0.74)	**(0.42)**	(0.19)	(0.34)		
Non O_WD	0.50	0.48	0.80	**-0.08**	0.07	203	0.80
	(0.30)	(0.48)	(0.27)	**(0.13)**	(0.22)		
Non O_RS	0.25	-0.70	1.13	-0.52	**0.75**	203	0.84
	(0.40)	(0.64)	(0.36)	(0.17)	**(0.29)**		
Total Employment	0.09	-0.96	1.00	-0.65	0.93	203	0.85
	(0.48)	(0.76)	(0.43)	(0.20)	(0.35)		

Source: Authors' calculations based on Stats NZ Census data, 1976–2013

Note:

1. M_RS: Regionally specialised manufacturing. M_WD: Widely distributed manufacturing. P4: Primary industries. O_RS: Regionally specialised service and other industries. O_WD: Widely distributed service and other industries. Regressions estimated with time effects using weighted least squares. Standard errors in parenthesis "Non M_RS" means all sectors other than M_RS.

Summary of results for manufacturing

The estimated own-shock coefficients β^{ii} for the two manufacturing sectors are each close to and insignificantly different from $\beta^{ii} = 1$. In both cases this means a city's manufacturing employment covaries fully with manufacturing employment in the rest of the country. In both cases there are offsetting changes in employment in other industries so that total employment in a city changes by much less than manufacturing employment. However, the size of the offsetting response seems to be a lot larger for widely distributed rather than regionally specialised manufacturing industries.

The evidence for the different size of the offsetting response is three-fold. The first evidence, which is weakest, is the size of the estimated cross-sector coefficients $\beta^{\bar{i}i}$ between the manufacturing shock and local employment in other sectors. These coefficients are -1.48 (with a 95% confidence interval of -0.3 to -2.7) for widely distributed manufacturing industries, and -0.60 (with a 95% confidence interval of 0.2 to -1.4) for regionally specialised manufacturing industries. While the difference in these estimates is large, the large standard errors mean it is not possible to reject the hypothesis that the aggregate employment responses to the shocks are the same.

More conclusive evidence comes from the regression in which the employment change in the widely distributed service sector is regressed against the shocks to the five different sectors (Table B.1). The coefficient estimates show negative shocks hitting widely distributed manufacturing industries were offset by a larger expansion of employment in the widely distributed service sectors than shocks hitting regionally specialised manufacturing industries. The coefficient estimates are -1.36 (standard error = 0.44) and -0.24 (standard error = 0.25) respectively and the hypothesis that the coefficients are the same can be rejected.[23]

The third evidence comes from disaggregating the sector-specific employment changes into 15 sectors and estimating a new set of regressions linking employment change in each sector to the five different sector shocks (Table B.2). While most estimates of the coefficients are imprecisely estimated, all the coefficients between the ten private-sector service sectors and the widely distributed manufacturing shocks are negative and the coefficients for retail trade and banking and finance are both sizeable and statistically significant.[24] In contrast, only five of the coefficients between the ten private-sector service sectors and the regionally specialised manufacturing shocks and are negative, none are statistically significant and eight of them are larger than the corresponding coefficients for widely distributed manufacturing. This evidence is consistent with the evidence from Table B.1 that the shocks hitting

[23] See row 4 of Table B.1. An F(1,163) test of the hypothesis that the coefficients are the same has a value of 7.04 and the hypothesis can be rejected at the 1% significance level.

[24] The ten service sectors are construction; retail trade; hospitality and accommodation; recreation services; wholesale trade; transport; banking and finance; professional services; administrative services; and utilities.

widely distributed manufacturing industries were offset by increases in service sector employment by a much larger extent than the shocks hitting regionally specialised manufacturing industries. The census data used in this study is not sufficiently detailed to explain these differences further.

Table B.2 The effect of sector employment shocks on local employment disaggregated into 15 sectors. (Auckland excluded from dependent variables.)

Employment change↓↓	Bartik M_RS	Bartik M_WD	Bartik P4	Bartik O_WD	Bartik O_RS	F-test βMWD=βMRS	R^2
Manufacturing WD	-0.134	0.88	0.222	0.07	0.002	25.97	0.741
	(0.118)	(0.208)	(0.128)	(0.077)	(0.112)	(0.000)	
Manufacturing RS	0.956	0.288	0.111	-0.006	-0.154	10.25	0.590
	(0.123)	(0.218)	(0.134)	(0.08)	(0.117)	(0.002)	
Primary P4	-0.1	-0.226	0.631	0.018	0	0.69	0.511
	(0.09)	(0.158)	(0.098)	(0.058)	(0.085)	(0.406)	
Construction	-0.137	-0.333	0.253	-0.071	0.453	0.71	0.695
	(0.138)	(0.243)	(0.15)	(0.09)	(0.131)	(0.401)	
Government	-0.189	-0.079	0.071	0.029	-0.13	1.52	0.725
	(0.053)	(0.093)	(0.058)	(0.034)	(0.05)	(0.219)	
Health and Education	0.102	0.016	-0.003	0.056	0.039	0.42	0.774
	(0.079)	(0.139)	(0.086)	(0.051)	(0.075)	(0.517)	
Retail	0.067	-0.263	0.129	-0.188	0.089	9.02	0.761
	(0.065)	(0.114)	(0.071)	(0.042)	(0.062)	(0.003)	
Accommodation	0.03	-0.155	0.036	-0.105	0.201	2.85	0.689
	(0.065)	(0.114)	(0.07)	(0.042)	(0.062)	(0.093)	
Recreational Services	0.031	-0.08	-0.054	-0.037	0.066	2.5	0.83
	(0.042)	(0.074)	(0.046)	(0.027)	(0.04)	(0.116)	
Wholesale Trade	-0.052	-0.017	-0.093	-0.063	0.063	0.13	0.695
	(0.057)	(0.10)	(0.062)	(0.037)	(0.054)	(0.716)	
Transport	0	-0.019	0.13	-0.129	0.023	0.03	0.798
	(0.066)	(0.117)	(0.072)	(0.043)	(0.063)	(0.859)	
Banking and Finance	-0.084	-0.323	-0.066	-0.029	0.089	4.97	0.641
	(0.063)	(0.112)	(0.069)	(0.041)	(0.06)	(0.027)	
Professional Services	0.012	-0.14	0.037	-0.117	-0.21	2.13	0.785
	(0.061)	(0.108)	(0.067)	(0.040)	(0.058)	(0.147)	
Administrative Services	-0.036	-0.064	-0.076	-0.101	0.174	0.13	0.460
	(0.047)	(0.083)	(0.051)	(0.031)	(0.045)	(0.722)	
Utilities	-0.11	-0.089	-0.241	0.013	0.213	0.05	0.936
	(0.053)	(0.094)	(0.058)	(0.035)	(0.051)	(0.082)	

Source: Authors calculations based on Stats NZ Census data, 1976 – 2013

Note:

1. M_RS: Regionally specialised manufacturing. M_WD: Widely distributed manufacturing. P4: Primary industries. O_RS: Regionally specialised service and other industries. O_WD: Widely distributed service and other industries. Regressions estimated with time effects using weighted least squares. Standard errors in parenthesis

The overall employment response to the different types of manufacturing industries are quite different in magnitude. Consider a shock that is forecast to reduce manufacturing employment by 100 jobs. The point estimates in the last row of Table B.1 indicate that total employment *reduced* by 36 jobs if the shock reduced a regionally specialised manufacturing industry, but total employment *increased* by 60 jobs if the shock hit a widely distributed manufacturing industry. This difference primarily reflects the difference in the amount of offsetting employment in the widely distributed service sectors.

The size of the positive estimate, which indicates negative employment shocks to widely distributed manufacturing industries were associated with rapid overall employment growth, is puzzling. The disproportionate growth of Auckland's service sectors since 1981 is not part of the explanation as these regression results do not include Auckland as a dependent variable. It is possible that the size of the coefficient reflects the effect of city size, because small towns have below average employment in widely distributed manufacturing sectors and below average employment growth in professional service and banking industries. Unfortunately, our ability to examine whether the responsiveness to manufacturing employment shocks systematically differed with the size of cities is undermined by the large degree of multicollinearity between the size of cities and the fraction of their employment in regionally specialised and widely distributed industries. Nonetheless, the statistical evidence that there is a much smaller increase in service sector jobs when 'regionally specialised' manufacturing plants shut down relative to when 'widely specialised' manufacturing plants shut down is consistent with the stories from small towns such as Greymouth and Tokoroa about the difficulties of creating new jobs following major job losses in their manufacturing industries. It is also consistent with evidence from Canada that workers who lose their manufacturing jobs in small company towns are less likely to find employment in the same town than workers who lose their jobs in more diversified centres (Polèse and Shearmur 2006).

Summary of results for the primary sector

The estimates of the effects of primary sector employment shocks are different. The estimated own-shock β coefficient is 0.63 (with a 95% confidence interval of 0.4 to 0.8) which indicates local primary sector employment does not fully covary with national level industry shocks. This value may reflect regional differences in the efficiency of different primary industries that raise the importance of local factors. There is a positive correlation between primary sector employment shocks and employment in other sectors suggesting weak multiplier effects, although the coefficient is not significantly different from zero. In combination, total employment changes by the same amount as the predicted shock: that is if a city is forecast to lose 100 jobs due to a primary sector shock, our estimates suggest it loses 108 jobs of which 63 are in the primary sector and a further 45 in other sectors. These coefficients are not very precisely estimated, but, unlike the situation for manufacturing employment shocks, there is no evidence that jobs expand in other sectors to compensate for losses in the primary sector.

Summary of results for the service sectors

Tables 6 and 7 also report the employment response to employment shocks affecting service sector industries. Unfortunately, these results have econometric problems that limit their usefulness. The basic problem occurs for two reasons. First, local service sector employment growth is highly correlated with local aggregate employment growth since service sector employment is dependent on local demand. This means national employment growth is highly correlated with national population growth. However, there is no reason why local population growth is strongly correlated with national population growth. If local population growth is not highly correlated with national population growth, which it is not, changes in national employment growth in a service sector will not be a good proxy for local employment demand in this sector. Secondly, there is little variation in the Bartik shock measure across cities since many service sectors are found in similar proportions in all towns and cities. This induces a negative bias into the coefficient between employment growth and the Bartik measure because the latter will be lower than average for rapidly growing towns and cities and higher than average for slowly growing towns and cities. This negative bias does not matter much if the fraction of employment in each sector differs a lot across cities, as is the case for manufacturing and primary-sector industries, but it may dominate the regression if there is not much variation in the fraction of employment in each non-tradeable industry.

The results for the widely distributed service sector bear out this concern. According to Table B.1, the own-shock coefficient β^{ii} is -0.58 (with a 95% confidence interval of -0.3 to -0.9) rather than the expected value $\beta^{ii} = 1$. The estimated effect of shocks to widely distributed service industries on total employment may also reflect this bias: the total employment coefficient β^{Ei} is estimated to be -0.66 (with a 95% confidence interval of -1.2 to 0.1), which indicates total employment in a city is negatively correlated with employment in widely distributed service industries in the rest of the country.

Is it likely that the bias in the coefficients is the reason why these coefficients are negative? We are not convinced as the bias, while negative, should not be that big. Rather, we suspect the negative coefficients reflect internal migration from slow-growing to fast-growing cities: it is the result you would expect if representative slices of a city moved from one city to another. Consider a slowly growing city. When people move from a slowly growing city to a rapidly growing city, the Bartik measure for widely-distributed services reflects employment growth in the rest of the country, which is higher than employment growth in the slowly growing city. This induces a negative relationship into the regression because city-level employment in widely redistributed service sectors is highly correlated with total employment in the city. Consequently, the negative coefficient between total employment changes in one city and service sector employment in other cities also means that city level employment changes are negatively correlated with city level employment changes in the rest of the country. Given that there is large scale internal migration from slow growing cities to fast growing cities in New Zealand, we suspect the negative coefficient occurs because the effects of shocks to particular widely distributed service industries on total employment are dominated by overall population shifts between cities.

For regionally specialised industries, the estimated own sector coefficient $\beta^{ii} = 0.25$ (with a 95% confidence interval of 0.03 to 0.5) and the total employment coefficient $\beta^{Ei,}$ is estimated to be 0.92 (with a 95% confidence interval of 0.2 to 1.7). The latter coefficient indicates aggregate city employment changes nearly one for one with changes in regionally specialised service industry employment in the rest of the country. The estimated coefficient is similar to the estimated coefficient of the primary sector. If this estimate is accurate, it indicates that shocks to regionally specialised industry employment are not offset by employment changes in other sectors.

Summary

The main findings from these regressions are as follows:

- Employment shocks to widely distributed manufacturing employment tend to be offset by changes in other employment, so total employment changes by less than the shock. Negative employment shocks to the widely distributed manufacturing industries that were a feature of New Zealand's larger urban areas were absorbed by expanding specialist service industries.
- Employment shocks to regionally specialised manufacturing industries were absorbed less well and were not associated with expansions in specialist service industries. Since these manufacturing industries are disproportionately located in smaller towns, smaller towns had a much more difficult transition to the decline in manufacturing than larger urban areas.
- Employment shocks to primary industries and specialist service industries do not appear to be absorbed by other sectors of the economy. Total employment appears to change by the amount of the shock to specific industries.
- The Bartik methodology does not capture employment shocks to widely distributed services (such as retailing or education) very well, as changes in local employment in widely distributed services are dominated by local population changes not national industry trends.

These results are in line with overseas evidence that suggest cities have a more difficult time adjusting to regionally specialised manufacturing job loss than other types of job loss. Polèse and Shearmur (2006) discuss this phenomena with respect to small cities that are dominated by a single firm, but Glaeser, Kerr and Kerr (2015) suggest that the problem may occur in large cities with a history of specialised manufacturing as well. Unfortunately, the high correlation between regionally specialised industries and the size of cities in our dataset have prevented us from untangling the extent to which the different rate at which manufacturing employment shocks were absorbed in New Zealand between 1976 and 2013 was primarily an industry effect or a small city effect. As emphasised in the disclaimer at the beginning of the Appendix, questions remain about the robustness and statistical significance of the results. Nevertheless, the results as presented here support the contention that small urban areas that were specialised in primary product manufacturing were less successful than larger urban areas in diversifying into other industries when they experienced negative employment shocks to their manufacturing industries.