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A quarter century of subnational working-age population change in New Zealand: Contributions of migration and cohort turnover 1998-2023

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Abstract

This paper quantifies the demographic drivers of change in New Zealand's working-age population (ages 15-64) across 66 territorial authorities and 21 Auckland local boards over 1998-2023. Using Stats NZ population estimates and subnational mortality data, we implement a demographic accounting decomposition in five-year intervals that separates working-age population change into cohort turnover (entries aged 15-19 minus exits aged 60-64), working-age deaths, and residual net migration. Nationally, the working-age population expanded in every period, but the dominant component shifted. Positive cohort turnover accounted for most growth through 2013, whereas residual net migration contributed over 90% of growth after 2013. Subnationally, negative cohort turnover spread from being experienced by no areas in 1998-2003, to a substantial minority of areas by 2018-2023. The number of areas with declining working-age populations fluctuated substantially from one period to the next. A four-category typology and analysis of residual migration offset ratios for areas with negative cohort turnover shows that positive migration offsets negative cohort turnover in some places but not consistently, leaving local labour-supply trajectories increasingly contingent on volatile and spatially uneven migration.

Keywords

Working-age population
Cohort turnover
Migration
Population ageing
New Zealand

JEL Codes

J11, J21, J61, R12, R23

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Generative AI Use Statement

The authors used generative artificial intelligence tools to assist in drafting portions of the Introduction, Discussion, and Conclusions, and for general language editing. All AI-generated text was reviewed and substantially revised by the authors, who rewrote the manuscript as needed and remain solely responsible for the content, interpretations, and conclusions presented.

1. Introduction

Population ageing is now a defining demographic feature of many high-income countries, but its most immediate consequences are often felt subnationally. Local labour markets, housing demand, and the financing and provision of public services depend heavily on the size and age composition of the resident population. In that context, the working-age population (WAP, conventionally ages 15-64) is particularly consequential. Changes in the WAP shape potential local labour supply and, indirectly, the fiscal capacity that supports local infrastructure and services. Yet demographic narratives that reflect changes at the national level can obscure substantial spatial heterogeneity. Even in countries that remain relatively youthful in aggregate, subnational areas may face pronounced ageing and incipient population decline (Jackson and Brabyn 2017; Jackson and Cameron 2018).

A long-standing policy question is whether migration can meaningfully offset demographic pressures associated with ageing. The idea that international migration might "rejuvenate" populations has been discussed extensively, including through the influential "replacement migration" framing (Coleman 2002). For Australia and New Zealand, early demographic policy analyses similarly emphasized that migration could affect the short-to-medium-term size of the labour force, while recognizing limits to migration as a long-run response to below-replacement fertility and structural ageing (McDonald and Kippen 2000; Jackson and Cameron 2018). This is substantively because the fertility of migrant women tends to rapidly converge to the sub-replacement rates of the local population (Sobotka 2008). Importantly, however, the most policy-relevant question at the local level is not whether migration can prevent ageing in general, but whether migration has offset declines in the working-age population that arise mechanically from cohort succession driven by progressively smaller cohorts entering working ages and larger cohorts exiting them.

Recent demographic and regional science research underscores why this distinction matters. First, population decline (and depopulation) is not simply a story of "people leaving". Instead, it reflects the interaction of migration, fertility, and mortality over long horizons, including second-order effects whereby persistent out-migration reshapes age structures and thereby alters future natural population change (births minus deaths) (Johnson and Lichter 2019). Second, a growing body of evidence shows that local population decline can spread even without an increasing prevalence of net out-migration (Johnson, Field and Poston 2015; Johnson 2020). Falling fertility can remove a 'demographic tailwind' that previously allowed places to grow despite modest net migration losses, thereby turning migration rates that once implied growth into rates consistent with decline (Asquith and Mast 2025). These findings caution against interpreting local population (or local working-age population) decline as prima facie evidence of newly adverse migration dynamics.

A complementary literature focuses directly on the demographic accounting of WAP change. Ghio, Goujon, and Natale (2022) decompose WAP change across European territories into cohort turnover (the difference between entries into and exits from the working age population), mortality, and residual net migration. They show that negative cohort turnover is widespread, net migration is frequently positive, and yet migration fully counterbalances cohort-driven WAP deficits in only a minority of territories (Ghio, Goujon, and Natale 2022).

More broadly, regional demographic research highlights that migration and age structure tend to reinforce spatial disparities, as net inflows, particularly of young workers, concentrate in more prosperous regions while poorer or peripheral areas experience net losses (Prenzel 2021; see also Fratesi and Percoco 2014). These patterns can amplify unequal ageing and labour supply trajectories (Rees et al. 2012).

Despite prominent policy debates about migration, labour supply, and uneven regional growth, the demographic mechanisms underlying subnational WAP change in New Zealand have not been documented comprehensively over a long horizon using a consistent accounting framework. The extant New Zealand research makes clear that subnational population change is heterogeneous and that structural ageing is likely to be especially consequential outside major urban centres (Jackson and Brabyn 2017; Jackson and Cameron 2018). What remains missing is a systematic, local-area decomposition of WAP change that can answer a straightforward question: how much of observed subnational change in working-age population is a result of cohort turnover and mortality, and how much reflects net migration? Moreover, it is important to evaluate how that balance has shifted over time.

This paper fills that gap by providing a decomposition of WAP change across New Zealand territorial authorities and Auckland local boards (TALBs) over the period 1998-2023, in five-year time steps. We decompose the change in each TALB's WAP (ages 15-64) into three components: (i) a cohort turnover effect, defined as the difference in size between cohorts entering and exiting the WAP over each five-year interval; (ii) a mortality effect (deaths within the WAP); and (iii) net migration, calculated as a residual component that reconciles observed WAP change with cohort turnover and mortality. This approach follows a widely used demographic accounting logic and is closely aligned with the method applied by Ghio, Goujon, and Natale (2022) for European regions, who themselves cite the residual approach as a practical response to incomplete subnational migration statistics in intercensal periods (de Beer, van der Erf, and Huisman 2012; Ghio, Goujon, and Natale 2022). Our approach extends beyond that employed by Ghio, Goujon, and Natale (2022) for Europe, as we look at changes in the decomposition over time, rather than only considering cross-sectional variation. However, as with any residual method, the net migration estimates inherit limitations. They depend on the accuracy of the other components and do not distinguish in- from out-migration or internal migration flows from international migration flows (Siegel and Hamilton 1952; Ghio, Goujon, and Natale 2022).

The decomposition yields two central findings. First, cohort turnover becomes progressively less favourable over time, consistent with the advance of structural ageing. Across an increasing number of TALBs, the cohorts entering the WAP are smaller relative to those exiting from the WAP. Second, net migration becomes increasingly decisive in explaining WAP change in more recent years. In many TALBs, positive net migration, concentrated at prime working ages, offsets cohort-turnover deficits, supporting continued WAP growth or muting declines. In other TALBs, migration is insufficient to counterbalance negative cohort turnover, resulting in WAP stagnation or decline. Taken together, the results imply that national WAP growth can mask a growing subnational vulnerability, and that local

WAP stability is increasingly contingent on migration conditions that may be volatile or unevenly distributed across space.

This remainder of the paper proceeds as follows. Section 2 describes the data and geographic units and sets out the analysis framework and component definitions. Section 3 briefly outlines the relative importance of cohort turnover and net migration at the national level, then examines subnational heterogeneity across TALBs, including a typology of local working-age change regimes based on the sign and magnitude of cohort turnover and net migration. Section 4 discusses measurement considerations, including the residual construction of net migration. Section 5 concludes by synthesising the paper's core finding that cohort turnover is an increasingly important structural driver of subnational working-age population change, with migration providing an uneven and potentially volatile offset, and draws out implications for anticipating local labour-supply pressures in an ageing New Zealand.

2. Data and Methods

We work with data at the subnational level in New Zealand. New Zealand has 67 territorial authorities, which are the lowest level of political subdivision. The territorial authorities range in population size from Auckland (2023 estimated resident population of 1,755,200) to Chatham Islands Territory (2023 estimated resident population of 600). Auckland is substantially larger in terms of population than the second largest territorial authority, Christchurch City (2023 estimated resident population of 407,700). To ensure that our results are not biased by Auckland, we separate Auckland into its 21 constituent local boards, which are individually similar in size to territorial authorities. Specifically, they range in population size from Howick local board (2023 estimated resident population of 165,100) to Aotea/Great Barrier local board (2023 estimated resident population of 1240). That provides a sample of 87 territorial authorities and local boards (TALBs), made up of 66 territorial authorities and 21 Auckland local boards. The TALBs mostly had consistent boundaries over the entire period, with two main exceptions. First, Banks Peninsula District was amalgamated with Christchurch City in 2006. We treat the merged entity as a single territorial authority throughout our sample period. Second, the Auckland territorial authority was formed in 2010 by the merger of all of six previous territorial authorities (Rodney District, North Shore City, Waitakere City, Auckland City, Manukau City, and Papakura District) and part of a seventh territorial authority (Franklin District). The southern part of Franklin District was merged with Waikato District. We align the data for Auckland and Waikato District to the post-2010 boundaries, as explained below.

All data were obtained from Stats NZ. This included subnational population estimates by five-year age group, for each five-year time step from 1998 to 2023, for each TALB (n=87). These data are available for all TALBs based on post-2010 boundaries. For Census years (1996, 2001, 2006, 2013, 2018, 2023), Stats NZ derives population estimates at 30 June from the Census usually resident population, adjusted for: (i) net census undercount ("people who should have been counted but were missed less those counted in error or counted more than once by the census"; (2) residents temporarily overseas on census night; (3) births, deaths, and net migration between census night and 30 June; and (4) reconciliation with demographic estimates for ages 0 to 14 years. For non-Census years, the population estimates from the most recent Census year are updated to account for births, deaths, and estimates of net internal and international migration.[1] We used population estimate data for 1998, 2003, and 2008, rather than the Census years of 1996, 2001, and 2006, to ensure consistent five-year time steps in the analysis.[2]

We also obtained from Stats NZ annual mortality (vital statistics) data by five-year age group for June years from 2001 to 2023, for each TALB (n=87). For Auckland and its local boards, as well as Waikato District, data aligned with the post-merger boundaries are only available from the June 2012 year onwards. Data aligned with the pre-merger boundaries were available for the 2001 to 2011 years. We apportioned the deaths data to each Auckland local board and to Waikato District by their share of the combined Auckland and Waikato District populations in each year from 2001 to 2011. To extend the data for all TALBs from 2001 back to 1999, we scaled the 2001-year deaths for each TALB to the population for each of 1999 and 2000. Given that this approach will not capture short-run irregularities in mortality at the subnational level, the results for 1998 to 2003 should be treated with some caution.

We study the dynamics of the working age population over each five-year time period, where t is the start of the period, and t+5 is the end of the period. We define the working-age population (WAP) as the population aged 15 to 64 years (OECD 2021). We further define the 'entry cohort' as the population aged 10 to 14 years at time t, being the population that aged into the WAP during the five-year period from t to t+5, and the 'exit cohort' as the population aged 60 to 64 years at time t, being the population that aged out of the WAP during the five-year period from t to t+5.

To decompose population change into its components, we follow Ghio, Goujon, and Natale (2022), disaggregating the components of change in the WAP using the following identity:

$$(1) \qquad pop_{j,t+5}^{15-64} = pop_{j,t}^{15-64} + netmigr_{j,t\to t+5}^{15-64} - deaths_{j,t\to t+5}^{15-64} + entries_{j,t\to t+5}^{10-14} - exits_{j,t\to t+5}^{60-64}$$

where j indexes location (TALB), t indexes time, superscripts refer to the age group, *pop* is the population, *netmigr* is net migration, *deaths* is deaths of those in the WAP during the period, and *entries* and *exits* refer to entries into the WAP and exits from the WAP, respectively.

Because deaths are reported for the population aged 15 to 64 years in each year, but we observe the population aged 15-64 only at the beginning and end of each five-year period, some adjustments are required. To see why an adjustment is necessary, consider the following. For the cohort aged 10-14 at time t, one of four things can happen:

[1] See https://www.stats.govt.nz/information-releases/estimated-resident-population-2023-base-at-30-june-2023/.
[2] The Census originally scheduled for 2011 was delayed by two years (to 2013) due to a series of severe earthquakes in Canterbury in 2010 and 2011. From 2013, the five-year schedule of the Census was restarted.

(1) They age into the 15-19 cohort at time t+5 and are observed as part of the WAP at time t+5;

(2) They die at any time between t and t+5 before ageing into the 15-19 cohort, and are therefore not part of the WAP at time t+5;

(3) They age into the 15-19 cohort sometime between t and t+5, and then die before t+5, and are therefore not part of the WAP at time t+5; or

(4) They migrate out between t and t+5, and are therefore not part of the WAP at time t+5.

The problem is that, if we ignore this problem entirely, we would be treating all of (2), (3), and (4) as part of residual net migration. Residual net migration would be under-estimated (since the deaths that should be excluded [(2) and (3)] would be treated as out-migration). On the other hand, if we considered all of the deaths of those aged 10-14 at time *t* between time *t* and *t*+5 (necessarily proxied by the 10-14 deaths for each of the five years), we would be treating the inverse of (2) as part of residual migration. Residual migration would be over-estimated (since too many deaths would be subtracted from out-migration). There is an analogous situation at the 60-64 years age group. In their paper, Ghio, Goujon, and Natale (2022) make an adjustment by including only half of deaths in the 60-64 years age group. However, they fail to make the symmetrical adjustment to deaths in the 10-14 years age group. We make adjustments to deaths in both age groups. Note that this adjustment assumes that deaths are uniformly distributed both across the five-year age group and over time.[3]

We then further define the change in the working age population (ΔWAP) as:

(2) $$\Delta WAP_{j,t\rightarrow t+5}^{15-64} = pop_{j,t+5}^{15-64} - pop_{j,t}^{15-64}$$

and we define cohort turnover (CT) as:

(3) $$CT_{j,t\rightarrow t+5}^{15-64} = entries_{j,t\rightarrow t+5}^{10-14} - exits_{j,t\rightarrow t+5}^{60-64}$$

Net migration is calculated as a residual from the identity in Equation (1) (de Beer, Van der Erf, and Huisman 2012). That is:

(4) $$netmigr_{j,t\rightarrow t+5}^{15-64} = pop_{j,t+5}^{15-64} - pop_{j,t}^{15-64} + deaths_{j,t\rightarrow t+5}^{15-64} \\ - entries_{j,t\rightarrow t+5}^{10-14} + exits_{j,t\rightarrow t+5}^{60-64}$$

As noted by Ghio, Goujon, and Natale (2022), there are several limitations to this residual method of estimating net migration. First, the accuracy estimates of net migration

[3] A small amount of bias will remain, as we use deaths of those aged 10-14 (and 60-64) years in each year, rather than increasing the age of each cohort by one year in each year of the five-year period. Since mortality increases with age, this likely slightly under-estimates the number of deaths, and therefore slightly under-estimates residual net migration. We anticipate that the amount of bias introduced by this is small, and the overall bias is certainly much smaller than making no adjustments at all.

obtained using the residual method depends crucially on the accuracy of the other components. In our case, the other components are derived from official population estimates and vital statistics data, which are expected to be of high quality. Second, the residual method offers no way of distinguishing between net internal migration and net international migration. This somewhat limits our ability to derive policy implications from the results, because immigration policy (which affects net international migration) will likely have different impacts than regional development policy (which affects net internal migration), and we cannot separately distinguish the two components of migration flows. Third, there is an implicit assumption in the analysis that entry and exit cohorts of workers are close substitutes. This is obviously not the case, as entry cohorts have less work experience than exit cohorts. As Morin (2015) notes, the substitutability between cohorts of workers is negatively correlated with the age difference between them. Again, this matters for the policy implications to be derived from our results.

We decompose the change in the working age population into its three components (cohort turnover, deaths, and net migration) for each TALB (and for New Zealand in total) for each five-year period from 1998 to 2023. We then look at the relationship (at the TALB) level between net migration and cohort turnover, each expressed as a ratio (or percentage share) of the WAP change. In this, we mostly set aside the mortality effect. The number of working age deaths is fairly constant in absolute terms in each five-year period, even during the COVID-19 pandemic, where New Zealand was less affected than most other countries (Plank, Senanayake and Lyon 2025). Thus, changes in the share of WAP change arising from mortality change mechanically with the size of WAP change.

Next, for each five-year period we categorise each TALB into one of four types (clusters): (1) TALBs with positive cohort turnover and positive net migration (Cluster One); (2) TALBs with positive cohort turnover but negative net migration (Cluster Two); (3) TALBs with negative cohort turnover but positive net migration (Cluster Three); and (4) TALBs with negative cohort turnover and negative net migration (Cluster Four). We further separate each cluster into TALBs that experienced overall growth in the working-age population from those that experienced over decline in the working-age population. That overall results in eight categories of TALBs in each five-year period (four clusters for each of overall growth and decline in WAP). Although this approach to clustering is somewhat arbitrary compared to using a more formal clustering approach such as *k*-means clustering, we argue that the difference between positive and negative changes is salient and important to policy-makers, and therefore this approach is justified.

Finally, for each TALB that experiences negative cohort turnover in any five-year period, we calculate the residual migration offset ratio:

$$(5) \qquad offsetratio_{j,t\to t+5} = \frac{netmigr_{j,t\to t+5}^{15-64}}{-CT_{j,t\to t+5}^{15-64}}$$

The residual migration offset ratio can take any real value. If the ratio is positive and larger than one, then residual migration is more than sufficient to offset the negative cohort turnover. If the ratio is positive but smaller than one, then residual migration only partially offsets the negative cohort turnover. Finally, if the ratio is negative, then residual migration worsens the negative impact of cohort turnover on WAP change. We limit the calculation of the residual migration offset ratio only to TALBs with negative cohort turnover, in order to answer the question of whether net migration can consistently offset the effects of negative cohort turnover.

3. Results

Table 1 summarises the change in working age population, and its components, for New Zealand as a whole for each five-year period from 1998-2023. The working-age population increased in every five-year period, with the smallest percentage increase in the period 2008-2013, in the wake of the Global Financial Crisis. The largest percentage increase was in the period immediately following that, from 2013-2018. The relative contributions of the components of change have varied strikingly over time. Cohort turnover has exerted a declining effect on WAP change over time, from a 5.5 percent increase in 1998-2003 to a 1.3 percent increase in 2018-2023. Deaths have been a relative constant contributor to WAP change, varying between 1.0 and 0.8 percent, although with a modest downward trend. In contrast, residual net migration has varied substantially, from being the smallest component in 2008-2013 to the largest in 2013-2018. This simply reflects cyclical changes in net international migration (Poot 1993; 2008). Thus, in the periods when WAP change is largest, residual net migration is also the largest.

Table 1: National-level working-age population change and its components

	1998-2003	2003-2008	2008-2013	2013-2018	2018-2023
WAP change (%)	**+6.6%**	**+6.3%**	**+2.8%**	**+10.7%**	**+5.1%**
Cohort turnover (%)	+5.5%	+5.3%	+3.2%	+1.9%	+1.3%
Net migration (%)	+2.1%	+2.0%	+0.4%	+9.7%	+4.6%
Deaths (%)	-1.0%	-1.0%	-0.9%	-0.9%	-0.8%

Notes. Working age population change is calculated as the percentage change between the start and the end of each five-year period. The remaining rows show the components of WAP change, as a percentage of the WAP at the start of each five-year period. As such, the three component shares sum to the percentage change in WAP in the first row.

The results in Table 1 do not suggest much of a relationship between the cohort turnover and net migration components of working-age population change at the national level.

However, we explore this idea further in Figures 1 and 2, which plot cross-sectional variation in cohort turnover (entries minus exits) against net migration using data at the TALB level, for the periods 1998 to 2003 and 2018 to 2023, respectively (figures that plot the other three five-year periods are included in the Appendix, Figures A1 to A3). We observe a negative relationship between cohort turnover and net migration (both measured as a percentage of the WAP at the start of the period) in all five-year periods, shown by the dotted line in each figure. The Pearson correlation coefficient between cohort turnover and net migration is -0.495 for 1998-2003, and -0.398 for 2018-2023 (with similar values for the other three periods).

Comparing Figure 1 and Figure 2 highlights two changes. First, there has been a general shift to the left, towards smaller and more negative cohort turnover. In the 1998-2003 period, no TALBs experienced negative cohort turnover, but a substantial minority of TALBs in the 2018-2023 did so. Second, there has been a smaller but still apparent shift upwards, towards more positive net migration. This latter effect is likely picking up the substantial increase in net international migration at the national level (as shown in Table 1), albeit playing out at the subnational scale. However, as noted earlier this may reflect cyclical change in international net migration, rather than a general trend over time.

Figure 1: The relationship between cohort turnover and net migration at the sub-national level, 1998-2003

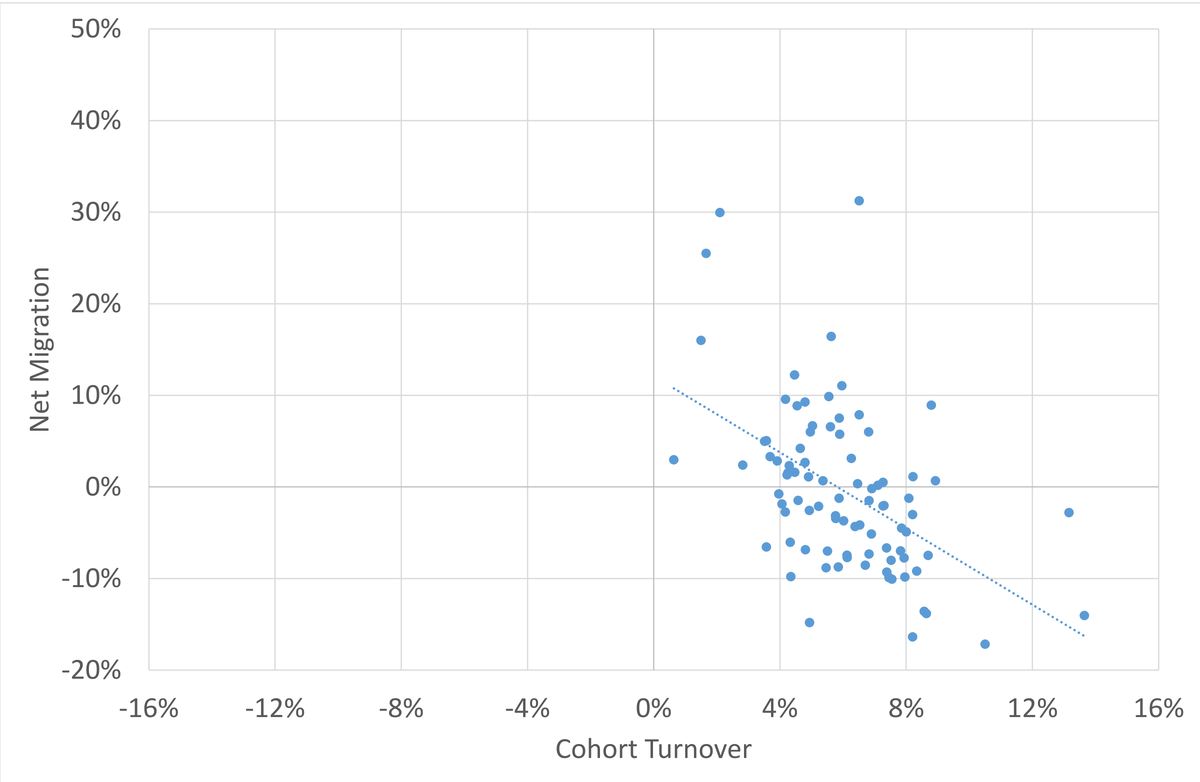
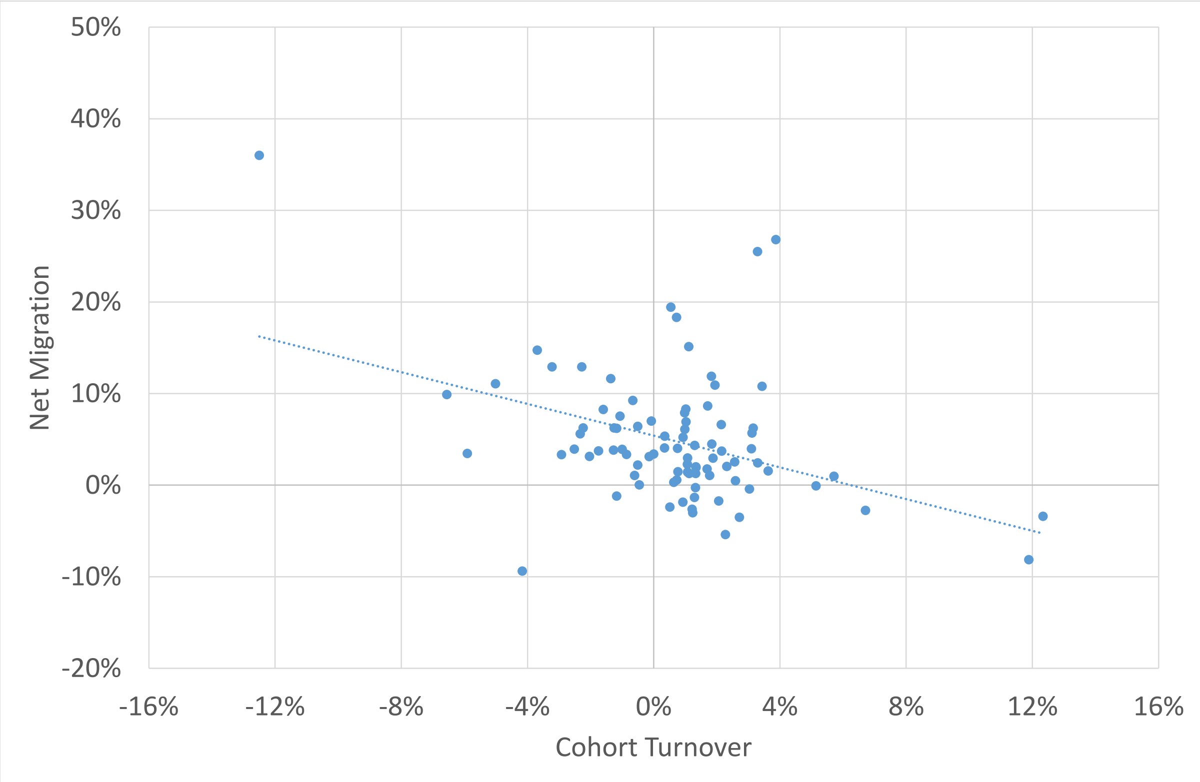


Figure 2: The relationship between cohort turnover and net migration at the sub-national level, 2018-2023



We next investigate subnational changes in the working age population and its components, categorising each TALB into one of four clusters, as described in the Data and Methods section. We perform this exercise separately for each five-year period. The categorisation of TALBs for each five-year period from 1998 to 2023 is shown in Table 2. The arrows in each table cell provide a comparison with the proportions in the previous five-year period. Panel (a) of Table 2 shows the categorisation of TALBs for the period 1998 to 2003. Consistent with Figure 1, no TALBs experienced negative cohort turnover in this period, so all TALBs are categorised in either Cluster One or Cluster Two, with a slightly higher proportion of TALBs in Cluster Two. Of the TALBs in Cluster Two, more than half experienced a decrease in the working age population in this period.

The categorisation of TALBs for the period 2003 to 2008 is shown in Panel (b) of Table 2. In comparison with the previous period, more TALBs were categorised in Cluster One, and fewer in Cluster Two. In addition, among Cluster Two TALBs, fewer experienced a decrease in the working age population in this period. However, against that general trend, one TALB was categorised in Cluster Three, making it the first TALB to experience negative cohort turnover. That was Thames-Coromandel District, a common retirement destination and widely recognised as the territorial authority with the oldest population in the country.

Table 2: Categorisation of TALBs, 1998-2023

	Cluster One: +ve cohort turnover; +ve net migration	**Cluster Two:** +ve cohort turnover; -ve net migration	**Cluster Three:** -ve cohort turnover; +ve net migration	**Cluster Four:** -ve cohort turnover; -ve net migration
		(a) 1998-2003		
All TALBs (Number; %)	**38 (43.7%)**	**49 (56.3%)**	**0 (0.0%)**	**0 (0.0%)**
TALBs with +ve change in WAP (Number; %)	38 (43.7%)	22 (25.3%)	0 (0.0%)	0 (0.0%)
TALBs with -ve change in WAP (Number; %)	0 (0.0%)	27 (31.0%)	0 (0.0%)	0 (0.0%)
		(b) 2003-2008		
All TALBs (Number; %)	**38 (43.7%) ↑**	**48 (55.2%) ↓**	**1 (1.1%) ↑**	**0 (0.0%)**
TALBs with +ve change in WAP (Number; %)	38 (43.7%) ↑	29 (33.3%) ↑	1 (1.1%) ↑	0 (0.0%)
TALBs with -ve change in WAP (Number; %)	0 (0.0%)	19 (21.8%) ↓	0 (0.0%)	0 (0.0%)
		(c) 2008-2013		
All TALBs (Number; %)	**32 (36.8%) ↓**	**46 (52.9%) ↓**	**8 (9.2%) ↑**	**1 (1.1%) ↑**
TALBs with +ve change in WAP (Number; %)	32 (36.8%) ↓	19 (21.8%) ↓	4 (4.6%) ↑	0 (0.0%)
TALBs with -ve change in WAP (Number; %)	0 (0.0%)	27 (31.0%) ↑	4 (4.6%) ↑	1 (1.1%) ↑
		(d) 2013-2018		
All TALBs (Number; %)	**65 (74.7%) ↑**	**3 (3.4%) ↓**	**18 (20.7%) ↑**	**1 (1.1%)**
TALBs with +ve change in WAP (Number; %)	65 (74.7%) ↑	2 (2.3%) ↓	18 (20.7%) ↑	0 (0.0%)
TALBs with -ve change in WAP (Number; %)	0 (0.0%)	1 (1.1%) ↓	0 (0.0%) ↓	1 (1.1%)
		(e) 2018-2023		
All TALBs (Number; %)	**43 (49.4%) ↓**	**14 (16.1%) ↑**	**28 (32.2%) ↑**	**2 (2.3%) ↑**
TALBs with +ve change in WAP (Number; %)	42 (48.3%) ↓	5 (5.7%) ↑	24 (27.6%) ↑	0 (0.0%)
TALBs with -ve change in WAP (Number; %)	1 (1.1%) ↑	9 (10.3%) ↑	4 (4.6%) ↑	2 (2.3%) ↑

Notes. Working age population (WAP) change is calculated as the percentage change between the start and the end of each five-year period. Cohort turnover is positive in TALBs where the number of entrants to the working age exceeds the number of exits, and is negative in the reverse case. The arrows in each cell denote the change in the proportion compared with the corresponding cell from the previous five-year period.

The categorisation of TALBs for the period 2008 to 2013 is shown in Panel (c) of Table 2. In comparison with the previous period, fewer TALBs were categorised in Cluster One, and fewer in Cluster Two as well. In addition, among Cluster Two TALBs, more experienced a decrease in the working age population in this period. There was also an increase in the number of TALBs classified in Cluster Three, as well as the first TALB categorised in Cluster Four. This was Marlborough District, in the north of the South Island, another of the oldest territorial authorities in the country. Half of the TALBs in Cluster Three experienced a decrease in the working age population (Aotea/Great Barrier local board; Waiheke local board; Thames-Coromandel District; and Central Otago District), and half experienced an increase (Waitematā local board; Carterton District; South Wairarapa District; and Waitaki District). The TALBs in Cluster Three are all common retirement destinations or rural or remote areas, typically with older populations.

The categorisation of TALBs for the period 2013 to 2018 is shown in Panel (d) of Table 2. In comparison with the previous period, more TALBs were categorised in the positive net migration Clusters One and Three, and fewer in Cluster Two. Only one TALB (Buller District on the west coast of the South Island) was categorised in Cluster Four. In addition, only two TALBs experienced a decrease in the WAP in this period, one being Buller District and the other the neighbouring Grey District (in Cluster Two). These changes reflect a period of high net international migration, pushing more TALBs into positive net migration clusters and increases in WAP. However, there was a further increase in the total number of TALBs in Clusters Three and Four, where cohort turnover is negative.

The categorisation of TALBs for the period 2018 to 2023 is shown in Panel (e) of Table 2. In comparison with the previous period, fewer TALBs were categorised in Cluster One, and more in each of the other three clusters. There was a further increase in the number of TALBs in the negative cohort turnover Clusters Three and Four, as well as a substantial increase in the number of TALBs experiencing an overall decrease in the WAP. This included one TALB in Cluster One (Gore District in the rural South Island), where working age mortality exceeded the combination of both positive net migration and positive cohort turnover. The number of TALBs in Cluster Four increased to two, with both experiencing a decrease in WAP – the remote Chatham Islands Territory, and Waitematā local board, which covers the central business district of Auckland. The latter is somewhat surprising on the face of it, but may reflect out-migration as a result of the COVID-19 pandemic, as well as a substantial decline in international student numbers (two large universities have their campuses in the Waitematā local board area).

Table 3 further explores the TALBs experiencing negative cohort turnover in each five-year period, summarising the residual migration offset ratio for those TALBs. As noted in the previous table, the number of TALBs experiencing negative cohort turnover increases substantially over time, from no TALBs in the 1998-2003 period, to 30 TALBs in the 2018-2023 period. Table 3 makes clear that most, but not all, TALBs with negative cohort turnover have nevertheless more than fully offset that negative cohort turnover by residual net migration. In the 2008-2013 period, two TALBs only partially offset negative cohort turnover (Aotea/Great Barrier local board; and Thames-Coromandel District), and one experienced negative net migration that exacerbated the negative cohort turnover (Marlborough District). In the 2013-2018 period, one TALB experienced negative net migration that exacerbated the negative cohort turnover (Buller District). Finally, in the 2018-2023 period, two TALBs only partially offset negative cohort turnover (Kaikoura District; and Dunedin City), and two experienced negative net migration that exacerbated the negative cohort turnover (Waitematā local board; and Chatham Islands Territory).

Table 3: Residual migration offset ratios for TALBs with negative cohort turnover, 1998-2023

	1998-2003	2003-2008	2008-2013	2013-2018	2018-2023
TALBs with -ve cohort turnover (C3 and C4) (Number; %)	0 (0.0%)	1 (1.1%)	9 (10.3%)	19 (21.8%)	30 (34.5%)
TALBs with full offset (ratio>1)	0	1	6	18	26
TALBs with partial offset (0<ratio<1)	0	0	2	0	2
TALBs with negative offset (ratio<0)	0	0	1	1	2
Median offset ratio	N/A	14.83	1.41	5.81	3.45

Notes. C# denotes the cluster number from Table 2.

The previous results highlight both a general increase in the number of TALBs experiencing decreases in WAP, as well as an increase in the number of TALBs with negative cohort turnover. However, they also highlight substantial churn in which TALBs are categorised in each cluster. We turn our attention to further exploration of the dynamics of changes in the working age population and its components over time. Table 4 shows the number of TALBs shifting between each of the four clusters, and between positive and negative WAP change, between each five-year period. Each panel in the table shows the change in categorisation from one five-year period to the next. Within each panel, the row shows the categorisation for the first five-year period in each pair, and the column shows the categorisation for the second five-year period in each pair. The quadrants (denoted by dark borders within each panel) group the TALBs with positive or negative WAP change in each five-year period. Shading of the cells denotes persistence over time. The darkest shaded (main) diagonal shows TALBs that have the same categorisation in the second five-year period as in the first, as well as maintaining positive or negative WAP change. The shaded cells in the top-right and bottom-left quadrants show TALBs that have maintained the same categorisation, but switched from positive WAP change to negative WAP change and vice versa, respectively.

The lightest shaded cells in the top-left and bottom-right quadrants show TALBs that have changed categorisation, but maintained positive or negative WAP change, respectively

The first noticeable result from Table 4 is that there is a large degree of persistence. Most TALBs are categorised the same from one five-year period to the next, as well as maintaining either positive or negative WAP change. For instance, between 1998-2003 and 2003-2008, 64 out of the 87 TALBs were categorised the same (and had the same direction of WAP change) in 2003-2008 as they were in 1998-2003. Similarly, 54 TALBs were categorised the same (and had the same direction of WAP change) in 2008-2013 as in 2003-2008, 32 TALBs were categorised the same (and had the same direction of WAP change) in 2013-2018 as in 2008-2013, and 58 TALBs were categorised the same (and had the same direction of WAP change) in 2018-2023 as in 2013-2018.

Second, even when TALBs switch from positive to negative WAP change, or vice versa, many remain in the same category (shown by the shaded diagonals in the top-right and bottom-left quadrants in each panel of Table 4). For example, between 1998-2003 and 2003-2008, both TALBs that shifted from positive WAP change to negative WAP change remained in the same cluster (Cluster Two), while seven out of ten TALBs that shifted from negative WAP change to positive WAP change remained in the same cluster (also Cluster Two).

Third, when TALBs shift from positive to negative WAP change (in the top-right quadrant of each panel in Table 4) and change categories, they invariably shift categories to the right of the diagonal. That means that a shift from positive to negative WAP change is often accompanied by a shift from positive to negative net migration (a shift from Cluster One to Cluster Two or Cluster Four, or a shift from Cluster Three to Cluster Four), positive to negative cohort turnover (a shift from Cluster One to Cluster Three or Cluster Four, or a shift from Cluster Two to Cluster Four), or both (a shift from Cluster One to Cluster Four). In contrast, when TALBs shift from negative to positive WAP change (in the bottom-left quadrant of each panel in Table 4) and change categories, this is accompanied by a wider variety of changes in category.

Table 4: Changes in the categorisation of TALBs, 1998-2023

(a)		2003-2008							
		C1+	C2+	C3+	C4+	C1-	C2-	C3-	C4-
1998-2003	C1+	31	6	1	0	0	0	0	0
	C2+	4	16	0	0	0	2	0	0
	C3+	0	0	0	0	0	0	0	0
	C4+	0	0	0	0	0	0	0	0
	C1-	0	0	0	0	0	0	0	0
	C2-	3	7	0	0	0	17	0	0
	C3-	0	0	0	0	0	0	0	0
	C4-	0	0	0	0	0	0	0	0

(b)		2008-2013							
		C1+	C2+	C3+	C4+	C1-	C2-	C3-	C4-
2003-2008	C1+	25	2	4	0	0	4	2	1
	C2+	7	14	0	0	0	8	0	0
	C3+	0	0	0	0	0	0	1	0
	C4+	0	0	0	0	0	0	0	0
	C1-	0	0	0	0	0	0	0	0
	C2-	0	3	0	0	0	15	1	0
	C3-	0	0	0	0	0	0	0	0
	C4-	0	0	0	0	0	0	0	0

(c)		2013-2018							
		C1+	C2+	C3+	C4+	C1-	C2-	C3-	C4-
2008-2013	C1+	26	0	5	0	0	0	0	1
	C2+	18	1	0	0	0	0	0	0
	C3+	0	0	4	0	0	0	0	0
	C4+	0	0	0	0	0	0	0	0
	C1-	0	0	0	0	0	0	0	0
	C2-	21	1	4	0	0	1	0	0
	C3-	0	0	4	0	0	0	0	0
	C4-	0	0	1	0	0	0	0	0

(d)		2018-2023							
		C1+	C2+	C3+	C4+	C1-	C2-	C3-	C4-
2013-2018	C1+	42	3	8	0	1	9	2	0
	C2+	0	2	0	0	0	0	0	0
	C3+	0	0	14	0	0	0	2	2
	C4+	0	0	0	0	0	0	0	0
	C1-	0	0	0	0	0	0	0	0
	C2-	0	0	1	0	0	0	0	0
	C3-	0	0	0	0	0	0	0	0
	C4-	0	0	1	0	0	0	0	0

Notes. C# denotes the cluster number from Table 2, while +/- denotes an increase or decrease in the working age population (WAP) respectively. Shading denotes persistence over time. The darkest shaded (main) diagonal shows TALBs that have the same categorisation in the second five-year period as in the first, as well as maintaining positive or negative WAP change. The shaded cells in the top-right and bottom-left quadrants show TALBs that have maintained the same categorisation, but switched from positive WAP change to negative WAP change and vice versa, respectively. The lightest shaded cells in the top-left and bottom-right quadrants show TALBs that have changed categorisation, but maintained positive or negative WAP change, respectively.

4. Discussion

This paper set out to document how New Zealand's working-age population (WAP; ages 15-64) has changed nationally, as well as subnationally across territorial authorities and Auckland local boards (TALBs), from 1998 to 2023, and to quantify the relative contributions of cohort turnover, mortality, and net migration to those changes. The results underscore a central demographic tension for an ageing country: national WAP growth can coexist with increasing subnational exposure to WAP decline driven by cohort turnover. In the earlier periods (1998-2013), national WAP growth was driven primarily by positive cohort turnover (as shown in Table 1). In contrast, in the more recent decade (2013-2023), net migration became the dominant component of national WAP change, while cohort turnover has become markedly less positive across a growing number of TALBs (as shown in Table 2). Put differently, the arithmetic of structural ageing is increasingly visible at local scale, and local WAP trajectories are correspondingly more contingent on migration conditions that are volatile and spatially uneven.

The most robust and policy-relevant signal arising from our decomposition results is the steady spread of negative cohort turnover across TALBs. Negative cohort turnover, wherein smaller cohorts are ageing into working ages relative to cohorts ageing out, operates mechanically through cohort size differences and is therefore a useful summary statistic for subnational exposure to ageing-driven reductions in labour supply. In the early periods we examine (1998-2003), no TALBs had negative cohort turnover, whereas by the later periods (2018-2023), negative cohort turnover characterised a substantial minority (as shown in Figures 1 and 2, and Table 2). This pattern is consistent with a broader international literature showing that (i) local population decline and labour-supply pressures often arise from long-run age-structure dynamics rather than from a sudden 'exodus'; and (ii) natural decrease and cohort turnover can become increasingly decisive as fertility remains below replacement and larger cohorts move into older ages (Johnson, Field, and Poston 2015; Johnson 2020; Johnson and Lichter 2019). It also aligns closely with prior New Zealand work emphasising that subnational ageing and ageing-driven growth and decline unfold unevenly, with rural, peripheral, and amenity or retirement destinations often at the leading edge of demographic ageing (Jackson and Brabyn 2017; Jackson and Cameron 2018).

Two implications follow from these results. First, where negative cohort turnover is present, local WAP growth requires either: (1) sufficiently positive net migration at working ages; (2) sustained increases in labour force participation among older ages (beyond the scope of this paper); or (3) offsetting changes outside the working age population, such as delayed retirement that effectively extends working life beyond age 65. Second, as negative cohort turnover becomes more widespread, the set of places competing for a limited pool of working-age potential migrants expands, raising the likelihood that migration becomes a zero-sum (or near zero-sum) competition nationally, even while migration remains pivotal for local population growth.

Our decomposition clarifies a point sometimes lost in public debates about whether migration is a solution to population ageing. The relevant question at local scale is not whether migration can stop population ageing in general, which it cannot feasibly do (Jackson and Cameron 2018; McDonald and Kippen 2000), but whether migration can offset cohort-driven declines in the WAP. Across TALBs, our results are consistent with the proposition that migration often counterbalances adverse cohort turnover over short horizons, but not universally. There are a small number of TALBs in each of the latter periods where residual net migration only partially offsets (or even exacerbates) negative cohort turnover (as shown in Table 3). This mirrors evidence from Europe, where negative cohort turnover is more widespread than in New Zealand and net migration is frequently positive, yet net migration full offsetting cohort-driven WAP deficits occurs only in a minority of areas (de Beer, van der Erf, and Huisman 2012; Ghio, Goujon, and Natale 2022). Our results are also consistent with a long-standing demographic consensus that plausible immigration levels may slow over time, and therefore cannot be expected to offset underlying consequences of sustained low fertility and rising longevity on the population age structure, especially over long horizons (UNDESA Population Division 2000; Bijak et al. 2007; McDonald and Kippen 2000). In the New Zealand context, the increasing importance of net migration in the later periods (as shown in Table 1) should therefore be interpreted as both a short-to-medium run mechanism for sustaining WAP growth nationally and in many TALBs, and as a source of vulnerability, because international migration flows can shift sharply with macroeconomic conditions, policy settings, and national and international economic and other shocks.

The TALB-level heterogeneity we observe is consistent with spatially selective migration processes documented in regional science, whereby net inflows tend to concentrate in larger and/or more prosperous labour markets, reinforcing divergence in age structures and labour supply (Fratesi and Percoco 2014; Prenzel 2021). That selectivity is also visible in the typology results, where Clusters One and Three (positive net migration) expand markedly in 2013-2018, then partly retreat in 2018-2023 (as shown in Table 2). The central lesson is that migration can buy time for some places, but it does so unevenly, and its capacity to substitute for cohort turnover is limited.

The four-cluster typology provides a useful descriptive map of local demographic 'regimes' of WAP change. Cluster One (positive cohort turnover and positive net migration) corresponds to demographically and economically advantaged contexts where both cohort turnover and migration support WAP growth. Cluster Two (positive cohort turnover but negative net migration) and Cluster Three (negative cohort turnover but positive net migration) are perhaps the most policy-relevant regimes. Cluster Three represents places that are already facing ageing-driven negative cohort turnover but still able, at least intermittently, to attract enough working-age net migration to stabilise or grow the WAP. Cluster Two, on the other hand, represents the reverse – places that have favourable cohort turnover, and yet where migration flows are mostly outwards. Cluster Four represents the acute-risk regime where both cohort turnover and migration are negative.

Two patterns stand out in the transition matrix (as shown in Table 4). First, there is substantial persistence. Many TALBs remain in the same cluster (and maintain the sign of WAP change) from one period to the next. This is consistent with slow-moving fundamentals, such as long-run differences in economic opportunities, amenities, housing markets, and accessibility, that shape the attractiveness of different places to migrants. It is also consistent with the age-selectivity of migration, whereby the age distribution migration flows between particular areas differ in specific ways, such as with retirement migration. Second, when TALBs switch from WAP growth to decline, this deterioration in WAP outcomes is often associated with a worsening of net migration, cohort turnover, or both. This reinforces the interpretation that, once negative cohort turnover emerges, local WAP growth becomes more sensitive to changes in migration conditions.

The results for particular TALBs mentioned in the paper also illustrate how local context matters. Thames-Coromandel's early appearance as the first TALB with negative cohort turnover (in the 2003-2008 period) is consistent with its role as a retirement/amenity destination and its older age structure; similar interpretations likely apply to other areas that enter Cluster Three over time. The identification of Waitematā local board in Cluster Four in 2018-2023 is substantively plausible in light of pandemic-era disruption to central-city residence patterns and the sharp fall in international student numbers during border restrictions, although the residual nature of net migration measurement also cautions against over-interpreting any single local outcome without corroborating data on migration flows.

Our results point toward three policy-relevant implications, each with important caveats. First, local WAP stability is increasingly conditional on migration. Given that migration flows are both cyclical and increasingly volatile, this also makes the future WAP more uncertain. Where negative cohort turnover is emerging, sustained WAP growth depends on net migration inflows at working ages. However, migration is cyclically sensitive and policy-sensitive. For New Zealand, the sharp swing in net migration around the pandemic period and subsequent reopening illustrates this volatility (even if our decomposition exercise ends in 2023). A planning implication is that local labour-supply baselines and infrastructure/fiscal forecasts should treat migration as a high-variance component, while cohort turnover provides a more stable "structural" signal of underlying pressure.

Second, immigration policy cannot be used as a simple substitute for regional development policy. While national immigration settings may affect WAP at the aggregate (national) level, they will not automatically deliver working-age residents to places experiencing adverse cohort turnover. Indeed, the local destination of the majority of international migrants to New Zealand is Auckland, rather than the TALBs that are experiencing WAP decline. For subnational WAP, the distribution of migration across space is as important as the national total. That suggests a continuing and increasingly important role for regional development policy in ensuring the resilience of regions to population ageing and WAP decline.

Third, as noted in the Introduction, entry and exit cohorts are not perfect substitutes. Even if net migration offsets the number of working-age residents, it may not offset the effective labour supply if entrants differ from exit cohorts in occupation-specific skills, experience, or local labour-market fit (Morin 2015). This is especially salient for smaller TALBs with specialised industry mixes (e.g. primary industries, tourism) where occupational matching constraints may be binding. Thus, policies oriented toward replacing exiting workers via migration should be paired with strategies that raise labour force participation, productivity, and skill formation locally (including for older workers), rather than relying on replacement of the WAP alone.

The decomposition framework we employed in our analysis is transparent and well suited to long-run, consistent subnational accounting, but several limitations constrain interpretation. First, the residual measurement of net migration means that any measurement error in population estimates and mortality is attached to the measurement of net migration. Even with high-quality official inputs, non-census-year population estimation methods may smooth underlying components, affecting the period-by-period partitioning between cohort turnover and net migration. The early-period approach to extending mortality data back to the 1998-2003 period adds additional uncertainty for that period. Second, we are unable to separate internal and international migration, or migration inflows from outflows. This limits the extent to which we can attribute any particular change to contemporary policy settings or local labour market conditions, and prevents the identification of whether changes reflect changes in in-migration, out-migration, or both. Third, the typology we employ in categorising TALBs is intentionally coarse. Classification by sign (positive/negative) is transparent, but it may mask important magnitude differences. Two TALBs may be in the same a cluster while facing very different degrees of cohort turnover and net migration. Extending the framework to statistically identified clusters (rather than sign-based bins) would likely sharpen inference about persistent ‘regime types’. Nevertheless, these limitations do not undermine the core descriptive contribution of the paper, which maps broad structural patterns rather than providing fine-grained measurement of directional migration flows.

Our research opens several high-value directions for extension. First, an obvious extension is to quantify the net migration required for each TALB to stabilise its WAP. This could be compared to actual net migration, to identify areas with persistent shortfalls that may be in need of policy attention. This could be further extended by considering future trajectories of WAP change using the projected population by age group and projected net migration flows. Future research could move beyond the coarse typology used in this paper to adopt a data-driven clustering approach. This has the advantage of identifying statistically coherent demographic regimes but comes at a potential cost of easy interpretation. Separating net migration into internal and international migration, and into in-flows and out-flows, also offers a high-value opportunity to extend this work. This is feasible in New Zealand due to the availability of high-quality administrative data in the Stats NZ Integrated Data Infrastructure, but was outside the scope of the present project. Finally, linking WAP change and its components to local economic outcomes would potentially offer better policy prescriptions from future work. Together, these extensions could offer deeper contributions that build on the descriptive demographic accounting in our paper.

5. Conclusion

This paper provides the first long-horizon, consistent decomposition of working-age population change across New Zealand territorial authorities and Auckland local boards from 1998 to 2023. The results show that national WAP growth masks substantial and increasing subnational heterogeneity in the demographic forces shaping local labour supply. In the earlier part of the period, favourable cohort turnover was the main contributor to WAP growth nationally, but over the last decade residual net migration became the dominant driver. At the same time, negative cohort turnover spread across an increasing number of TALBs, reflecting the advance of structural ageing and signalling that, for more places, WAP outcomes increasingly depend on sufficiently large net migration.

Migration can offset cohort-driven WAP deficits in some TALBs for short periods, and it has become increasingly decisive in explaining WAP outcomes in recent years. However, our analysis also reinforces the limits of migration as a durable response to ageing. That is because migration effects are unevenly distributed across space and can be volatile, while cohort turnover is a predictable structural pressure once age structures have shifted. For policymakers and planners, the key implication is that strategies to sustain local labour supply cannot rely on migration alone. They must also account for persistent cohort dynamics and consider complementary responses, such as raising labour force participation and productivity, adapting service provision and infrastructure to changing age structures, and aligning regional development settings with realistic demographic constraints.

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Appendix

Figure A1: The relationship between cohort turnover and net migration at the sub-national level, 2003-2008

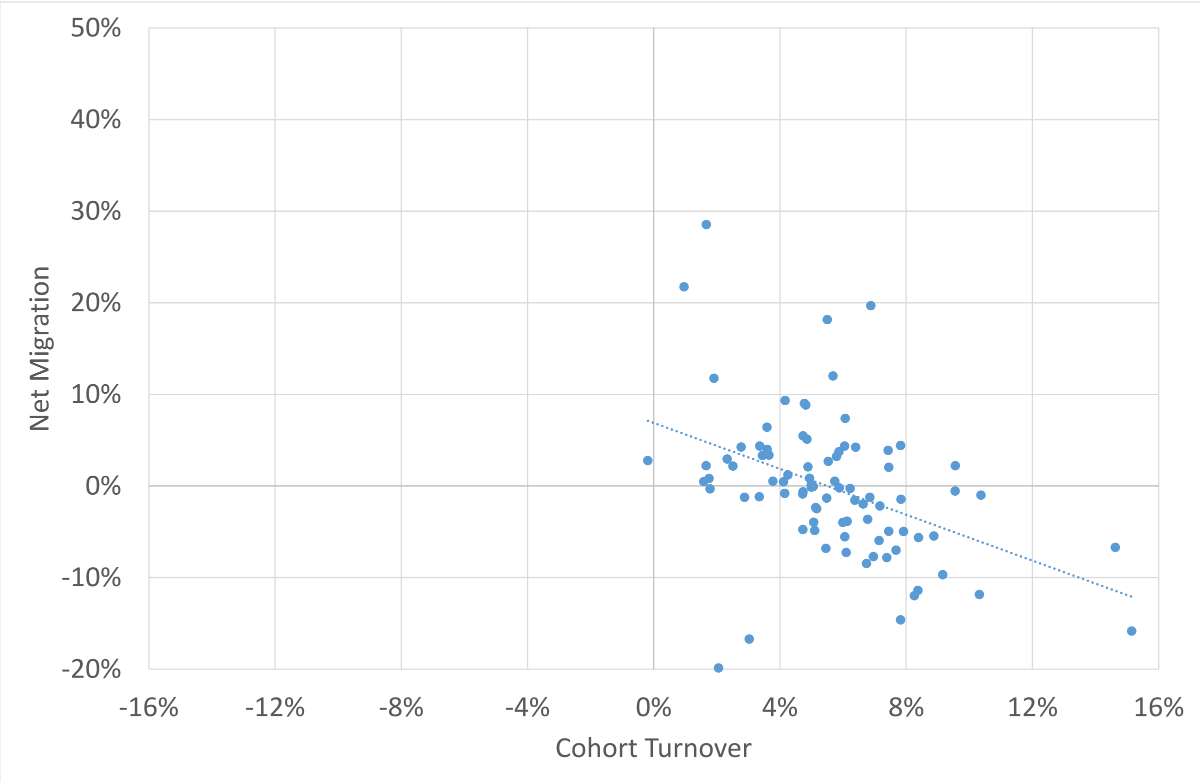

Figure A2: The relationship between cohort turnover and net migration at the sub-national level, 2008-2013

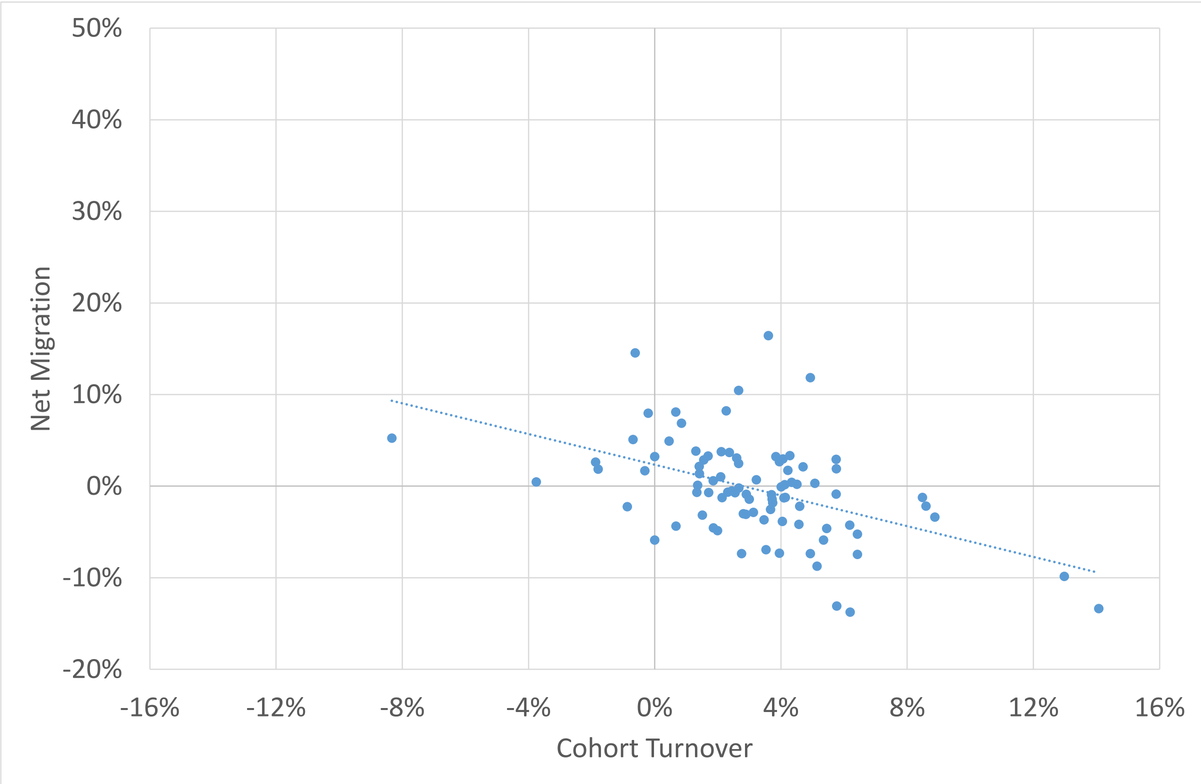

Figure A3: The relationship between cohort turnover and net migration at the sub-national level, 2013-2018