

The mechanisms of subnational population growth and decline in New Zealand 1976-2013

Introduction:

This article summarises key findings from the strand of the *Tai Timu Tangata. Taihoa e?* project that examined the mechanisms of subnational population change in New Zealand for 143 towns, 132 rural centres and 66 territorial authority areas (hereafter TAs), for the 37-year period 1976-2013. Because of space constraints we present the information as a set of 10 summary observations. For the underlying analyses please refer to Jackson, Brabyn and Maré (2016); Jackson and Cameron (2017), Jackson, Brabyn, Maré, Cameron and Pool (forthcoming); and Jackson and Brabyn (forthcoming).

Dr Natalie Jackson was Professor of Demography at Waikato University and Adjunct Professor of Demography at Massey University during the period of this research. She is also Director, Natalie Jackson Demographics Ltd (demographics@nataliejackson.net). Dr Lars Brabyn is Senior Lecturer, School of Geography, University of Waikato (larsb@waikato.ac.nz).

The broader rationale for the *Tai Timu Tangata* project is outlined by Jackson (*infra*). Essentially, current New Zealand has a relatively young and rapidly growing population. However, widespread *subnational* depopulation between 1996 and 2013 saw one-third of the nation's TAs decline in size; Auckland and 12 TAs shared 90 percent of growth, while the remaining 10 percent of growth was spread very thinly across 32 TAs. The situation has led to some towns being disparagingly labelled as 'zombie towns' (NBR 2014), and contrasted against their more successful growing counterparts.

With two large cities among those declining (Dunedin and Invercargill), and structural ageing known to drive a reduction in natural increase (the difference between births and deaths), we wished to better understand why some areas are growing and others not. Specifically, we wished to know whether parts of subnational New Zealand might be following their international counterparts in declining from what is proposed as a 'new' and increasingly

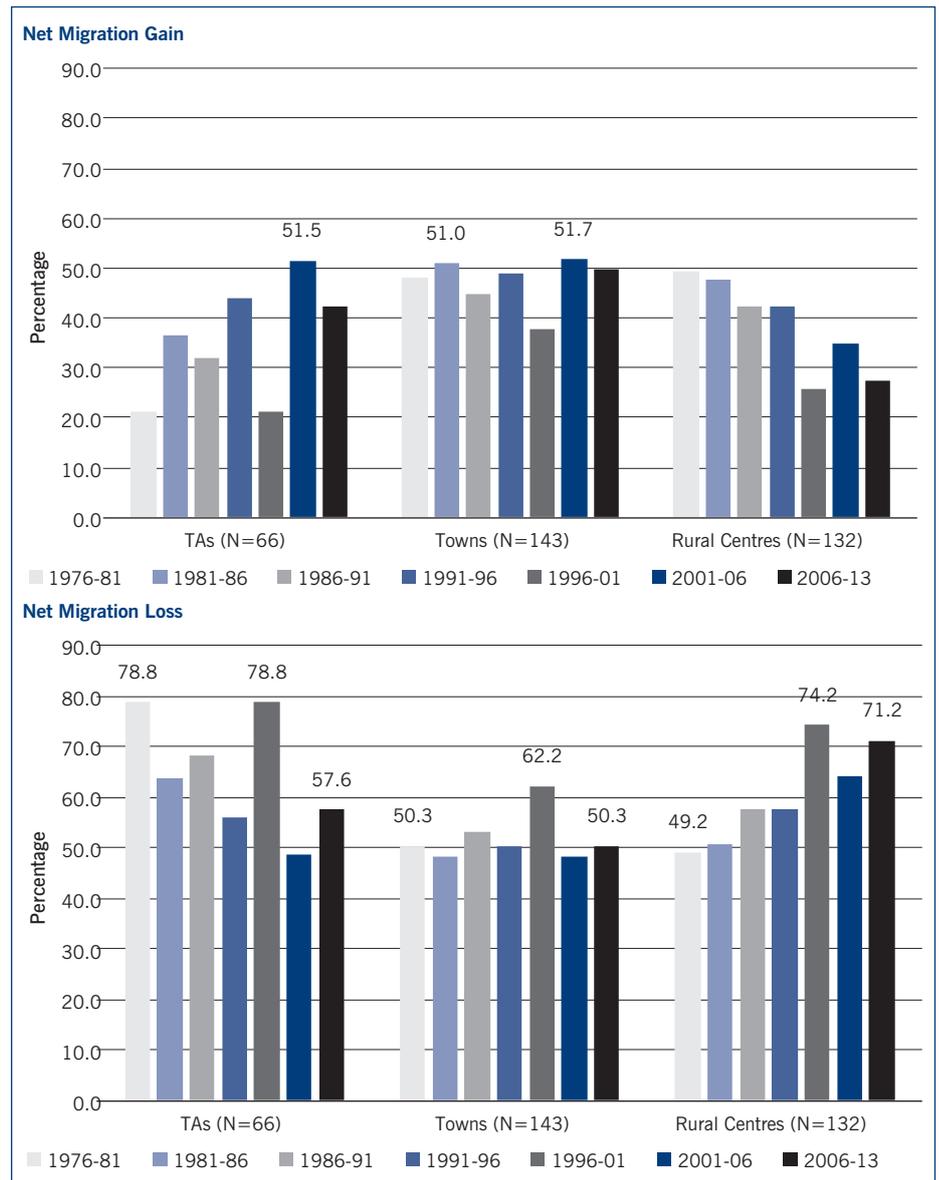
intractable form of population decline (where net migration loss is accompanied by natural decrease), as opposed to the 'old' form, where natural increase is positive but fails to offset net migration loss (Bucher & Mai 2005, cited in Matanle & Rausch 2011: 19-20, 46-47).

The question was not merely academic. Globally, population growth is theorized to end around the end of the present century, but much sooner across the developed world (Lutz, Sanderson & Sherbov 2004; Davoudi, Wishardt & Strange 2010; Reher 2007, 2011, Lee & Reher 2011). Reports from newly depopulating countries such as Japan are largely negative, indicating reduced investment in local infrastructure, widespread abandonment of schools, homes and business, and general social, economic and environmental damage outside of the main cities; at the same time, opportunities arising from a potential 'depopulation dividend' (Matanle 2017) need to be engaged with in a timely manner, long before local councils and similar agencies are overwhelmed with sustained depopulation that they have not been anticipating (Matanle & Sato 2010; Audirac 2012; Martinez-Fernandez, Kubo, Noya & Weyman 2012; McMillan 2016).

Indeed, if subnational New Zealand is following its international counterparts while at the same time being relatively youthful and growing strongly at national level, we asked if there could be broader theoretical implications that would contribute to a theory of depopulation, and thereby support councils and other agencies to plan for this eventuality in a more positive way (McMillan 2016).

Because the data we needed for the exercise were not available for many subnational jurisdictions, or for the period required, or on consistent geographical boundaries, we had to first extract them via statistical means. The methodology for creating this unique database is briefly described in the attached Appendix, with more detail available in Jackson et al., (2016). Key methodological points are that 'usually resident population' data for all census years 1976-2013 were aggregated to 2013 geographic boundaries based on Statistics

Figure 1: Percentage of Territorial Authority Area, Town and Rural Centre Populations experiencing net migration gain or loss, 1976-2013



Source: Jackson and Brabyn (forthcoming).

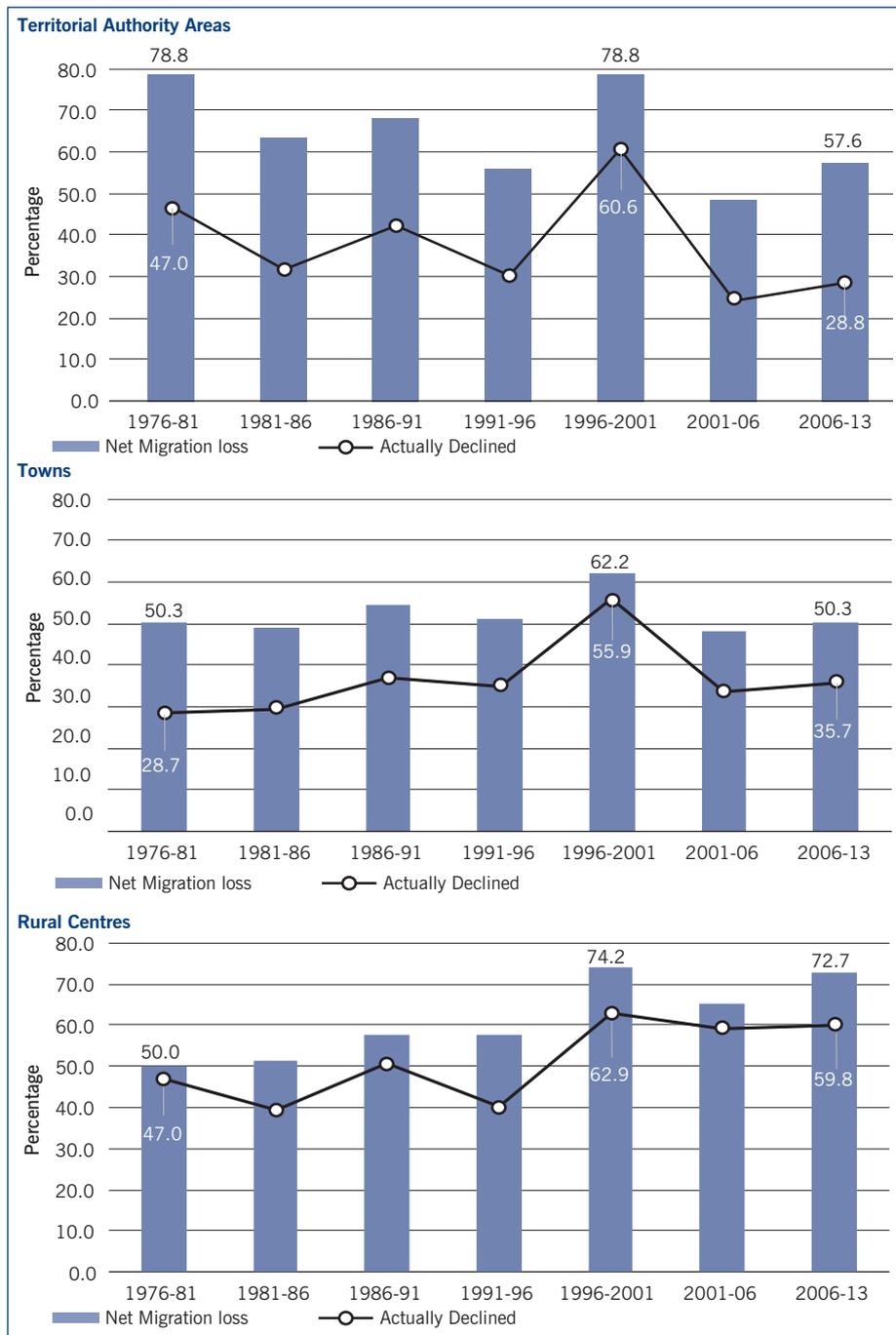
Notes: These data were first published in Jackson et al. 2016. Proportions here differ slightly, due to database revisions.

New Zealand's coding. The demographic components of change (births, deaths, natural increase) for each area were then retrospectively modelled using TA-level fertility and survivorship rates. An estimate of net migration (total and by age) was then extracted via the conventional residual method (net change minus natural increase = net migration). The exercise permitted us to develop births, deaths, natural increase and population by age data, both with and without migration. Although the baseline data and all rates for modelling have been sourced from statistics New Zealand, the resulting output has been developed for the purposes of this project, and should not be seen as official statistics.

Our 143 towns and 132 rural centres conform to Statistics New Zealand's 'urban areas'. This means that our 'towns' range in size from major (>30,000 people) to minor (1,000 – 9,999 people) urban areas, and our 'rural centres', from 300 to 999 people, in terms of their size in 1976. Under these arrangements, Auckland is divided into four zones, while data for rural districts is excluded. The latter was an unfortunate necessity, reflecting the large number of small units that would have needed to be analysed; however, where possible we note trends for the aggregate rural district population.

Methodologically it should also be noted that each data point carries equal

Figure 2: Percentage of TAs, Towns and Rural Centres experiencing net migration loss, and actually declining, 1976-2013



Source: Jackson and Brabyn (forthcoming)

weight, irrespective of size. This was a deliberate choice, in that our research is concerned with the extent to which individual jurisdictions - all of which have implications for such things as rates and resources - are affected, rather than what proportion of the total New Zealand population is affected (Jackson & Cameron 2017). For example, TA level patterns and trends are of interest to TA councils, while those for towns and rural centres are of interest to local councils, and their respective planners and

communities. The exclusion of rural districts from our detailed analyses means that such communities have only broad trends on which to deliberate.

One major theoretical conundrum also needs to be acknowledged. As outlined in the introduction to this Issue, the project has been informed by both demographic and mobility transition theories. Demographic transition theory (Davis 1945) is a 'global and national' level theory that essentially treats populations as 'closed', that is, changing only due to births

and deaths, while mobility theories by definition deal with 'open' populations affected by migration, and are applied sub-nationally, nationally and globally. To avoid getting tangled in theoretical constructs (but see but see Pool, *infra*; Jackson and Pool, forthcoming), we proceed here on the basis that the New Zealand population is in fact both 'open' as in mobility theories, and is ageing structurally, as theorised in demographic transition (following Dyson 2011).

Following are ten key observations drawn from the project. These are necessarily brief, but, as noted, more formally elaborated in the referenced papers. We conclude the article with a short summary and consideration of related policy implications.

Observation 1: The majority of areas experience net migration loss rather than gain
 Figure 1 compares the percentage of TAs, towns, and rural centres experiencing net migration gain or loss from 1976-2013. The majority of TAs and rural centres experienced somewhat greater net migration loss than gain at most observations. For towns the split was typically close to 50:50, although net loss was somewhat greater than gain between 1986 and 1991, and 1996 and 2001. Recalling that rural district data were not analysed in detail for this project, their aggregate suggests a slightly different story, with slightly more years of gains than losses, and those gains being sustained since 2001.

Observation 2: Net migration loss does not always result in population decline
 Figure 2 shows the percentage of TAs, towns and rural centres experiencing net migration loss from 1976 to 2013, and the percentage actually declining. The difference between the two measures is accounted for by natural increase (births minus deaths), discussed further below. On average 59 percent of TAs experiencing net migration loss actually declined; for towns and rural centres the proportions were 70 and 84 percent respectively. These data indicate that TAs and towns have been more able than rural centres to cover their net migration loss with natural increase, and conversely, that

net migration loss is a stronger predictor of net decline for rural centres than towns and TAs.

Observation 3: The majority of areas are smaller with, than without, migration

In total, 62 percent of TAs, 66 percent of towns and 50 percent of rural centres were larger in 2013 than in 1976. However, because net migration was often negative, a proportion of those growing across the period was smaller with migration than they would have been without. By ‘with migration’ we mean population change due to both migration and natural increase; by ‘without migration’ we mean population change due to natural increase only (see Appendix). Thus, those growing, but smaller than they would have been without migration, owe much of their growth to natural increase. We elaborate on these interactions further below.

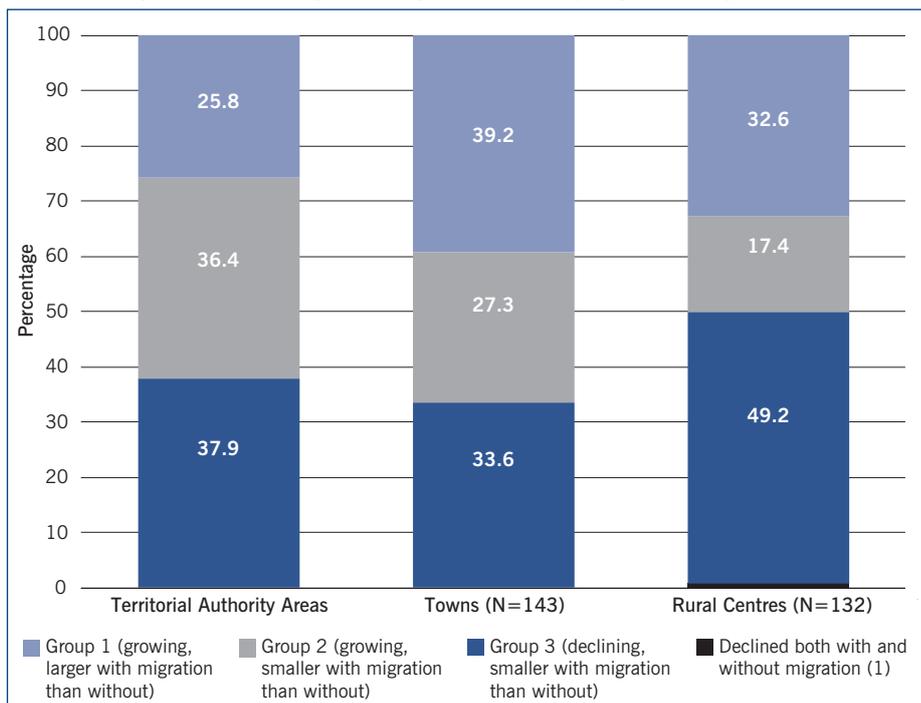
The exercise generated three groups of interest (Figure 3):

Group 1: Areas that grew between 1976 and 2013 and were larger with migration than without. This situation pertained to 26 percent of TAs, 39 percent of towns, and 33 percent of rural centres.

Group 2: Areas that grew between 1976 and 2013, but were smaller in 2013 with migration than without. These areas experienced periods of net migration loss, but it was either partially or fully offset by natural increase. This situation pertained to 36 percent of TAs, 27 percent of towns, and 17 percent of rural centres. In the aggregate it also pertained to rural districts, the total population of which was larger in 2013 (513,951) than in 1976 (398,436), but smaller than it would have been in the absence of migration (599,218).

Group 3: Areas that declined in size between 1976 and 2013, all of which were also smaller in 2013 with migration than without. In most cases these areas experienced natural increase, but it was completely offset by net migration loss. This situation pertained to 38 percent of TAs, 44 percent of towns, and 39 percent of rural centres.

Figure 3: Percentage of Territorial Authority Area, Town and Rural Centre Populations Growing/Declining 1976-2013 by impact of migration on size



Source: Jackson and Brabyn (forthcoming).
Notes: (1) refers to one rural centre (Waitati) which declined both with and without migration, but slightly less 'with'

Figure 4: Percentage of Territorial Authority Area, Town and Rural Centre Populations experiencing natural increase or natural decrease, 1976-2013, and projected for TAs to 2043

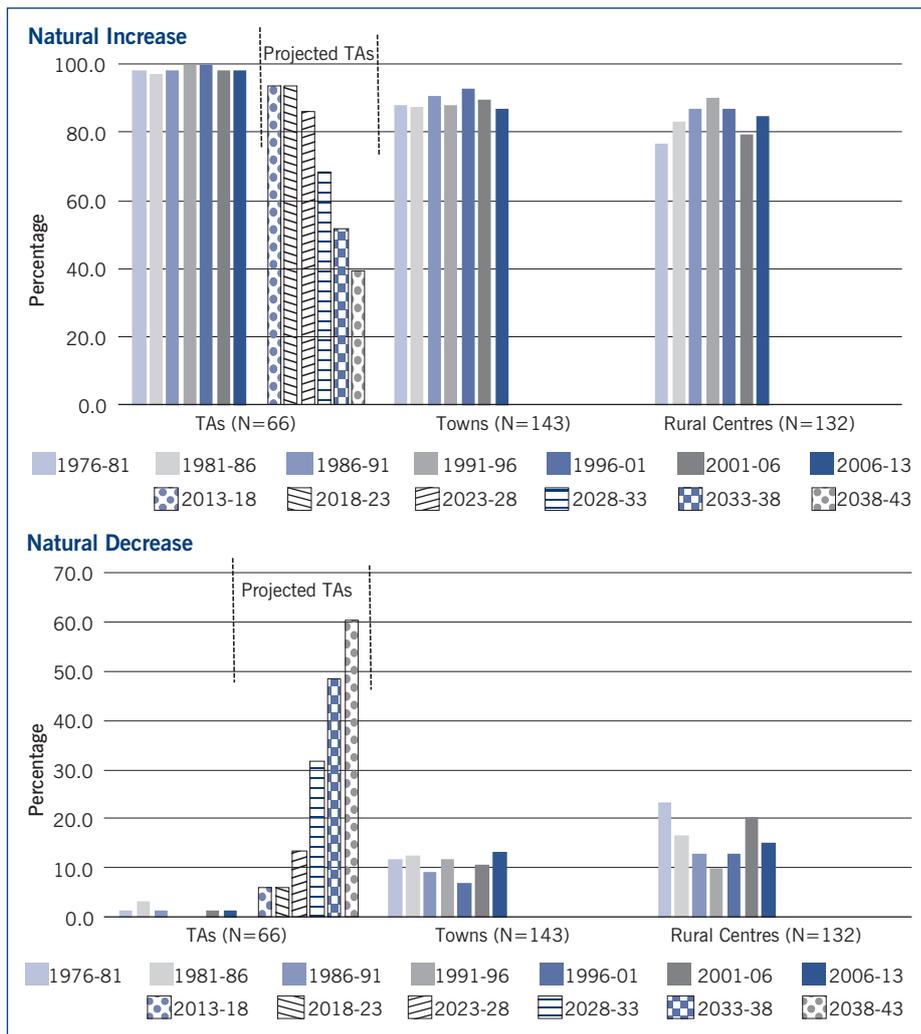


Table 1: Combination of components of change that deliver net growth or net decline

Outcome	Combination of Components
GROWTH	A: Natural Increase and Net Migration are both positive
	B: Natural Increase offsets Net Migration Loss
	C: Net Migration Gain offsets Natural Decrease
DECLINE	D: Net Migration Gain fails to offset Natural Decrease
	E: Natural Increase fails to offset Net Migration Loss
	F: Natural Decrease and Net Migration Loss
ZERO GROWTH	G: Natural Increase = Net Migration Loss
	H: Natural Decrease = Net Migration Gain

Source: Jackson, Cameron and Pool (2015). Notes: By 'offset' we mean to 'completely conceal'

In sum, migration is not a panacea for growth, while growth *per se* may not reflect net migration gain, but rather, be the result of natural increase offsetting underlying net migration loss.

Observation 4: The majority of areas experience natural increase – but this will soon change, with profound implications

During the period 1976-2013 the vast majority of TAs, towns and rural centres experienced natural increase, with levels in 2013 slightly higher for towns than rural centres (Figure 4, left panel). In the aggregate, rural districts also experienced natural increase across each five-year period. Natural *decrease* thus remains relatively low (right panel). However, supporting the main tenets of demographic transition theory, which

hold that the emergence of natural decrease is initially 'incipient' (intermittent onset), 47 towns and rural centres (17 percent) experienced natural decrease across more than one five-year period between 1976 and 2013, and 22 (8 percent) experienced it across five or more periods. In 2013, 19 towns (13 percent) and 20 rural centres (15 percent) were regularly experiencing natural decrease; for towns this had increased slightly, and for rural centres, reduced. These findings reflect those for the counties of the United States and Europe (Johnson, Field & Poston 2015), and confirm that New Zealand is following its older counterparts, but is as yet at a much earlier stage.

Attempting to extend the analysis forward, we drew on projections at TA level.¹ These data show that while natural

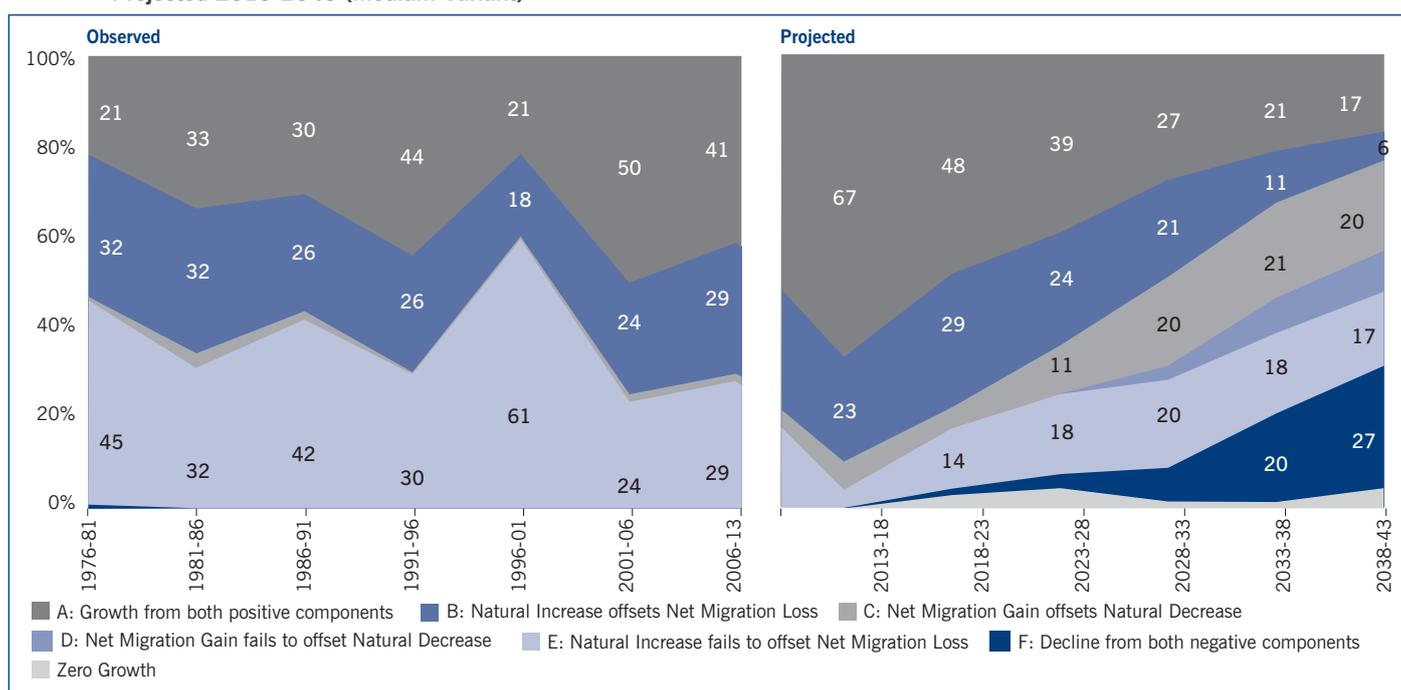
decrease is as yet barely evident at TA level, the projections (medium variant) indicate that it will be the experience of the majority (61 percent) of TAs by 2043, and thus of many of the towns and rural centres which comprise them (see also Jackson & Cameron 2017, and Cameron *infra*).

Observation 5: There are complex interactions between net migration and natural increase/decrease

Net migration and natural increase or natural decrease interact in several different ways to generate three different outcomes: growth, decline, and zero growth. Our project has identified three combinations that generate growth, three that result in decline, and two that result in zero growth (Jackson, Cameron & Pool 2015). We refer to these as Types A-C growth, Types D-F decline, and Types G and H zero growth (Table 1, and Figures 5 and 6).

For the policy community the typology is important because it provides 'advance warnindding end notdg' of the permanent ending of growth (see also Jackson 2014). Type A growth, where both elements are positive, is more robust than either Type B or C growth, where one or other element is negative, and is likely to be sustained for much longer. In particular, areas growing

Figure 5: Percentage of Territorial Authority Areas by Cause of Growth and Decline, 1976-2013, and Projected 2013-2043 (Medium Variant)



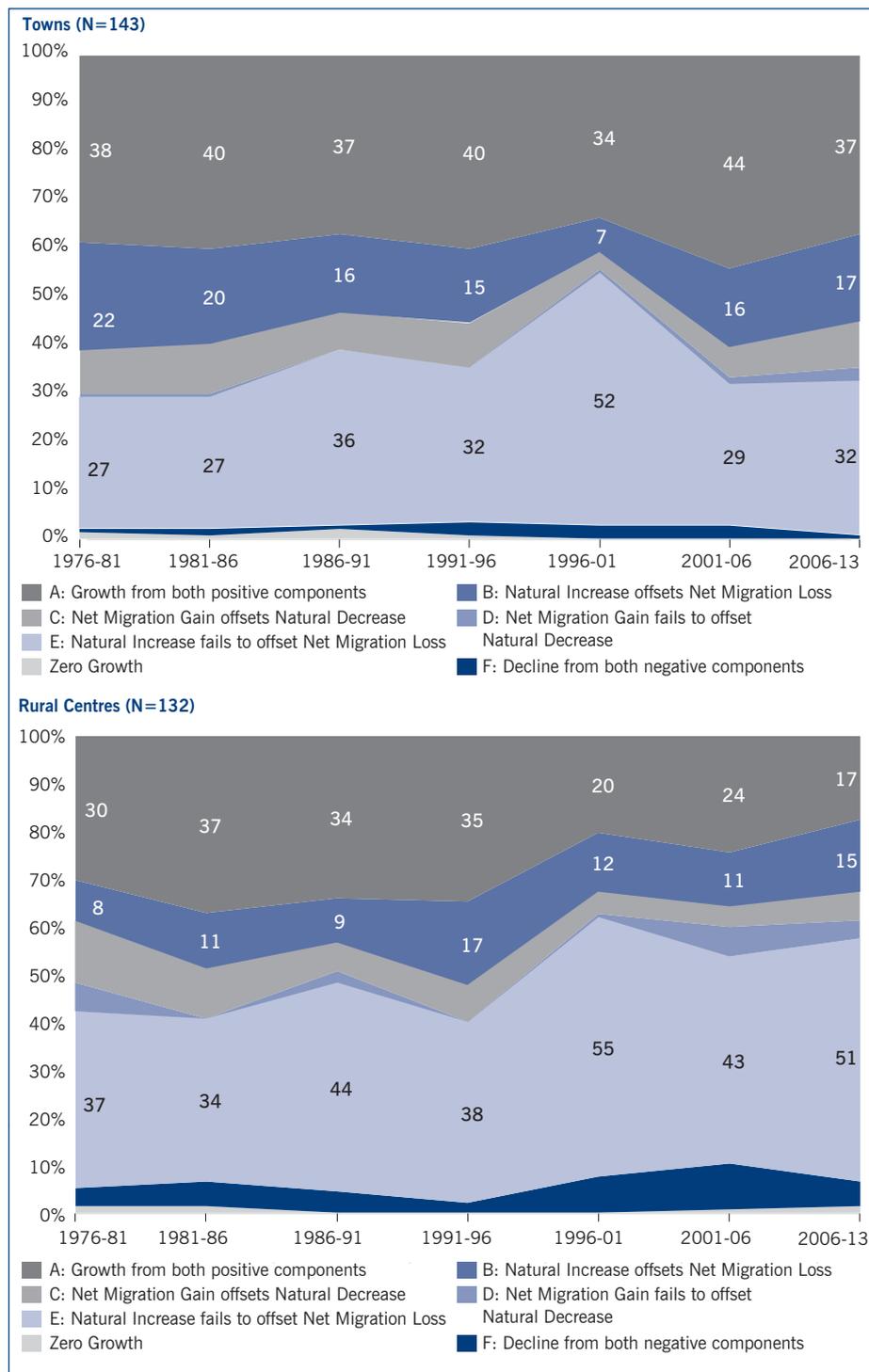
Source: Jackson and Brabyn (forthcoming).

because of Type B growth, where natural increase is completely concealing net migration loss, are highly vulnerable to decline as natural decrease emerges, and their growth should not be seen in the same light as Type A. Type D decline (where net migration gain fails to offset natural decrease) is more 'preferable' to Type E or F decline, in that the former has a good chance of reverting to population growth, at least in the short-term. By contrast, Type E decline typically indicates that natural increase is becoming very low, while Type F decline, the 'new' form of population decline, foreshadows a self-reinforcing and increasingly intractable type of depopulation. In order to 'extend' the period covered in our 1976-2013 analysis to indicate what will unfold for towns and rural centres, we include TA level projections to 2043 (medium variant).

Type A Growth: Across the period 1976-2013 the majority of TAs and towns grew from 'Type A' growth, where both net migration and natural increase were positive, although there was an anomalous period, nationally, between 1996 and 2001, when this cause of growth was overwhelmed by Type E decline (see below). The percentage of TAs growing from Type A growth increased overall across the period, from 21 to 41 percent (Figure 5). For towns, Type A growth remained relatively stable, at 38 percent of towns in 1976 and 37 percent in 2013; for rural centres, Type A growth declined across the period, from 30 to just 17 percent of rural centres (Figure 6). In the aggregate, rural districts also grew from Type A growth between 1991 and 1996, and 2001-2013. The TA level projections in Figure 5 show this form of growth increasing until 2018, then steadily diminishing across the period, pertaining to just 17 percent in 2043.

Type B Growth (where natural increase completely conceals net migration loss) declined across the period for TAs and towns but increased for rural centres. For TAs it pertained to 32 percent in 1976 and 29 percent in 2013; for towns, 22 and 17.5 percent

Figure 6: Percentage of Towns and Rural Centres by Cause of Growth and Decline, 1976-2013

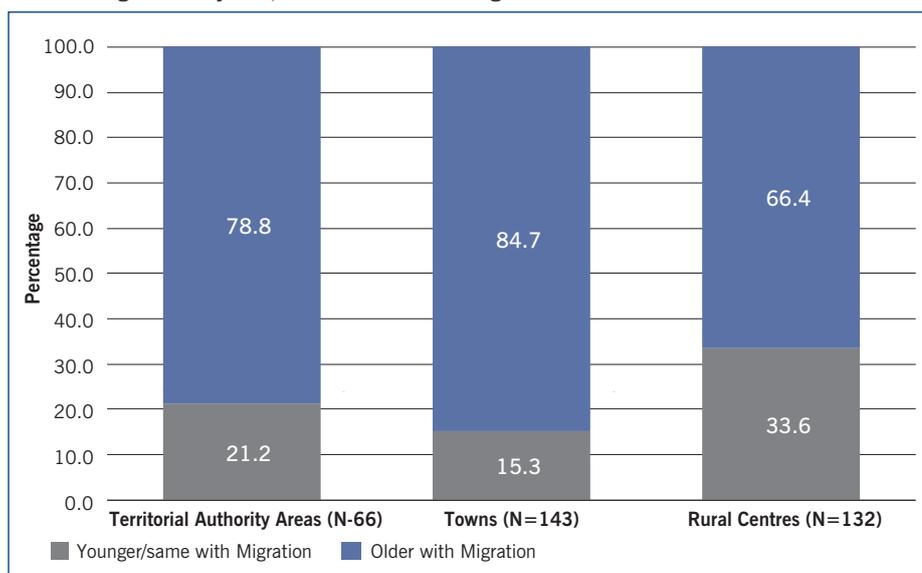


Source: Jackson et al. (forthcoming)

respectively. For rural centres the proportions were 8.3 and 15 percent. In the aggregate, rural districts experienced this type of growth between 1981 and 1991, and 1991-1996. This type of growth places affected areas in a somewhat more vulnerable position than Type A growth, because as indicated above, natural increase is trending

downwards, and over the next few decades will increasingly leave areas experiencing net migration loss, 'unprotected'. TA projections indicate that this form of growth will diminish as the proportion experiencing natural decrease grows, with Type B growth accounting for as few as 6 percent of TAs in 2043.

Figure 7: Percentage of Territorial Authority Area, Town and Rural Centre Populations by impact of migration on structural ageing (as indicated by percentage aged 65+ years, with and without migration)



Source: Jackson and Brabyn (forthcoming).

Type C Growth (where net migration gain offsets natural decrease) has as yet been the experience of relatively few areas, because natural decrease itself is as yet not widespread. However, TA level projections indicate that Type C growth will now become more prominent, pertaining to around 20 percent by 2043, and becoming the largest driver of growth and the second-largest driver of population change. Type C growth may be a more robust driver of growth than Type B, at least in the short-term, because while migration remains positive it has a good chance of offsetting underlying natural decrease.

Type D Decline (where net migration gain fails to offset natural decrease) is as yet similarly uncommon, not yet experienced at TA level and pertaining to less than 3 percent of towns and 4 percent of rural centres in 2013. TA projections indicate that this form of decline will become noticeable from around 2028 and pertain to around 6 percent of TAs in 2043.

Type E Decline (where natural increase fails to offset net migration loss), has, by contrast, been very common across New Zealand’s TAs, towns and rural centres, although diminishing for the former and increasing for the latter. For TAs, the proportion fell from 45

to 29 percent; and for towns and rural centres, increased from 27 to 32 percent, and 47 to 60 percent, respectively. Aggregate data for rural districts suggests they experienced this combination between 1976 and 1981 only. TA projections indicate this form of decline will remain a common experience for the towns and rural centres which comprise them, although will diminish over time as it gives way to Type F decline (see below). This is the shift from the ‘old’ form of depopulation referred to by Bucher and Mai (2005) to the ‘new’ form, where both elements are negative.

Type F Decline (where both elements are negative) has so far played a minor role in New Zealand’s subnational population change, albeit more evident for rural centres than towns. At TA level the combination has not yet been experienced. However, projections indicate that it will become notable at TA level from the early 2030s, become the major driver of population change *per se*, by 2043 – when it will account for around 27 percent of TAs.

Zero Growth: No cases of zero growth were observed at TA level during 1976 to 2013, although a few came very close. It was also a minor cause of

population change for either towns or rural centres. Instead, the long-theorized arrival of zero growth as the ‘end point’ of demographic transition has been shown in our project – as it has internationally – to be a transitional stage through which most areas pass on their journey from growth to decline, and in a few temporary cases, *vice versa*.

In sum, the TA level projections provide advance warning of the ongoing impact of structural ageing, with both Type A and B growth steadily diminishing and Type C growth (net migration gain offsetting natural decrease) ultimately taking over as the main cause of growth. Type D, E, and F decline each grow, with Type F decline (both components negative) taking over as the main cause of decline around the mid-2030s, and of population change *per se* in 2043 (Jackson et al., 2016).

Observation 6: The vast majority of TAs, towns and rural centres are older as a result of migration

Across the period 1976-2013, migration caused the majority of TA, town and rural centre populations to have older age structures than would have been the case in the absence of migration (Figure 7). That is, migration either removed young people and/or added older people, causing the proportion aged 65+ years to be greater than it would have been without migration.²

This is known as ‘age-selective’ migration (see below), which has also been shown internationally to accelerate structural ageing as much as the conventional driver, low fertility rates (Johnson et al., 2015).

The greatest ‘juvenescent’ (youth-imparting) impact was for towns, only 15 percent of which had populations younger with, than without, migration. The same situation pertained to one-fifth of TAs and one-third of rural centres. This means that, by contrast, 79, 85, and 66 percent of TAs, towns, and rural centres respectively were older with, than without, migration. Notably this was not the case for New Zealand’s rural districts, which, in the aggregate, had an almost identical percentage aged 65 and older in 2013 both

with and without migration (13.0 and 13.1 percent respectively).

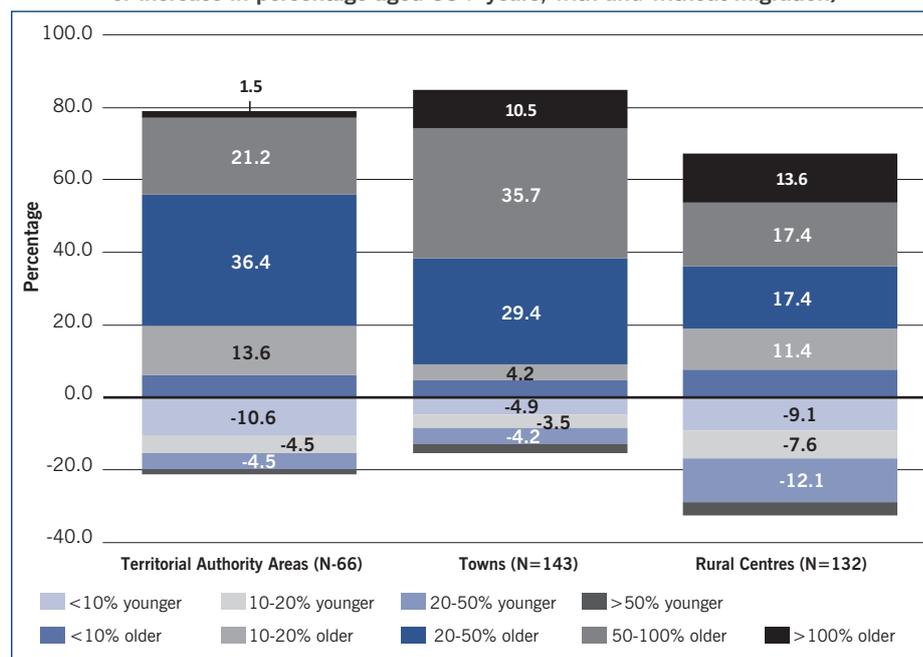
Only a minority of TAs, towns and rural centres have thus become more youthful as the result of migration, a finding which, at least in terms of international migration, runs counter to many governmental pronouncements on the issue (see McDonald & Kippen 1999 and Kippen & McDonald 2000 for a refutation of this perception for Australia; and Jackson & Cameron 2017 for New Zealand).

Moreover, many jurisdictions are decidedly older as a result of migration (Figure 8). At TA level, 36 percent had populations that were between 20 and 50 percent older because of migration, and 31 percent, between 50 and 100 per cent older. By contrast, just one was more than 50 percent younger (Wellington City). Almost 30 percent of New Zealand towns had populations between 20 and 50 percent older as the result of migration; 36 percent, between 50 and 100 percent older; and 10 percent, more than 100 percent older. Rural centres had larger proportions than towns that were both more than 100 percent older (13.6 percent) and more than 50 percent younger (4 percent compared with 3 percent for towns), as the result of migration. Rural centres also had greater proportions in each of the 'younger with migration' groups.

Observation 7: Towns are more likely than rural centres to have more than 20 percent aged 65+ years

The finding of greater proportions of rural centres than towns being younger as a consequence of net migration is one of the more surprising findings of this project. We had theorised that rural centres would be more affected by the loss of young adults and have greater levels 'ageing-in-place', and this combination would have caused those areas to age faster. The explanation is that while the populations of rural centres are, *on average*, older than those of towns (in 2013, 17 and 14 percent aged 65+ years respectively), there is a greater proportion of towns with more than 20 percent aged 65 years (Jackson et al., forthcoming, Tables 3 and 4).³ In 2013, 41 percent of towns compared with 29

Figure 8: Percentage of Territorial Authority Area, Town and Rural Centre Populations by extent of impact of migration on structural ageing (as indicated by reduction or increase in percentage aged 65+ years, with and without migration)



Source: Jackson and Brabyn (forthcoming).

percent of rural centres (and 15 percent of TAs) had greater than 20 percent of their respective populations aged 65+ years. As a result, towns are on the one hand currently less likely than rural centres to be experiencing natural decrease (as noted above, in 2013, 13 and 15 percent respectively), but on the other, seeing a more rapid shift to that situation. As both Pool and Brabyn (this issue) propose, tertiary education and jobs are attracting young people to the larger cities, while lifestyle and amenity factors are attracting older people from both the rural centres and the larger towns to the smaller towns.

Observation 8: Age-selective migration is accelerating structural population ageing in most areas

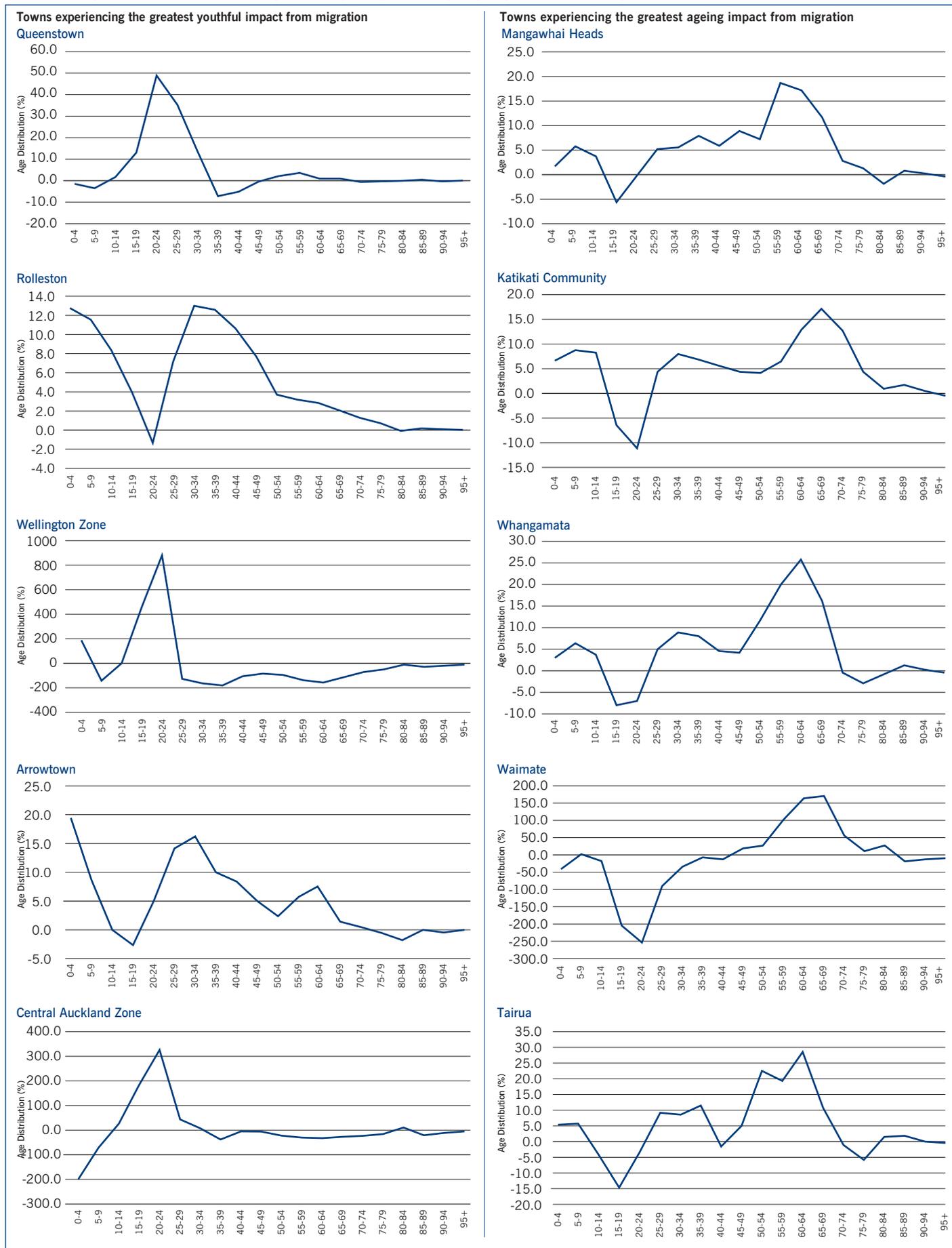
Figure 9 shows the age distribution of migration for the five towns experiencing the greatest juvenescent impact of migration (left figures) and the five towns experiencing the greatest ageing impact (right figures). The respective left- and right-hand skews clearly illustrate the difference in impact. Queenstown, Rolleston, Wellington, Arrowtown and Central Auckland all gain a disproportion of migrants at the younger ages, albeit Rolleston and Arrowtown experience minor net loss at 20-24 and 15-19 years respectively, but this is offset by substantial

gains of those of parenting age and thus also their children – and reinforced by loss at the oldest ages. By contrast, the towns experiencing the greatest ageing effect from migration all see net losses at 15-19 or 20-24 years, and make their gains at the older ages, particularly 'early retiree' age. The reverse effect from age 75 is also very clear, reflecting the classic move many older people make 'back' towards health services and/or family.

Although not studied in detail, aggregate data for rural districts suggests an age migration profile that falls between the two extremes. On the one hand the data show consistent net loss at 15-19 and 20-24 years, but on the other, in most years, net gains at the main parental and child ages, offset by net loss at age 65 and above. Similar to Rolleston and Arrowtown, this combination leads to a relatively low percentage aged 65+ years, and further indicates that the structural ageing of rural districts is primarily due to ageing-in-place, albeit in some cases the ageing of past migrants, but not direct immigration at older ages.

As also proposed, these migration age profiles are typically altered by natural increase, both the net difference between births and deaths, and change in the size of individual cohorts as they age. That is, when larger cohorts take the place of

Figure 9: Net migration age distribution (percentage of migrants at each age) for the five towns experiencing the greatest youthful impact and the five towns experiencing the greatest ageing impact from net migration, 1976-2013



Notes: Different scales on Y-axis

smaller ones, and vice-versa, the net change for those age groups may be less or greater than indicated by migration alone. However for the most part, it is the concentration of migration at either younger or older ages, and particularly the level of net out-migration around age 15-24 years, and/or in-migration at 50+ years, that determines the 'speed' of structural ageing.

Observation 9: The proportion of women aged 15-44 is a stronger driver of natural increase or decrease than the total fertility rate

Conventionally, the shift from natural increase to natural decrease is associated with a total fertility rate (TFR)⁴ of less than 2.1 births per woman, for around a generation (c. 25 years). New Zealand's TFR is still around 2 births per woman, although at TA level it ranges from 1.5 for Queenstown-Lakes District to 3.3 for Opotiki District (Statistics New Zealand 2016). However, reflecting the age-selective migration patterns above, we found a much stronger relationship⁵ between natural increase and the percentage of women aged 15-44 years⁶, than with the TFR (Jackson et al., forthcoming). Although we have reliable subnational TFR data for only three observations, our findings concur with Johnson et al., (2015: 667-669), whose study on the counties of the United States and Europe showed that the higher/lower the proportion of women at the main childbearing ages, the more/less likely it is for them to sustain the natural increase required to offset migration loss.

Also important is our finding that the national percentage of women aged 15-44 years (for New Zealand) peaked in 1991 at 46.6 percent and has since fallen to 39.8 percent, the latter almost identical to that for the USA and Europe. Unless fertility rates rise substantially, diminishing proportions of women at reproductive age mean diminishing birth numbers. The proportion of towns with lower than the national proportion of women in these childbearing age groups increased from 77 percent in 1976 to 87 percent in 2013 (+14 percent). For rural centres the proportion (lower than the national average) has increased from 70 to 90

percent, accelerating since 2001 (+29 percent). Rural centres are thus more vulnerable than towns to the loss of natural increase via decreased births, while towns are becoming more vulnerable to it from increased deaths.

Mirroring the trends at 15-44 years is the equally strong but negative correlation between the percentage aged 65+ years and natural increase⁷, indicating that the higher the percentage aged 65+ years, the lower the natural increase. Although to some extent auto-correlated with the proportion of women aged 15-44 years, this relationship was similarly found for the United States and European counties by Johnson et al., (2015: 665-666). The relationship is somewhat stronger for

towns the relationship is negative (the higher the natural increase, the lower the net change, and vice-versa), but it is not statistically significant after 1996. For rural centres the relationship is significant at only three observations, and it is positive (the higher the natural increase, the higher the net gain).

By contrast, the correlation between net growth and net migration gain is both very strong and positive, and never below +0.92 ($p=0.01$ for all observations, for both towns and rural centres). Thus, areas with higher net migration gain have higher growth - and vice-versa.

The analysis confirms that net migration is the stronger 'predictor' of net change; however, the foregoing analyses

What has been missing from the debate is an understanding of the widespread nature of decline across the country, and in particular, an understanding that it is not limited to small rural towns.

New Zealand's towns than rural centres, reflecting the finding that many towns have relatively old age structures, with proportions at older ages presumably increasing the number of deaths. While a greater proportion of towns than rural centres have been experiencing natural increase, the proportion is falling at a faster rate than for rural centres.

Observation 10: Net migration explains most of the variance in net change, but natural increase determines whether the outcome is positive or negative

We found that net migration explains around 95 percent of the variance in the net population change of towns and rural centres across the period 1976-2013. This is because natural increase is somewhat more even across these jurisdictions, and is mostly positive. At the same time, we found that natural increase has a relatively weak relationship with net change. For

demand that a caveat be added: only when migration is examined as a discrete variable.

Moreover, another important finding from the correlation analysis is that net migration and natural increase are negatively correlated. That is, the higher the net migration gain, the lower the natural increase, and vice-versa. For towns the correlation is statistically significant ($p=0.01$) at all but one observation. Although more modest for rural centres, and statistically significant at just three observations ($p=0.01$), the negative correlation is a salutary finding, as it appears that migration does not necessarily mean 'more births', as is often believed. Rather, it may reflect recent trends in the composition of migrants, from primarily families, to primarily non-family workers (students and others on temporary visas and/or early retirees moving for lifestyle reasons). That is, not

only is migration not a panacea for growth, but it may further hasten the end of natural increase, a finding also noted for the United States and Europe by Johnson et al., (2015) and for Europe over a very long period by Murphy (2016: 239).

Summary and discussion

Over the past few years, population change in New Zealand has attracted much media and political attention. Areas experiencing rapid growth have been contrasted with so-called 'zombie towns' (NBR 2014), the latter usually singling out a few rural towns that have experienced precipitous decline. What has been missing from the debate is an understanding of the

glaringly evident over the next few decades, as natural increase gives way to ageing-driven natural decrease. As Brabyn (*infra*) argues, the contribution of natural increase to population change has thus far been relatively even across New Zealand, with the result that migration accounts for 95 percent of variation. However, as we show in this article, the actual level of growth or decline is heavily dependent on whether natural increase augments or offsets that net migration gain or loss.

We have shown here that there are several combinations of natural increase and net migration, three of which deliver growth, three decline, and two, zero growth. The distinction between the

and projections at TA level indicate that it will become increasingly prevalent from 2028. By 2043 it is projected to affect around 27 percent of TAs, and to be the largest cause of depopulation and the single largest cause of population change *per se*. Type A growth will by then have diminished to around 17 percent of TAs.

Answering our second research question, the various combinations delivering population growth and decline also do more than simply affect population size; they also have a profound effect on the age structure of each population. Net loss at younger ages typically makes age structures older, and net gain, younger. Net in-migration at older ages further accelerates - or, where negative, slows - structural ageing. This 'age-selective' migration has resulted in just 15 percent of New Zealand towns having populations in 2013 that were younger as the result of migration across the period 1976-2013; conversely, 85 percent of towns were older. The latter situation also pertains to two-thirds of rural centres and four-fifth of TAs. Only a minority of our study areas have thus become more youthful as the result of migration, a finding which, at least in terms of international migration, runs counter to many pronouncements on the topic. Moreover, in many cases areas are substantially older (or, in fewer cases, substantially younger).

Again, these effects have policy implications, as areas gaining young adults (especially from internal migration) are at the same time playing a role in the ageing of the towns and rural centres they have left. Akin to 'watering the neighbour's garden' (Attané & Guilamoto 2007), future policy may need to consider having younger/growing areas compensate their ageing/declining counterparts. This proposition is strongly supported by correlations that show the relative size of the population of women aged 15-44 years is a critical factor in sustaining natural increase. Second only to the strong positive correlation between net migration and net change, the correlation for women aged 15-44 years and natural increase shows that the higher the former, the higher the latter. Conversely, the lower the percentage of women at these ages, the lower the natural increase. This very

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widespread nature of decline across the country, and in particular, an understanding that it is not limited to small rural towns. Both Dunedin and Invercargill cities, for example, are smaller now than they were in 1976, despite their annual gains of many of the nation's tertiary education students. Also missing from the commentary is that in many cases, growing towns and rural centres are growing only, or largely, because of natural increase – the difference between births and deaths; this component is regularly rendered invisible. Even Auckland's growth has been primarily the result of natural increase, accounting for 58 percent of the region's growth over the past 25 years (Jackson 2016).

The widespread perception of migration as the primary driver of growth and decline has diverted attention away from the all-important population replenishing role of natural increase (see also Cochrane & Pool, *infra*, on the critical role of Māori), a deficit that will become

growth and decline types is important for policy purposes. Type A growth, where both elements are positive, is somewhat more robust than Type B growth, where natural increase conceals net migration loss, and the two should not be conflated. As natural decrease unfolds, areas currently growing from Type B growth will become increasingly vulnerable to overall decline. Type E decline, on the other hand, where natural increase fails to conceal net migration loss (the widely experienced, 'old' type of decline), has the potential to revert to Type B growth, if migration in those areas turns positive. Type E decline is also less perverse than the 'new' type of depopulation, Type F decline, where there is both net migration loss and natural decrease. *Answering our main research question, we found that this new, 'dual' form of depopulation is as yet affecting a relatively small number of New Zealand's towns and rural centres (13-15 percent), and is not yet evident at TA level.* However, it is emerging intermittently,

strong correlation, which concurs with that found for the United States and Europe (Johnson et al., 2016), has also strengthened over time, and more so for rural centres, where the loss of women aged 15-44 years is greater than for towns.

Moreover, the correlation between women aged 15-44 years and natural increase is also substantially stronger than that between natural increase and the total fertility rate, for both towns and rural centres – although we have only three observations on which to base this proposition. While also positive, indicating that the higher/lower the TFR, the higher/lower the natural increase, the relatively weak correlation values indicate that there is as yet very little relationship between the two. Accordingly, we can at least tentatively conclude that age-selective migration is *the* major driver of New Zealand's current shift to natural decrease, rather than the conventional driver, low fertility.

This finding is further supported in another, even more surprising finding, which shows that net migration and natural increase are negatively correlated. Although the correlations are relatively weak, they are consistently negative and indicate that the higher the net migration, the lower the natural increase, and vice-versa – a finding also reported for the USA and Europe (Johnson et al., 2015; Murphy 2016). Migration may thus not be the 'bringer of babies' that many believe.

These findings are important from a migration policy perspective, not least because they have implications for the ideal composition of international migrants; that is, perhaps low growth/declining areas need more who are likely to have families, and fewer merely to 'work', especially in rural centres.

Similarly, where areas are gaining older people, either through migration or ageing-in-place, or alternatively are losing them to other areas, there are social policy implications in terms of the type of resources and services that are needed; one-size-fits-all policies are to be avoided. The same point pertains to areas gaining or losing families and children; their needs are very different.

In terms of policy development regarding structural ageing *per se*, New

Zealand's relatively high birth rates and currently very high per capita levels of net international migration may suggest to some that the ageing-driven ending of population growth is 'over the horizon', and thus may be paid less attention in the short term. We emphasise that this is not the case at the subnational level (see also Matanle 2017, which compares New Zealand with Japan). Although the decline experienced across the period 1976-2013 was disproportionately the result of net migration loss, that loss and its age-selective nature has greatly accelerated the structural ageing of affected areas. These areas will struggle to return to long-term population growth, as the increased proportions at older ages and decreased proportions at reproductive age afford little chance of resurrecting the natural increase they once enjoyed. As natural increase diminishes, more and more migrants will be required simply to maintain each population at the same size. This may happen for popular retirement towns, but not most towns. Ageing and declining areas thus require regionally-specific migration policies that give primacy to local, rather than national, demographics.

Finally, the question as to whether the ending of population growth and onset of depopulation will be 'good' or 'bad' has as yet been subjected to very little serious research – or theoretical development (see Matanle, *infra*). The end of population growth is likely to have both positive and negative outcomes – positive, for example, in terms of fewer people to consume resources and damage the environment, and potentially the development of a greater sense of community. However, its negative outcomes will include the loss of many economies of scale that have been enjoyed in the growth phase, and plausibly the loss of value of many assets, such as housing. In New Zealand it will have major implications for the way in which rate revenue has historically been gathered by local government councils (Jackson 2004; Jackson & Cameron 2017). Ultimately the ending of growth and onset of depopulation is expected to be the dominant situation across most countries of the developed world by mid-century; prior to that our populations will

age considerably (Atoh 2000; Lutz, Sanderson & Sherbov 2004; Reher 2007, 2011; World Bank 2009; Haartsen & Venhorst 2009; Audirac 2010; Lee & Reher 2011; Matanle and Rausch 2011; Martinez-Fernandez et al., 2012, among many others). In many cases there is the potential for a 'depopulation dividend', if the situation is accepted and engaged with positively and in a timely manner (Matanle 2017). Accordingly, it is time for our policy makers to begin revisiting our policies and the (growth) principles on which most are based (United Nations 2000:4).

- 1 These and all projections used in this article are based on Statistics New Zealand (2015e). They thus predate the latest '2013-base - 2043 Update' (2017) projections which became available after the article was written. Comparison indicates that population growth will be slightly higher in the first decade of the projection, but thereafter the outcomes are almost identical to those presented here.
- 2 It should be recalled that both 'with' and 'without' migration includes natural increase.
- 3 In 2013, the percentage of the usually resident population aged 65+ years ranged, for towns, from 3 percent (Waiouru, largely a military camp area) to 36 percent (Tairua, a North Island east coast beach town), and for rural centres from 0.5 percent (Burnham Military Camp) to 44 percent (Pauanui, also a North Island east coast beach town, immediately adjacent to Tairua).
- 4 The Total Fertility Rate is a 'synthetic' measure of the average number of children a woman would have across her lifetime if she were to experience all of the age-specific fertility rates occurring in that particular year.
- 5 In order to summarise the patterns and trends we examined the relative strength of key relationships, by applying the Pearson Correlation Coefficient 'r' to various combinations of the data. The Pearson Correlation Coefficient measures the linear strength of the relationship between two arrays of data, with +1.00 meaning that each item moved in exactly the same direction at the same rate of change (whether positively or negatively), and -1.00 meaning that each item moved in the opposite direction.
- 6 $p(0.01)$ for all observations for both towns and rural centres. By contrast the TFR was significant at either 0.01 or 0.05 for two of the three observations, for both towns and rural centres.
- 7 $p(0.01)$ at all observations for both towns and rural centres.
- 8 Description: The baseline data was created by Dave Maré (Motu Research) under microdata access agreement with Statistics New Zealand, MAA2003/18. dave.mare@motu.org.nz. The tables contain counts of the 1976, 1981, 1986, 1991, 1996, 2001, 2006 and 2013 usual resident population by age and sex, grouped by 2013 geographic area boundaries (Territorial Authority and Urban Area). The Urban Area classification has been extended to identify rural centres (ua13=501) separately (using 2013 Area Unit codes).
- 9 Disclaimer: Access to the data was provided by Statistics New Zealand under conditions designed to give effect to the security and confidentiality provisions of the Statistics Act 1975. The results presented in these tables are the work of the authors, not Statistics New Zealand. They are not 'official statistics'.

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Appendix

Data Sources and Methodology:

Population data: Mesh-block level counts of the usually resident population by 5-year age group (to 80+ years) and sex for all census years 1976-2013 were aggregated to the 2013 geographic area boundaries at urban area (UA) and territorial authority area (TA) level⁸. The allocation to 2013 geographic areas was based on a 'user-derived correspondence'. The counts are not official statistics but should be understood as experimental estimates intended for use in this research.⁹ This exercise resulted in data for 143 urban areas, 132 rural centres, and 66 TAs (The Chatham Islands were excluded from the TA level analysis because of small cell sizes).

Birth and survivorship rates for all years for which these data were required are not available at urban or rural centre level, and were instead constructed using indirect standardisation. In order to construct birth rates, we purchased a customised dataset from Statistics New Zealand (2016) covering births by 5-year age group of mother for the period 1997-2013 (June years) at territorial authority area (TA) level and 2013 geographic boundaries. Survivorship (Lx) rates by age and sex for each TA were accessed for the years 2005-07 and 2012-14 (Statistics New Zealand 2015a).

Calculating missing birth rates via indirect standardisation was done in two main steps. First, age-specific fertility rates were constructed for each of New Zealand's 66 TAs for the June years 1996-97, 2001-02, and 2006-2013, using number of births by age of mother as sourced above, and female estimated resident population counts for corresponding 5-year age groups 15-49 years sourced from Statistics New Zealand (2015b). The age-specific fertility rates for 1996 and 2001 were then summed and averaged (for each age group and each TA), and their ratio to the equivalent rates for total New Zealand constructed (drawing on Statistics New Zealand 2015c). These relative age-specific fertility ratios for each TA were then held constant and multiplied by the equivalent rates for total New Zealand for the missing years, 1976, 1981, 1986, and 1991. That is, the national values were retrospectively inflated or deflated by the relevant ratio, for each of the four observations 1976-1991, to generate approximate TA level age-specific rates for those years.

The second step involved constructing age-specific fertility rates for each town and rural centre, by applying the age-specific rates for the TA in which each is located to the number of women in each 5-year age group 15-49 years, in each town and rural centre.

The resulting birth rates and numbers at TA level differ slightly from those published by Statistics New Zealand (2015d) because they are constructed experimentally using both the 'estimated resident population count' (ERP) which includes adjustments for births, deaths and migration occurring between March and the ERP date (typically June or December), and the 'usually resident population count'

(URP) at each five-yearly census (which is taken in March). As with the underlying population counts, the fertility data should be thought of as best approximations extracted for these research purposes.

Calculating missing survivorship rates via indirect standardisation was similarly done in two steps. First, Lx values (the average number alive in each age group) by 5-year age group and sex for each TA for two Life-Table periods, 2005-07 and 2012-14, were compared to the average number alive in the preceding 5-year age group. This process produced sex- and age-specific survivorship ratios for each five-year age group to 95+ years, for these two observations (for the purposes of this exercise, considered to be 2006 and 2013). The 2006 ratios were then compared with their national equivalents, to generate relative survivorship ratios for each TA for the missing years: 1976, 1981, 1986, 1991, 1996, and 2001. That is, for each of those observations, the national values were retrospectively inflated or deflated by the relevant sex- and age-specific survivorship ratios for each TA in 2005-2007, to generate approximate TA level rates.

The second step involved constructing sex- and age-specific survivorship rates for each town and rural centre, by applying the rates for the TA in which each is located, to the number of males and females in each five-year age group, in each town and rural centre. In order to survive age groups above 80 years, the 80+ year age group was prorated to 80-84, 85-89, 90-94 and 95+ years according to the New Zealand distribution (by sex) at those ages. Again, the resulting data are 'best approximations' based on calendar year survivorship ratios and census usually resident population counts.

When the resulting data are compared with published birth and death numbers for each TA, which are available for all years 1992-2013, there is strong correspondence, and the model is thus considered sufficiently robust to use for our purposes of calculating the components of change for towns and rural centres. This is done using cohort component analysis and the 'residual' method for separating net migration from net change (Rowland 2003 Chapter 12).

Calculating components of change by the residual method: The resulting fertility and survivorship rates were used in a conventional cohort component analysis to separate out the contributing effects of both net migration and natural increase. First, survivorship rates for each age group were applied to the baseline usually resident population numbers for each individual observation (separately by sex), and fertility rates applied to survived women aged 15-49 years. The resulting births were summed and apportioned male/female according to the standard sex ratio for New Zealand (105 males per 100 females). Births were entered at age 0-4 years, and all other age groups 'aged' by five years. The resulting 'expected' population by age and sex was then

compared to the actual population at the relevant observation (for example, the survived and 'reproduced' population from 1976 was compared to the actual population for 1981), and the difference at each age (five-year age group) taken to be a residual measure of net migration by age across the five-year period. Subtracting total estimated migration from net change in population size between the two observations in turn generates the natural increase component, which in turn is disaggregated into its births and deaths components by summing each individual component generated at each step.

With and Without Migration

To generate the 'without migration' data used in our analyses we used a standard cohort component projection method, with the exception of excluding an assumption for migration. We applied period-based age-specific fertility and survivorship rates to the 1976 population by 5-year age group, separately by sex, adding in the resulting births at age 0-4 and subtracting deaths, then ageing the population by 5 years. We repeated the process for each census year to 2013. These data were then compared with those which had been developed similarly, but included migration.

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