Parliament of Victoria

Research Note

Parliamentary Library and Information Service

ISSN: 2204-4779 (Print) ISSN: 2204-4787 (Online)

2022 | No. 2

Abstract

One of the biggest impacts of the COVID-19 crisis so far has been a sudden reduction of the state's population. It fell by 0.68% or from 6,693,358 to 6,649,066 people by mid-2021. There were a range of flow-on effects within the state, such as a fall in population in some metropolitan areas and a rise of people living in regional areas.

Victoria has previously experienced a period of strong population growth due to strong net inward flows of people from inter-state and internationally. The state's 'natural' rate of population growth is very low. The COVID-19 crisis has, however, made many existing projections of the state's population redundant.

The paper explores the implications of the crisis in an historical perspective. It provides estimates of the impacts on different electorates and develops a cluster analysis of different areas in the state. These are presented using a range of visualisation techniques.

Visualising the population impacts of COVID-19 in Victoria

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1: Introduction

One of the major impacts of the COVID-19 pandemic and its associated public health measures in Australia was a sudden disruption to trends in population growth. Victoria experienced some of the most dramatic changes, with an estimated 0.68% fall in the state's population by mid-2021.

Estimates suggest that Victoria's population is already well below anticipated growth projections produced by the Australian Bureau of Statistics (ABS) (2018). These disruptions were accompanied by a range of intrastate shifts, such as a proportional fall in Melbourne's share of the state's overall population.

The medium and long-run implications of COVID-19 are difficult to predict. The pandemic and its associated policy measures are unprecedented, confounding global and subnational analyses and forecasts. However, understanding these changes and their implications can be acquired through an historical and demographic study of Victoria's population.

This report presents an overview of the changes and draws on two main sources. First, it outlines some of the key concepts involved in demographic analysis and how they apply to Victoria and the COVID-19 crisis. Second, it deploys statistical, visualisation and geospatial-based techniques to illustrate both the historical character and the impacts of COVID-19 on Australia's and Victoria's populations.

2: Demography and COVID-19

Understanding COVID-19 and its impacts benefit greatly from a structural and historical analysis of population change and demography in Victoria. These factors shaped the effect of the COVID-19 crisis on the population.

Victoria occupies a unique status within general analyses of demography and population change. Demography relies predominantly upon quantitative methods to understand processes, redress problems, and recommend policy measures (Lundquist, Anderton and Yaukey, 2015). The standard analysis tools involve manipulating statistics with functional equations and time series models. The models of population growth, distribution, and composition utilise linear equations. In the equation below, the lefthand variable – a change in population over time (P2 - P1) – is the outcome of changes to 'explanatory variables': the sum of births (B) minus deaths (D), plus the sum of net external and internal migration (M).

Equation of population change:

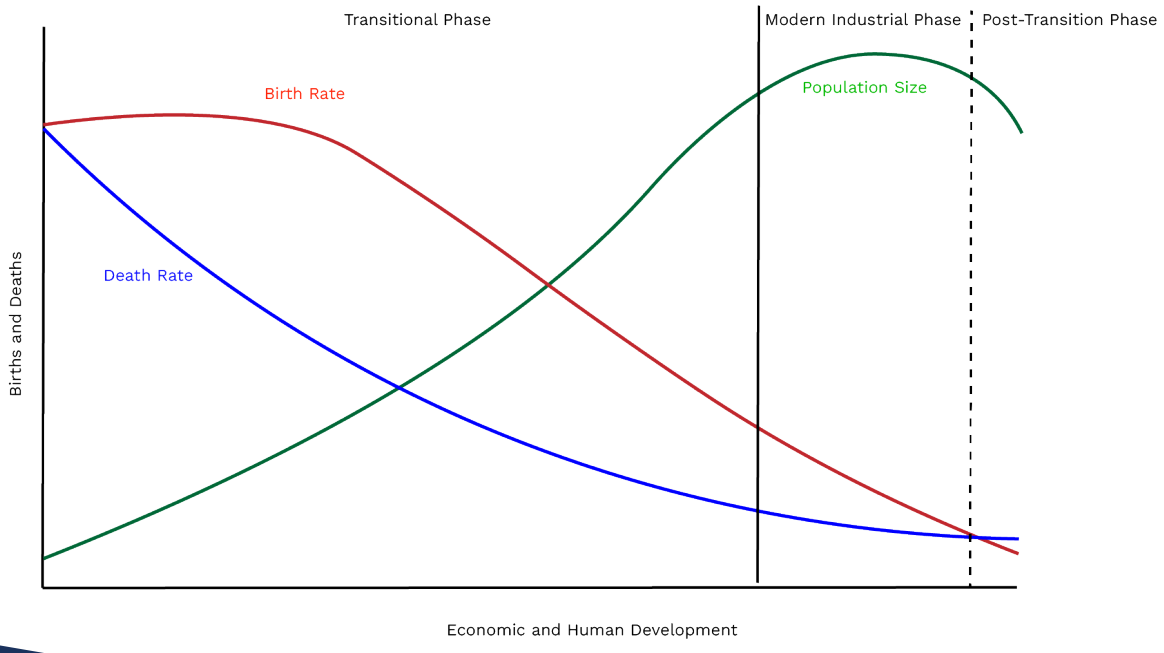
$P_2 - P_1 = B_{(1,2)} - D_{(1,2)} + M_{(1,2)}$

These changes are usually gradual but can be very sudden and episodic. Changes in births and deaths constitute the 'natural population's' rate of change, and migration comprises the external elements.

The application of these models suggests some common historical and gradual alterations have arguably occurred in various countries and regions. These changes reflect different phases of economic and human development, codified as the 'stylised demographic transition model' (Lee, 2003; Lundquist, Anderton and Yaukey, 2015; Zaidi and Morgan, 2017). (Figure 2.1).

The model is 'stylised' as it is a generalisation across different places and times. The modern industrial era in Europe started with high mortality and birth rates and low population Improved living conditions decreased mortality rates, resulting in a period of high population growth. Ultimately, birth rates declined as expectations changed and the status of women improved, leading to lower rates of population growth (excluding immigration). Most post-transition countries and regions have very low or even negative population growth rates.

Figure 2.1 Stylised Demographic Transition Model



Derived from Forgey (2017)

In addition, there are other associated trends not featured in Figure 2.1. Industrialisation facilitates urbanisation and changes in population distribution within countries and regions. Declines in rural employment often result in the stagnation or even decline of populations in some regional and rural areas and the movement of people to cities (Beall and Fox, 2009). Countries with so-called 'surplus' populations in agriculture can experience migration outflows, and people move to areas and countries with greater employment opportunities. The post-transition period brings other changes, such as a revival in population numbers in inner-city areas as industry declines.

Nevertheless, great debate surrounds whether these models can be applied historically or replicated in different regions and cultures in the world.

In contrast to these longer-run changes, little research exists on the impacts of more sudden crises that can bring spikes in either mortality or changes in migration. Most recent studies regard sudden demographic upheavals as either natural disasters or social and economic 'shocks' (Charles-Edwards et al., 2020: 7-8). However, the COVID-19 pandemic is different, and a public health emergency and its associated policy responses were the sources of social and economic shocks.

For Victoria, most of the existing analysis of COVID-19 and its impacts was necessarily partial and rapidly outstripped by changing events. Early contributions by Charles-Edwards et al. (2020: 4) pointed out that population projections made by the ABS were already redundant. The authors suggested that around 1.4 million fewer people will live in Australia than projected by 2040. A more recent analysis by Barnard et al. (2021) proposes 1.9 million fewer people, with approximately 308,167 fewer in Victoria over the same period.

Whatever the value of these existing studies, the impacts of COVID-19 are best understood in the context of Victoria’s historical and demographic evolution.

3: Population in Victoria: A longer view

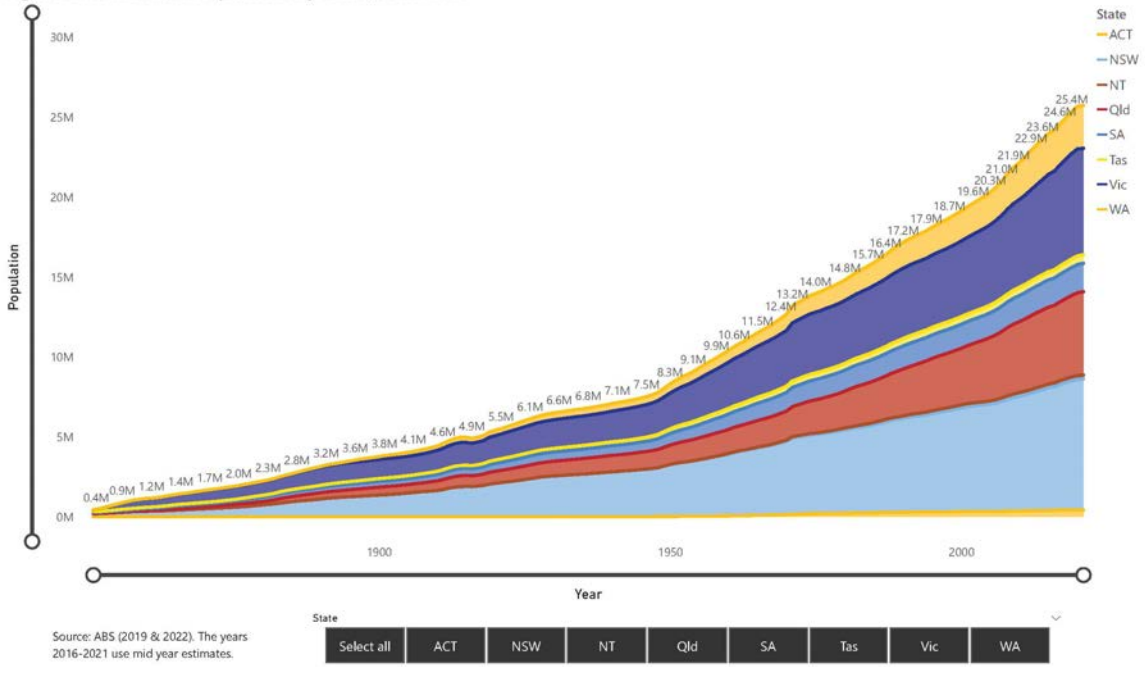
Victoria's population now exhibits many of the features of a post-transition society. It also has some comparatively unique characteristics that derive from its history.

The state's European settler population only emerged in the early-to-mid-nineteenth century. Much of the population migrated from Britain and other parts of Europe because of the social and economic changes discussed in section two. There was, of course, a pre-colonial Indigenous population, although great debate surrounds its estimated size. It, nevertheless, suffered badly during the colonisation process (Hunter, 2015). Census population estimates did not even include the Indigenous population in counts until the 1960s (Allen, 2020).

Figure 3.1 provides an overview of annual trends for Australia and its states (ABS, 2019, 2021b). The gold rush years of the 1850s resulted in the first surge in the state's settler population, and it continued until the economic depression of the 1890s. The subsequent rates of population growth varied considerably in Victoria (see Figure 3.2 and Table 3.1). Most notably, the great post-war inwards migration between 1950 and 1972 resulted in a steep increase in the population. After slowing slightly in the 1970s and 1980s, another period of high population growth occurred after the late-1990s. It continued until the pronounced decline of 2020-21.

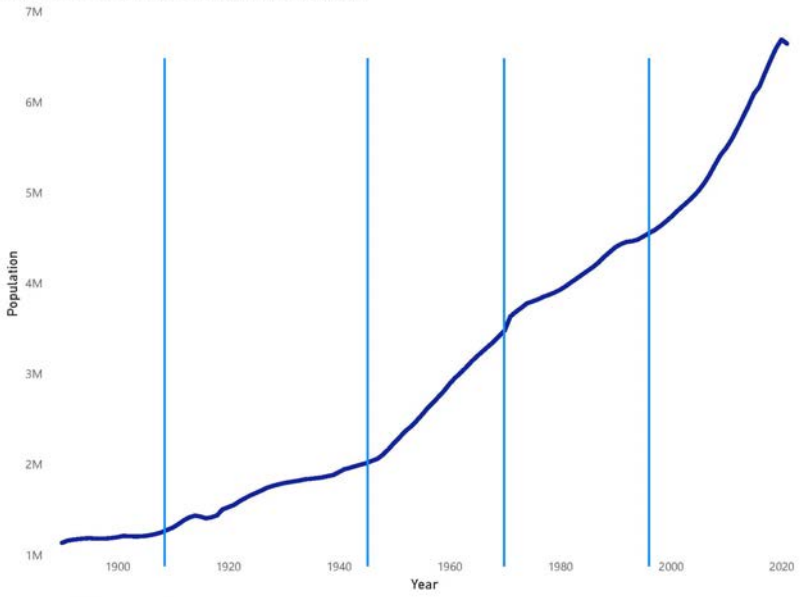
At the same time, the distribution of population within the state became increasingly urbanised and concentrated in Melbourne. By 1901, 496,079 (41.29%) of the state's population of 1,201,341 people lived in Melbourne (and another 17.19% in other urban areas) (Office of the Government Statist, 1911). Melbourne's population comprised 59.4% of the state's population in 1950 (Government of the State of Victoria, 1954). By 2000, it was 3.5 million (73.7%) of the state's population of 4.8 million (ABS, 2001).

Figure 3.1: Australia's Population By State, 1853-2021



*Control click to access the interactive visualisation.

Figure 3.2: Victoria Population by Year with Stages *



Source: ABS (various years).
* The years 2016-2021 use mid year population estimates

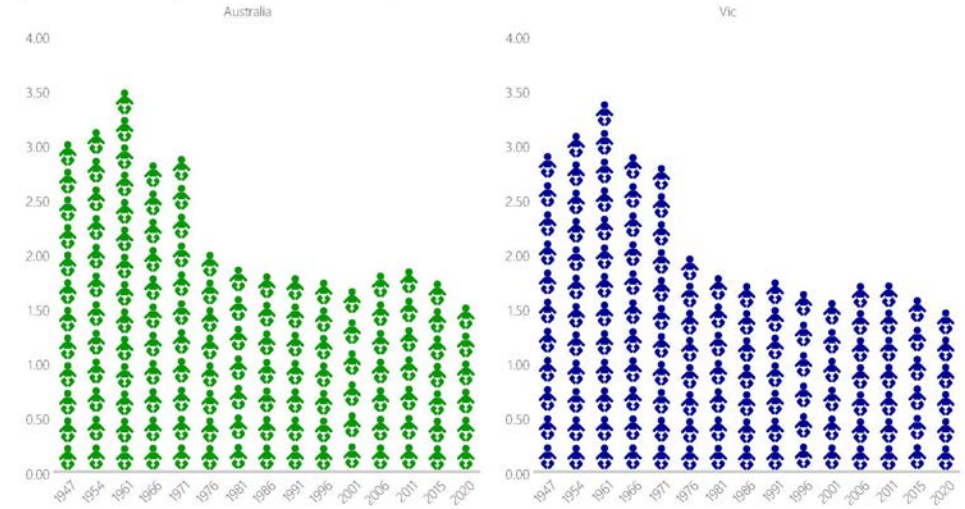
Table 3.1: Longer-run Stages of Population growth in Victoria

Period	Average Annual Growth Rate
1892-1908	0.45
1909-1949	1.36
1950-1972	2.33
1973-1998	0.88
1998-	1.59

*Control click to access the interactive visualisation.

Section two pointed out that the main contributors to population change are natural population change (births and deaths) and net migration. Most recently, Australia and Victoria exhibited many of the features of a post-industrial society with lower levels of natural population growth (Allen, 2020: 41). Average life expectancy continued to rise gradually. As with most higher-income countries, they experienced decades of declining total fertility rates (falling from 3.55 in 1961 to 1.58 births per woman by 2020) (ABS, 2020a) (see Figure 3.3).

Figure 3.3: Total Fertility Rate in Australia and Victoria, Selected Years *



Source: ABS (various years).
* Years derived from when Victorian state level data is available.

*Control click to access the interactive visualisation.

Figures 3.4 and 3.5 further outline some changes to the natural population growth rate (ABS, 2020a, 2020b, 2021b, 2022b). Australia and Victoria's annual crude death and birth rates follow similar trends. The crude birth and death rates are the number of these events per 1,000 people in the population. These fell consistently since the 1890s. The natural population growth rate slowed over time with industrialisation and development. The main consequences for Victoria by the 1980s are apparent in Figure 3.6. The contribution of natural population increases to the state's overall population has either remained static or declined slightly (ABS, 2021b). The population continued to grow, however, due to net inflows of people.

Yet, the trends in overall population change are very different (Figure 3.6). Overall, annual population growth was positive, with a low point of 0.19% in 1993. By 1995, however, the total population growth rate surpassed the natural rate and increasingly diverged, averaging 1.8% per year between 2000 and 2019.

Figure 3.4: Death-rate by Year

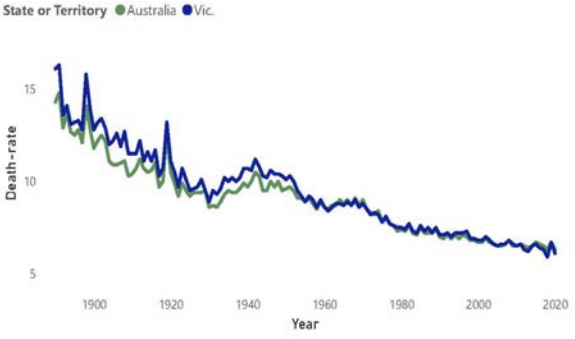
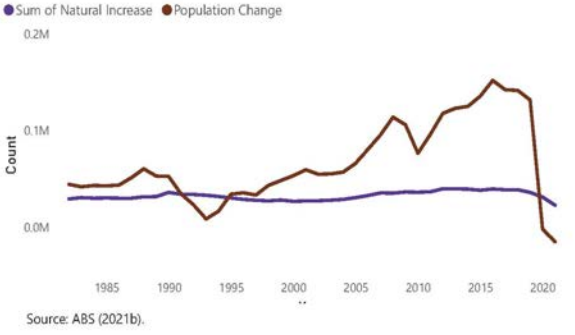


Figure 3.5: Birth-rate by Year

Figure 3.6: Natural Increase and Total Population Change in Victoria



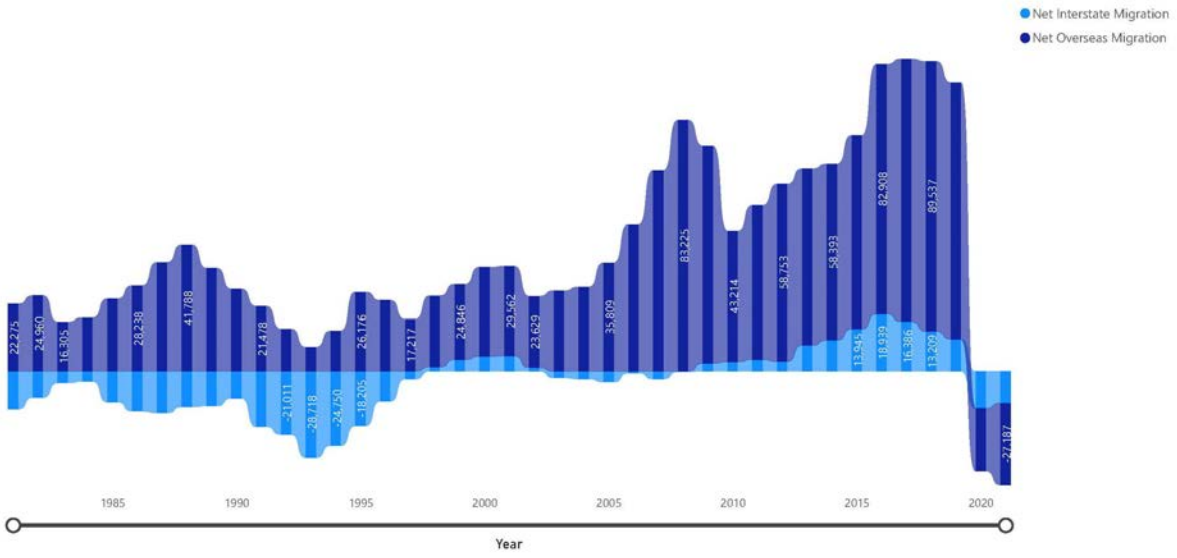
Source: ABS (2021b).

*Control Click to access the interactive visualisation.

The disparities between the natural and overall rates of annual population change were accounted for by differences in net overseas and interstate migration. Australia was also an anomaly before 2020, being both a post-industrial and high-income country with a large overall annual population growth rate. Substantial amounts of net overseas immigration meant annual population growth still averaged 1.54% per year between 2006 to 2020 (Charles-Edwards et al., 2020: 5; World Bank, 2022). In contrast, the overall average annual population was just 0.5% among the high-income and Organisation for Economic Cooperation and Development (OECD) member states.

The ribbon chart (Figure 3.7) presents the main trends in net migration for Victoria between 1981 and 2021. Outward interstate population flows to offset the high net inflows for international migration between the early 1980s and the late 1990s. The most noticeable trends in international migration were the two peaks in 2007-2008 and 2016-2019. Net international inflows of people accelerated considerably after 2005, with some interruption in the aftermath of the GFC.

Figure 3.7: Net Contribution of Migration to Population Change in Victoria, 1981-2021



Source: ABS (2021b).
* 2021 derived from September estimate.

*Control click to access the interactive visualisation.

Therefore, Victoria increasingly exhibited many of the demographic features of a post-industrial society: the general trend was a gradual decline in the natural population growth rates (births and deaths). Its net migration inflows offset the decrease, unlike most high-income countries and sub-national regions.

4: Scope of the COVID-19 disruption

The marked decline in Victoria's population between 2020 and 2021 was overwhelmingly due to COVID-19 and its associated public health measures. These had considerable impacts on net immigration and population distribution within the state.

It should be noted that the virus' effects on mortality have (so far) been modest across Australia and in Victoria. Figures 4.1-4.4 suggest crude death rates continued to fall across Australia, although there was a slight rise in the rate for Victoria in 2021 (ABS, 2020b, 2022b). The considerable increase in deaths since the start of 2022 is beyond the scope of the available data.

Instead, the first set of major impacts of COVID-19 was on the overall net interstate and international migration levels (ABS, 2020b, 2022b) As Figure 3.7 demonstrated, net population outflows from Victoria became positive in 2020 and 2021. Figures 4.6 and 4.7 provide more detail on these trends for Victoria and the more populous eastern states of Queensland and New South Wales. They outline quarterly counts for both variables for the period between 2000 and September 2021. Note that net-overseas immigration counts both permanent and long-term arrivals and departures (it excludes short-term visitors). Figure 4.6 suggests net overseas migration inflows were consistently higher for Victoria and New South Wales than Queensland before the crisis. Net inflows for both of the former states also increased considerably above those for Queensland between 2012 and 2020. Then net overseas migration contracts in all three states after March 2020, with Victoria experiencing the largest reduction in net arrivals for every quarter until September 2021. New South Wales only manages a modest return to net inflows in June and September 2021.

Figure 4.1: Australia Estimated Death Rates

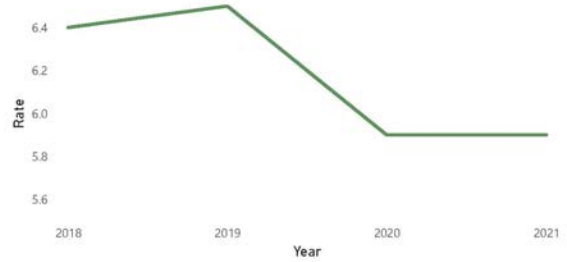


Figure 4.2: Victoria Estimated Death Rates

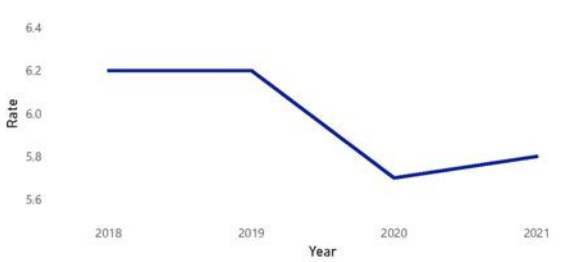


Figure 4.3: Australia Estimated Deaths

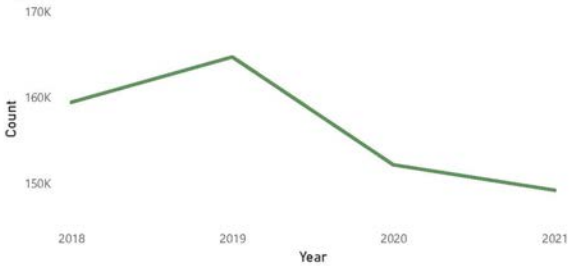


Figure 4.4: Victoria Estimated Deaths

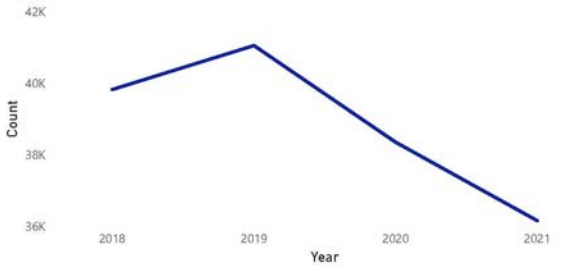


Figure 4.6: Qtr Net Overseas Migration, NSW, Vic and Qld

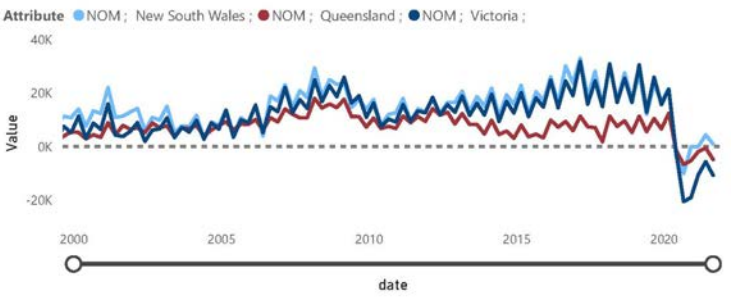
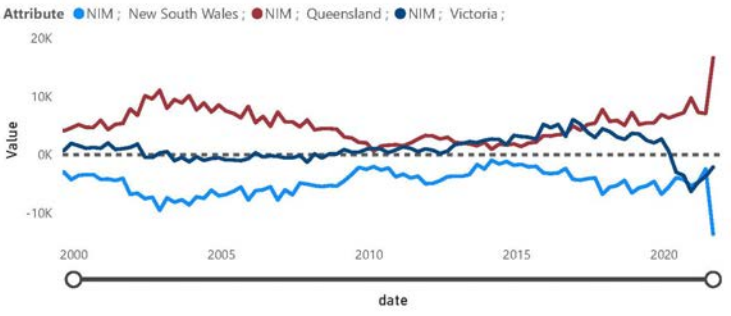


Figure 4.7: Qtr Net Inter-state Migration, NSW, Vic and Qld



*Control click to access the interactive visualisations.

Source: ABS (various years).

Moving on to Figure 4.7, Victoria also experienced sharp decreases in net interstate population inflows from June 2020. Net interstate migration had already long been negative for New South Wales across the whole period from 1990. Yet, the state still experienced a spike in net outflows in the September quarter of 2021. Previously both Queensland and Victoria had maintained net positive interstate migration levels. In the latter case, it was more after 1998 that the trend intensified (with a minor reversal between 2002 and 2008). Queensland remained a net beneficiary of these flows after 2020 before experiencing a very strong spike in net arrivals in September 2021. Victoria, therefore, experienced sharp declines in both net international and interstate population movement, corresponding with the COVID-19 crisis.

The second major impacts were considerable population distribution changes within some of Australia's states (ABS, 2022c). In general, stronger public health restrictions were imposed in the capital city areas in some states. Table 4.1 summarises the estimates of population changes within capital city areas. There was a 0.1% decline (a fall of almost 26,000 people) in the overall population for the capital city regions. Yet, most of these cities either still had modest positive rates of population growth or only a slight contraction (such as 0.1% in Sydney). Melbourne, however, stands out within these figures, with an estimated loss of 60,505 residents or a 1.2% decline in population for the 2020-21 financial year.

Table 4.1: Population Change in Main Urban Centres

City	Estimated Pop. at 30 June 2021	2020-21 Count	2020-21 Percentage
Total capital cities	17,376,986	-25,985	-0.1
Sydney	5,361,466	-5,151	-0.1
Melbourne	5,096,298	-60,505	-1.2
Brisbane	2,582,007	21,870	0.9
Perth	2,141,834	16,169	0.8
Adelaide	1,378,413	1,895	0.1
Canberra	431,611	398	0.1
Hobart	238,375	-334	-0.1
Darwin	146,982	-327	-0.2

*Control click to access the interactive visualisations.
Source: ABS (2022c).

The ABS's (2022c) smaller area estimates (Statistical Area 2 [SA2]) provide further detail on some intrastate population movements. Map 4.1 and Figure 4.8 present summary data based on Victoria's electorates. A spatial join was undertaken of the SA2-level data with their electorate locations, allowing a calculation of population estimates. Four contrasting zones are apparent in Map 4.1. First, many inner-city electorates experienced the largest share of population decline (between 2.6 and 5.2%). The largest proportional fall occurred in Albert Park, with an estimated reduction of 12,128 people (equivalent to 5.12%). Second, these were followed (in the main) by a belt of electorates in the outer suburbs that recorded smaller percentage declines—some of the electorate stretch beyond the greater capital city area. Third, the biggest population gains were in the electorates just outside of the Melbourne capital city area (Macedon, Buninyong, Yan Yean, Bellarine, and Bass). Fourth, many districts further afield also experienced growth, but at a lower rate. Finally, some electorates in the state's north and west also experienced declines.

Many of these electorates had very different underlying population trends for the years between 2001-2 and 2019-20. Some were very high-growth population areas, while others were either less or even experiencing declines. Figure 4.8 allows the reader to group electorates via their location within their Legislative Council (upper house) Regions. The electorates in Eastern Metropolitan Region, for example, all follow a similar trend of gradual growth across 20 years, followed by a decline in 2020-21. Others, such as those within the Northern Metropolitan Region, have more variation. Melbourne has stronger growth, followed by a big drop in 2020-21. Others, such as the outer suburban Yuroke grew more rapidly with very little change after COVID-19. Outside of Melbourne, areas like the Northern Victorian region also feature outer suburban and high population growth (such as Macedon and Yan Yean) areas with little or no change due to COVID-19. Northern Victoria also features electorates with flat or even declining populations. Similar patterns are evident in Western and Eastern Victoria. The latter features Bass, which borders Melbourne. Its population growth has been rapid, and it remained high during the COVID-19 period .

Figure 4.8: Population Estimates for Victorian Legislative Assembly Electorates

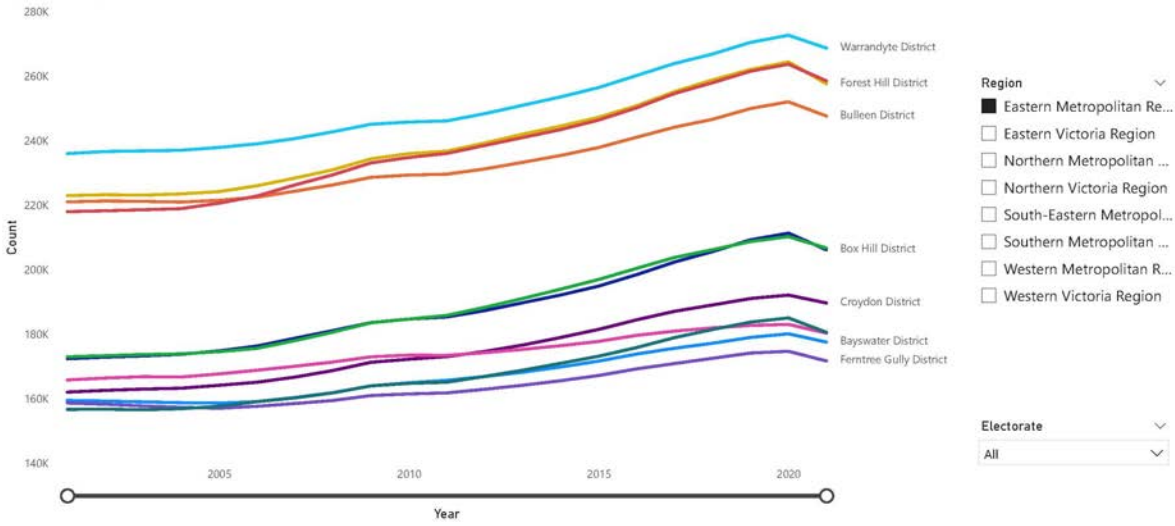


Figure 4.9: Cluster Analysis of Electorates

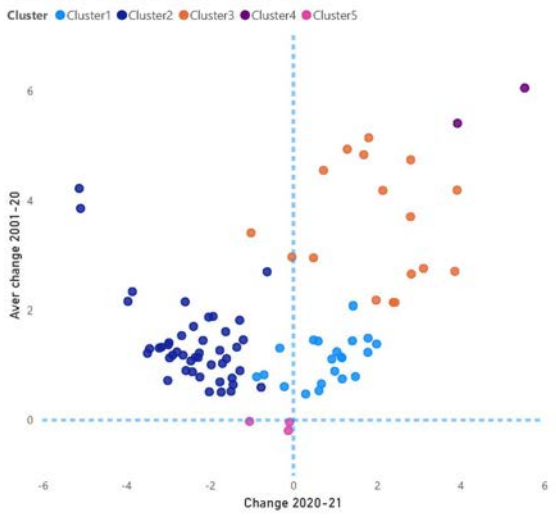


Table 4.2: Electorates by Cluster and Region

Electorate	Cluster	Aver change 2001-20	Change 2020-21	Region
Bayswater District	Cluster2	0.64	-1.44	Eastern Metropolitan Region
Box Hill District	Cluster2	1.08	-2.45	Eastern Metropolitan Region
Bulleen District	Cluster2	0.69	-1.76	Eastern Metropolitan Region
Croydon District	Cluster2	0.90	-1.28	Eastern Metropolitan Region
Eltham District	Cluster2	0.52	-1.49	Eastern Metropolitan Region
Ferntree Gully District	Cluster2	0.51	-1.73	Eastern Metropolitan Region
Forest Hill District	Cluster2	0.90	-2.57	Eastern Metropolitan Region
Ivanhoe District	Cluster2	1.01	-1.97	Eastern Metropolitan Region
Mount Waverley District	Cluster2	0.88	-2.42	Eastern Metropolitan Region
Ringwood District	Cluster2	1.03	-1.70	Eastern Metropolitan Region
Warrandyte District	Cluster2	0.76	-1.47	Eastern Metropolitan Region
Bass District	Cluster4	5.41	3.92	Eastern Victoria Region
Evelyn District	Cluster1	0.79	-0.88	Eastern Victoria Region
Gembrook District	Cluster3	2.95	0.48	Eastern Victoria Region
Gippsland East District	Cluster1	0.75	1.17	Eastern Victoria Region
Gippsland South District	Cluster1	1.39	1.99	Eastern Victoria Region
Hastings District	Cluster1	1.44	0.59	Eastern Victoria Region
Monbulk District	Cluster2	0.60	-0.77	Eastern Victoria Region
Mornington District	Cluster1	1.31	-0.33	Eastern Victoria Region
Morwell District	Cluster1	0.54	0.61	Eastern Victoria Region
Narracan District	Cluster1	2.08	1.43	Eastern Victoria Region
Nepean District	Cluster1	1.46	0.48	Eastern Victoria Region
Broadmeadows District	Cluster2	1.14	-2.28	Northern Metropolitan Region
Brunswick District	Cluster2	1.54	-2.67	Northern Metropolitan Region
Bundoora District	Cluster2	0.78	-2.24	Northern Metropolitan Region
Melbourne District	Cluster2	3.85	-5.09	Northern Metropolitan Region
Mill Park District	Cluster3	4.55	0.72	Northern Metropolitan Region

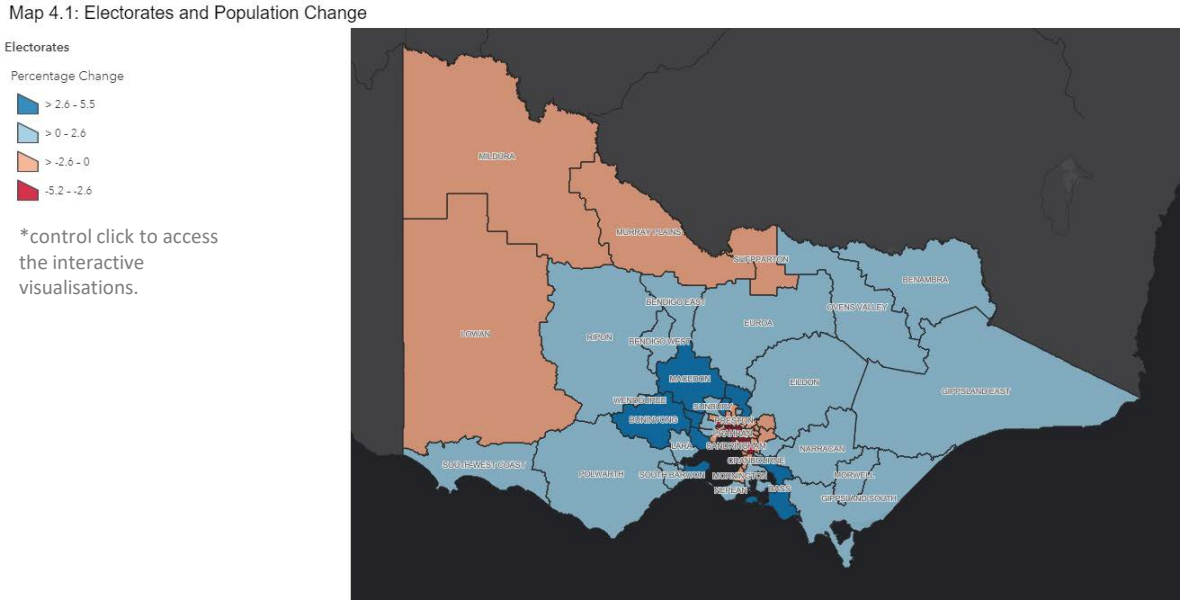
Electorate: All | Region: All | Cluster: All

*Control click to access the interactive visualisations.
Source: ABS (various years).

A cluster analysis of these electorates based on the changes leading up to and during the COVID-19 crisis provides further insights. Figure 4.9 and Table 4.2 groups electorates into five clusters. Most electorates belong to either cluster one or two, where the average population growth rate was positive between 2001 and 2020. Cluster one entities have positive longer-run and (or near positive) COVID-19 era population growth, and 24 of 25 electorates are regional. Forty-four of the 45 electorates in cluster two – with negative population change in 2020-21 – are metropolitan. The electorates in cluster three have long-run higher population growth and mostly positive changes in 2020-21. They are mostly urban (or near metropolitan). Finally, clusters four and five are 'outlier' areas. In cluster five, electorates like Lowan, Mildura and Murray Plains had average percentage declines in population over the past 20 years. Finally, cluster four comprises Bass and Melton, which are notionally regional but are close to Melbourne. They had very high population growth, and COVID-19 had only modest impacts on population change.

Overall, Victoria has a status as a post-transition entity with a low and declining rate of natural population growth. These factors meant COVID-19's biggest impacts were on net immigration. The sharp downturn in population was largely the result of changes in net immigration. There was also a partial reversal of the long-run trend for the increasing concentration of people in the capital city area. These impacts vary according to the longer-run changes in population in different regions.

Map 4.1: Electorates and Population Change



Source: ABS (2022c),VEC (2022).

5: Future projections

As outlined in section two, there have already been some attempts to model the longer-run impacts of these changes. It is clear, though, that established population projections have become redundant.

All population projections (or forecasts) are wrong to some extent, but some are useful. Various estimates produced by the Australian Government Treasury and the ABS have usually not fared well. More sophisticated models utilise a 'stochastic' approach to create a range of calculations based on different scenarios. ABS projections, for instance, feature high, intermediate, and low estimates. Figure 5.1 outlines the ABS's previous forecast (intermediate-range) for Victoria and how they compare to events since the pandemic began. The recorded population growth estimates are already almost 340,000 lower than projected. As section four outlined, this is overwhelmingly the result of dramatic falls in inwards migration and big increases in net outflows interstate.

Nevertheless, some agencies have produced revised projections. The Centre for Population's (2022) most recent forecast, for example, suggested Australia's population would grow to just over 29 million, and 7.9 million for Victoria, by the end of 2032 (see Figure 5.2); which is still below the ABS's original estimate of 8.05 million for 2030. Indeed, Figure 5.3 breaks the estimate down into components and indicates some of the assumptions behind the model. First, it presumes that net interstate migration returns to positive by 2024. Second, although net overseas immigration only has a low projection (11,000) for 2022, the ABS foresee it rising to above 35,000 by 2023. There are, of course, a range of unpredictable factors that could influence either of these two considerations.

Most notably, it is too early to determine trends in net travel of long-term visitors and permanent residents to and from Australia. Figure 5.4 presents the monthly permanent and long-term arrival figures between 2010 and January 2022 (ABS, 2022a). The longer-run data suggest arrival and departure numbers are highly seasonal, with peaks at the end/start of the year and in August (to a lesser degree). In keeping with Australia's status as a country with positive net migration, arrivals overwhelmingly exceed departures in most months. There is a steady upward trend until 2020 when both figures collapse. The crisis and recovery period sees net arrivals closely tracking departures, and influxes only slightly exceed outflows in January 2022. However, the overall traffic volume did reach the level of the pre-pandemic years, although it is plausible that pent-up demand may be at play. It is, therefore, too early to say if the Centre for Population's projections of net immigration for Australia reaching 41,300, or Victoria 11,000, is accurate.

While existing analyses foresee a gradual recovery of interstate and international population inflows, their extent and pace are difficult to anticipate.

Figure 5.1: Projected and Actual Yearly Population Growth in Victoria, 2017-2021.

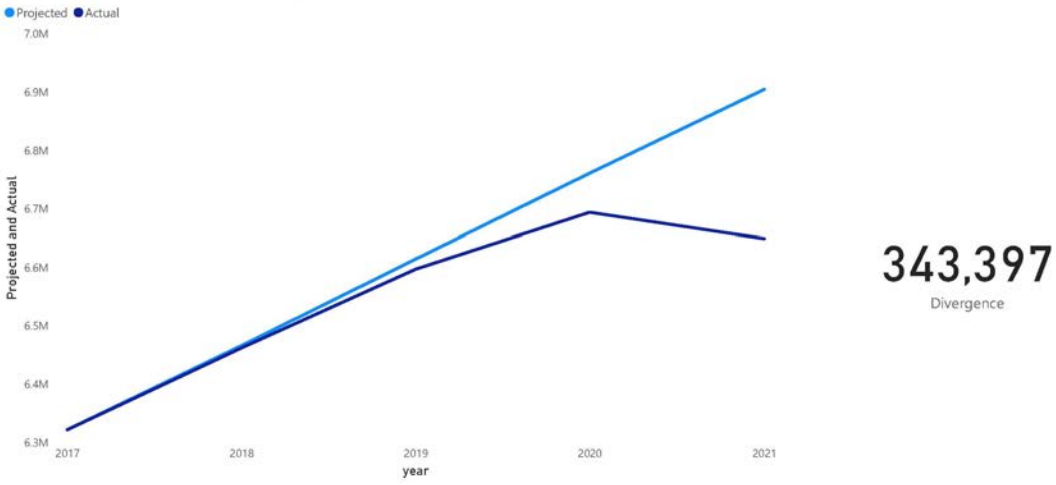


Figure 5.2: Projected Population by State, 2020-2026

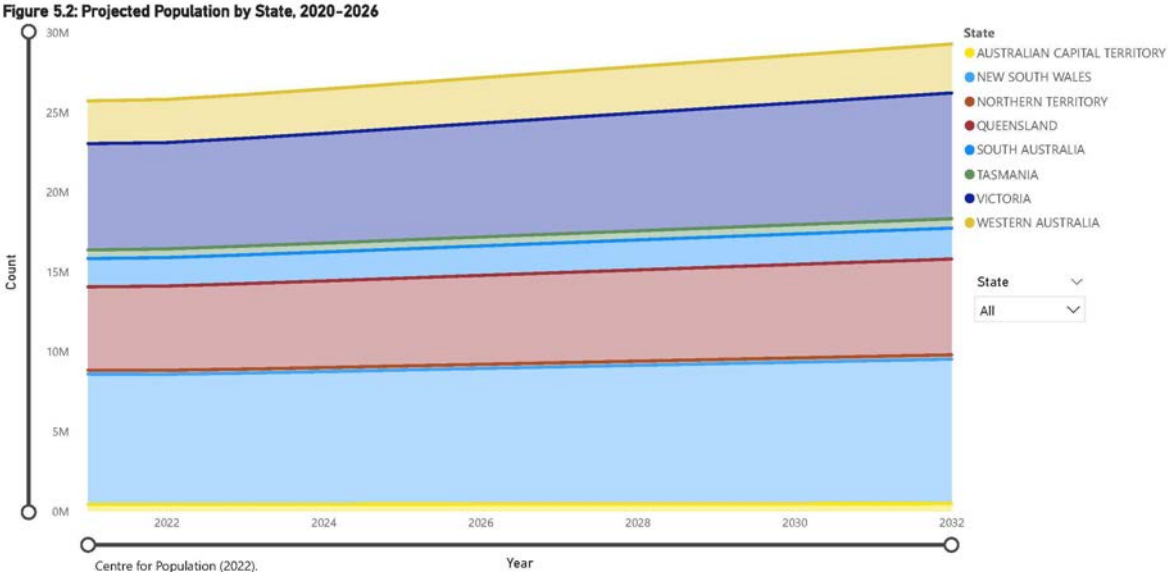
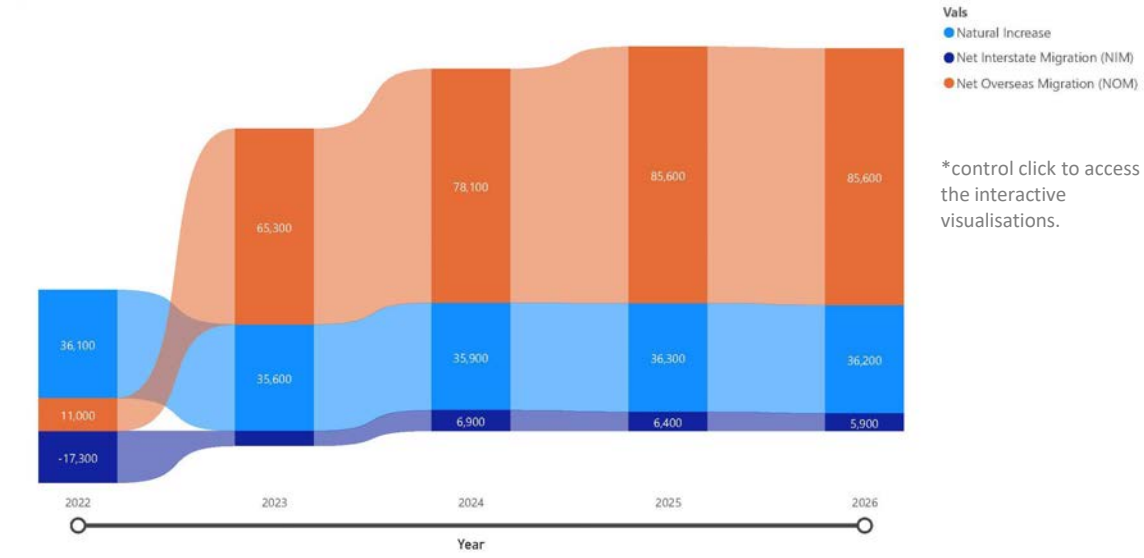


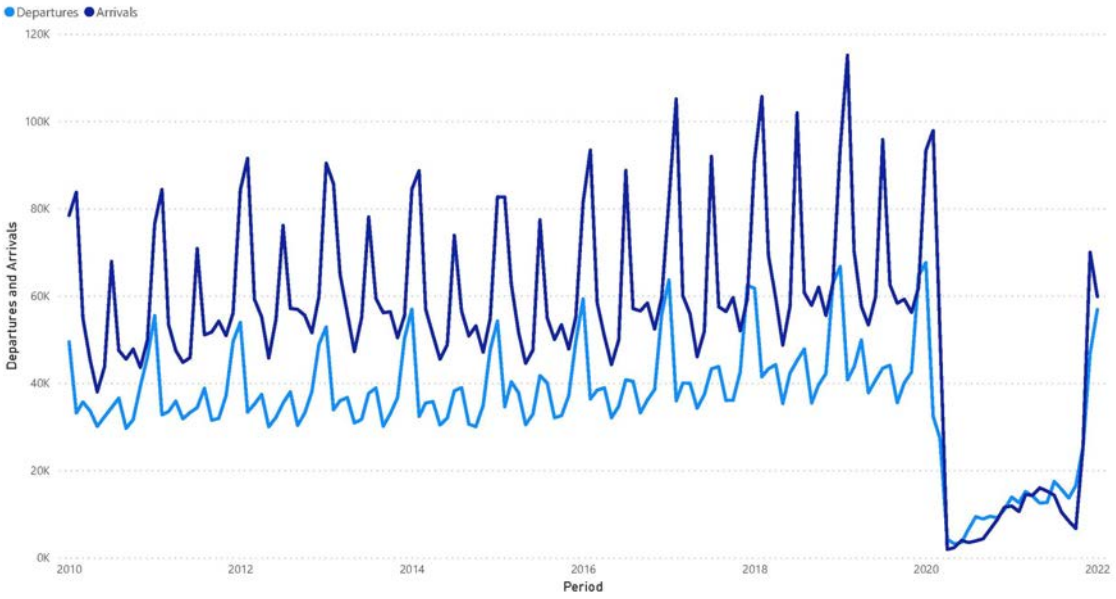
Figure 5.3: Contributions to Pojected Population Growth in Victoria , 2022-2026



*control click to access the interactive visualisations.

Source: ABS (various years).

Figure 5.4: Monthly Permanent and Long-term Departures and Arrivals to Australia, 2010-2022



Source: ABS (2022a).

*control click to access the interactive visualisations.

6: Summary and Conclusions

For Victoria, one of the most pronounced impacts of the COVID-19 pandemic was a sudden and deep disruption to population growth. The causes and extent of the shock are related to the state's history and stage of demographic evolution.

Both Australia and Victoria are unusual entities globally, featuring heavily urbanised, post-transition and high-income economies but with still considerably high levels of population growth. In keeping with the stylised demographic model, most developed countries now have very low or even negative levels of population growth. Victoria shares some of these features with a low natural population growth rate.

However, population growth remained high as there were strong net migration inflows across the post-war period. There was then a decline in these inflows between the 1970s and 1990s, accompanied by net inter-state outflows of the population. Finally, both became strongly positive from 1998 until 2020.

The COVID-19 pandemic caused considerable disruptions to these trends. First, an estimated decline – 0.68% or 44,792 people – already occurred in the state's population between 2020 and 2021. Second, as the crude death rate experienced only a partial rise, the population decline was mostly attributable to a dramatic fall in net overseas migration and a surge in net outwards interstate population flows. The latest estimates suggest a net outflow of almost 71,000 people from the state across both categories since 2020. Third, a cascading set of changes also took place within the state. Calculations derived from ABS SA2 estimates suggest that electorates within the Melbourne greater capital city area have either experienced a slow down or net decline in population growth. The largest areas of population increase have been in the regional areas close to Melbourne. A small number of seats in the state's west and north also experienced population declines.

It is unclear how prolonged these changes may be or their longer-run implications. The state's population is already 343,337 lower than anticipated by the ABS in its medium population projections. There has been a revival of international travel since early 2022; however, there is no trend toward net increases in arrivals. Some entities have produced projections, although it is too early to determine their accuracy.

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Suggested citation

Reid, B. (2022) *Visualising the population impacts of COVID-19 in Victoria.* Parliamentary Library & Information Service, Melbourne, Parliament of Victoria.

Acknowledgments

The Parliament of Victoria Library acknowledges the Traditional Owners of the lands across Australia on which we work and live. We pay our respects to Aboriginal and Torres Strait Islander Elders past, present and future; and we value Aboriginal and Torres Strait Islander history, culture and knowledge.

The author would like to thank Debra Reeves, Caleb Triscari, Anwyn Hocking and Carolyn Macvean for their feedback.

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