Chapter 2

People and their needs

From
Future Dilemmas: Options to 2050 for Australia's population, technology, resources and environment

Report to the Department of Immigration and Multicultural and Indigenous Affairs

By CSIRO Sustainable Ecosystems

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Chapter 2
People and their needs

ABSTRACT

This chapter describes a number of human population and consumption issues that largely frame the remainder of the report. By 2050 Australia could be home for 20, 25 or 32 million people under the zero, base case and 0.67%pa immigration scenarios respectively. By 2100 the population could be 17, 25 or 50 million people under those same scenarios. By 2050 both Sydney and Melbourne could each remain the same size (zero migration), grow by one million (base case) or by three million people (0.67%pa). By 2100 under the 0.67%pa scenario, Sydney and Melbourne could become megacities with populations of about 10 million people. Apart from the zero migration scenario, regional cities continue to grow in most states especially in New South Wales and Queensland. Rural areas continue their population decline under zero migration, generally remain stable under base case, and grow under 0.67%pa.

The number of Australians aged 65 years and over by the year 2050 varies from five million in the zero migration scenario to between six and seven million for the base case and 0.67% scenarios. As a proportion of total population in 2050, this represents 25-26% for the zero and base case scenarios and 20% for the 0.67% scenario. The lower proportion of Australians aged 65 years and over, for the higher population scenario agrees with some other studies and is caused by specific assumptions on the age distribution of immigrants and emigrants based on data from the past decade. When the age classes are converted to a total dependency ratio then six dependents for every 10 non-dependents results for the 0.67%pa scenario whereas the zero and base case scenarios give seven to eight dependents for every 10 non-dependents by the year 2050. The population requiring institutionalised aged care by 2050 is 470,000 for the zero scenario and more than 600,000 for the 0.67%pa scenario. The incidences of medical problems generally follow the patterns of population size and population ageing with issues relevant to younger people such as pregnancy, being stable or declining because of declining birth rates. By comparison, medical problems related to older age increase in all scenarios and are highest in the 0.67%pa scenario where the absolute number of aged persons is highest.

The total labour force stabilises at around 11 million by 2010 in the base case scenario due to stabilising population. For the zero scenario, it declines to nine million and increases to 15 million for the 0.67% scenario in 2050. The educational task stabilises or declines for the zero and base case scenarios by 2010, but continues to rise after 2020 for the 0.67%pa scenario. Population stability in the base case scenario obscures a number of regional patterns where states such as New South Wales and Victoria decline while Queensland and Western Australia continue to grow. Domestic tourism increases to 700 million visitor nights by 2050, due to an ageing population continuing to travel until they are 80 years old. The zero scenario stabilises slightly below 600 million visitor nights by 2020 whereas the 0.67%pa scenario increases continuously to 900 million visitor nights by 2050. Assumptions of growth in international inbound tourism lead to 550 million visitor nights by 2050 and 34 million visitors per year. This equates to 1.5 million full-time citizens in 2050 but with higher travel and consumption impact than an average citizen. Applying the current patterns of visitation gives a ratio of up to 5:1 of international to domestic visitor nights in Australian cities by 2050. Regional areas, with the exception of Queensland, are still dominated by domestic tourism.

The food required for the domestic population and inbound travellers increases with the population number in each scenario and we assume no major changes in dietary habits. The direct dietary requirement for grains varies from two to 3.5 million tonnes compared with current annual production of 30 million tonnes. The total meat required varies from 2.3 to 3.8 million tonnes and current production levels are around 3.5 million tonnes. The total fish required varies from 0.3 to 0.6 million tonnes with current production at 0.2 million tonnes. Apart from fish production, it is reasonable to assume that Australia will retain a positive food balance out to 2050 and beyond. However, domestic consumption may reduce the amount available for trade.

The requirement for general consumables such as paper and plastic continues to rise in line with growing population and rising affluence. By 2050 the requirement for paper could exceed

four million tonnes for the zero scenario and seven million tonnes for the 0.67% scenario. Similarly the requirement for plastics could vary from 1.5 to 2.5 million tonnes per annum. In both cases recycling will reduce the requirement for virgin materials but increase the requirement for process inputs, energy and transport.

Within the perspective of this scene-setting chapter, each population scenario has advantages and disadvantages depending on the reader's world view. The base case scenario gives a stable population number overall with continuing growth for the next 25 years in capital cities and main regional areas while maintaining an ageing population with linked effects of health and aged care. The 0.67%pa scenario gives population growth in most cities and regions and looming challenges for Sydney and Melbourne to function as megacities of nine to 10 million people in 2100. While the proportion of aged persons and total dependants is appreciably smaller in this scenario, the absolute number is larger and continues to grow, producing an ever expanding need for health and aged care. The zero scenario stabilises the size of most capital cities at around current levels but the population may continue to fall in many regional and rural areas. The proportion of aged and dependent persons is similar to the base case scenario out to 2050, but with lower numbers, and therefore lower health needs in an absolute sense. The overall population in the zero scenario declines by 15%, or three million people, in the period 2050 to 2100.

The real analytical task takes place in the subsequent chapters of this report and is largely driven by the decisions on human population contained in each of the three scenarios. Subsequent chapters will focus on both the advantages and the disadvantages of each scenario. As well, they contain a range of sub-scenarios, where particular innovations are implemented to grapple with areas of concern or to take advantage of perceived opportunities.

ISSUES FROM THE DIMA WORKSHOP SERIES

In preparation for the design and testing of the population scenarios with ASFF, a workshop series was conducted in 1999 (Conroy et al., 2000), to critically review the structure of the analytical framework and the implementation of the scenarios. Six important issues for this chapter are described briefly below but many more were documented in the workshop report. The six issues are as follows:

- There was reasonable agreement with the fertility and mortality assumptions underlying the population projections but less agreement on future rates of net immigration underlying the base case population scenario and the patterns of internal migration which spread people around the country. The three population scenarios used in the study are meant to give a range of population outcomes. This should deal with claims that the 70,000 net immigration flow, which drives the base case scenario, is an underestimate of policy settings that are currently in place. The internal migration issues were examined and scenario settings were adjusted to reduce the effect of sun-belt migration which took place in the early 1990s.

- There was some concern that the methods used in ASFF to determine number of households, did not adequately reflect trends such as rising divorce rates and the increasing numbers of single person households. This was important as households are key drivers of consumption for items such as houses, personal motor vehicles and furnishings. An examination of these issues showed that the newer methods of household formation produced by the Australian Bureau of Statistics agreed reasonably closely with the ASFF results, but that further methodological development, particularly if it was tied to specific consumption information for the different types of households, would improve the information about future material and energy flows under different population scenarios.

- The issue of the 'service economy' or the 'new economy' was discussed in depth, in particular its requirement for labour in the face of technological innovation and its future requirement for energy and materials. The starting position for all population scenarios assumes a steady transition towards the service economy and with it, employment located in offices rather than factories. However, most consumption is driven by households and commuter transport is still necessary whether it transports workers to the office or the factory. In addition, the assumptions behind exported commodities and manufactured goods see continual expansion as Australian industry focuses on globalised trade for the next 50 years. Thus, material and energy flows continue to expand under all population scenarios in spite of continual technological improvement and development of the service economy.

- The growth rates for inbound international tourism were widely discussed. In the scenario assumptions it was set at 7% per year until 2010, decreased to 3-4% per annum by 2020 and then stabilised at that rate until 2050. Many tourism industry views assume that growth rates of up to 10% per annum are possible well into the future. Compounding these rates of growth over the next 50 years gives very large numbers which the CSIRO analysts considered were over-optimistic. The more moderate rates of growth described above give 34 million inbound tourists by 2050.

- A number of definitional issues in national statistical terms describe the entry into Australia of students, business workers and tourists. The simulation analyses treat these in aggregate, but more detailed treatments of the issues, particularly when they are attached to consumption and affluence, could become important when considering resource use and environmental quality.

- The workshops considered the increased use of coastal areas for both domestic population settlement and tourism as one of the most important resource issues facing Australia. Any assessment of environmental impact resulting from the size and spread of population use must be related to detailed resource descriptions at a reasonable level of spatial detail. While the ASFF approach could be developed to higher levels of spatial detail, this version of the model could not provide detailed assessments of future population impact at the level of a statistical local area (SLA) or a collection district (CD) for example.

The following sections now detail and discuss the results of the population scenarios for issues such as future population size, education, health and tourism.

POPULATION SIZE AND LOCATION

Three population scenarios

The three net overseas migration options that form the basis of this study result in three different future populations for Australia. The **zero** scenario has a net yearly immigration rate of zero each year i.e. long-term arrivals equal long-term departures. The **base case** scenario has a net yearly immigration rate of 70,000 persons per year (70kpa in figure captions) and is meant to reflect a contemporary policy position. The **0.67%pa** scenario has a net yearly immigration rate of two-thirds of one percent of the current domestic population in each year. This chapter compares the three populations in terms of size, trajectory, age profile, household formation, location and labour force composition. It also explores their education, health and age care requirements and their basic food and material needs. These characteristics form the starting point for the assessment of environmental and resource implications, in the following chapters. This chapter also examines possible future levels of tourism, which will have significant physical impacts in addition to those of the resident population. Subsequent chapters explore the possible effects of each scenario on key aspects of the physical economy.

Total population

The total population for Australia under the base case scenario is 25.1 million by the year 2050 and 25.5 by the year 2100 (Figure 2.1). Under the zero net immigration scenario the population in 2050 could be 20.6 million and 16.7 million in 2100. Under the 0.67%pa scenario (a net immigration rate of 218,000 people per year by 2050) the population in 2050 could be 32.5 million and 50.6 million in 2100.

These outcomes are similar to a wide range of demographic analyses available in Australia but may vary slightly. The computational methods in the ASFF model are generally on a 5-year time step because of the scale and breadth of the model, and also to match the 5-yearly intervals between national population census activities. Thus the results could lack the finer resolution of a demographic analysis that runs on a one-yearly time step. Another reason for slight differences lies in the assumptions behind each scenario and how they are implemented over time in the simulation. The most important assumptions relate to the total fertility rate (declining to 1.65 children per woman by 2010), the death rate (longevity increases by one year for every 10 years of simulation out to 2050, i.e. a total of five years increase), the patterns of internal migration (similar to the past decade but with alterations to departures from Victoria and arrivals in Queensland), and the age structures for both immigrants and emigrants (patterns of the last decade).

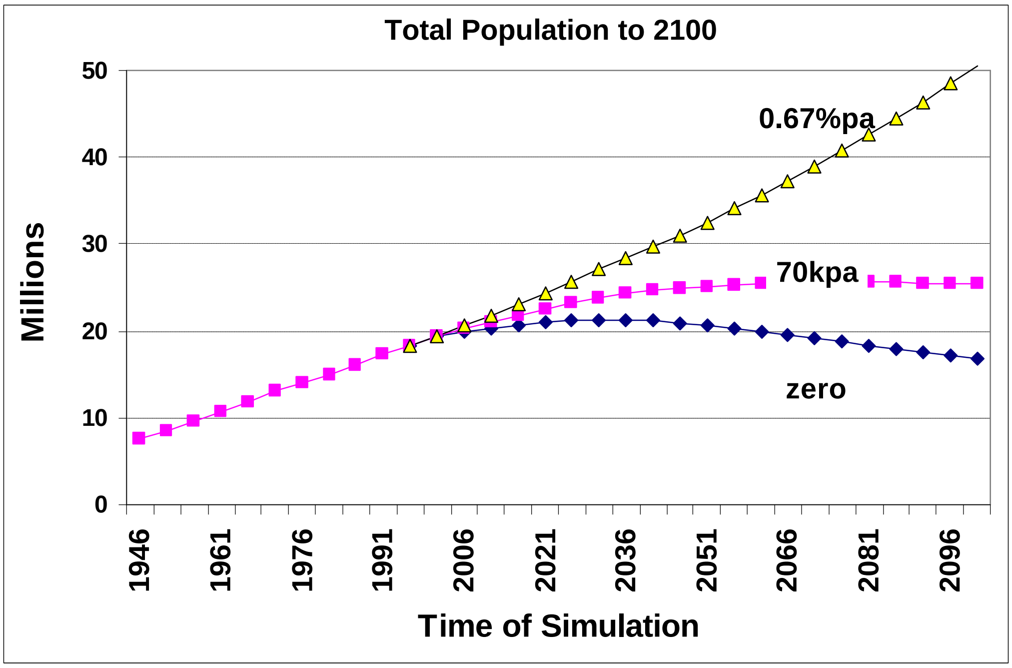

Figure 2.1. Simulated total population size in millions out to the year 2100 for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

The total numbers in 2050 for the base case scenario are within 0.3 million of the mid range *Series II* population projection developed by the Australian Bureau of Statistics (1998, 2000-b), but 2.7 million lower than their *Series I* and 1.43 million above their *Series III* projections. The assumptions and their implementation differ slightly between the ABS report and the ASFF results, but both studies would agree reasonably if all modelling parameters were standardised. The results for both the zero and 0.67%pa scenarios also agree closely with data tables in the ABS report using different levels of net overseas migration. The results for the base case scenario at 2050 are approximately 2 million persons higher than population projections published by the Department of Immigration and Multicultural Affairs (1999) and the standard projection of McDonald and Kippen (1999-a). This is due to small differences in the net immigration rates assumed, a greater longevity assumed in this study and the age distribution of immigrants and emigrants. An overall assessment suggests that the three scenarios defined as inputs to this study cover the range of reasonable possibilities currently developed by other groups for the national policy debate. A full comparison of population projections by CSIRO and ABS is given in Appendix 2.

Future city population

By 2050 under the base case scenario, the capital cities of Sydney, Melbourne, Brisbane and Perth may increase by about one million people each, with smaller increases in the other capitals (Table 2.1). The zero scenario constrains most capitals to their current size, except Brisbane and Perth which both grow by 0.3 to 0.4 million people. The 0.67%pa scenario sees both Sydney and Melbourne growing by nearly three million people while both Brisbane and Perth double in size to around three million people. Other cities grow by 40-100%.

Table 2.1. Simulated population size in millions for capital cities in states and territories in 1998, 2050 and 2100 for three population scenarios.

	Estimate 1999 ABS	Zero 2050	Base case 70kpa 2050	0.67%pa 2050	Zero 2100	Base case 70kpa 2100	0.67%pa 2100
Sydney	4.041	4.280	5.254	6.878	3.448	5.303	10.717
Melbourne	3.417	3.529	4.365	5.826	2.789	4.354	9.098
Brisbane	1.601	2.152	2.561	3.114	1.839	2.695	4.880
Adelaide	1.092	1.226	1.523	2.047	0.989	1.550	3.250
Perth	1.364	1.840	2.221	2.798	1.561	2.332	4.445
Hobart	0.194	0.224	0.279	0.377	0.178	0.280	0.593
Darwin	0.088	0.078	0.098	0.139	0.065	0.102	0.221
Canberra	0.309	0.268	0.333	0.455	0.216	0.335	0.706

By 2100 the patterns are enhanced with the zero scenario seeing the populations of Sydney and Melbourne shrinking by about 0.8 million people, while Brisbane and Perth continue to grow slightly. In the base case scenario the population levels in 2100 are similar to the 2050 patterns because the population has stabilised. Under the 0.67%pa scenario both Sydney and Melbourne grow to populations of about 10 million or what is termed a megacity. Functionally the cities would be much larger than 10 million as Sydney, Newcastle and Wollongong would effectively join and become one much larger unit. Similar linkages would increase the functional size of Melbourne as it amalgamated with Geelong, Ballarat and Bendigo. Under this higher population scenario, Brisbane, Adelaide and Perth might triple in size to the functional equivalents of today's Sydney and Melbourne, while the other capitals might double in size. The development of megacities brings many problems of scale, equity and environmental challenge. These issues are briefly described below by reference to the megacities of today.

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City size and economies of scale

In the year 2000, nearly one half of the world's population lived in cities and about 20 urban regions had populations in excess of 10 million people (Fenger, 1999). In this context, the 0.67%pa scenario in the year 2100 may be worthy of more scrutiny since both Sydney and Melbourne may develop population levels of between nine and 10 million people should the present patterns of internal migration be maintained.

Table 2.2. Issues of environmental, functional and social concern in six megacities with populations greater than 10 million people in the year 2000.

City	Estimated population in millions for 1998	Management and Environmental Challenges
Tokyo-Yokohama	29.344	• Earthquake hazard • Urban heat islands • Traffic congestion and air pollution
New York	14.642	• Open space greening • Noise • Waste prevention and recycling • Water quality
London	7.074	• Air quality • 24 hour noise • Traffic and parking
Seoul	20.736	• Water supply • Maintaining reasonable ratios of health professionals to urban residents • Air quality • Sanitation and solid waste
Sao Paulo	23.715	• Settlement of risk prone areas • Air and water quality • Fiscal resource constraints • Health of human population • Lack of urban infrastructure for the poor
Mexico City	26.176	• Air pollution and public health • Inequality between core city and surrounding regions • Personal security and crime

In an effort to foresee possible areas of environmental challenge should Sydney and Melbourne grow to the megacity size, a literature search was conducted to note possible areas of concern. This was undertaken for three cities that were likely to be around 10 million people in the year 2000 in more developed economies (Tokyo, New York, London) and three in less developed economies (Seoul, Sao Paulo, Mexico City) (Table 2.2). Large cities are becoming the hubs of the new economy with synergies gained from the scale of investment as well as a diversity of activity and markets (Brotchie et al., 1995). However, a number of studies centred on functional, environmental and social concerns (eg Newman and Kenworthy, 1999; Yenken and Wilkinson, 2000) note than cities beyond a certain size, while possessing all the positive attributes of scale and diversity, also exhibit a number of structural and functional fragilities.

The developed cities noted in Table 2.2 all exhibit problems associated with motor vehicles, traffic congestion and air quality. Both London and New York have noise problems and Tokyo has a number of social problems in spite of its relative affluence. Cities in developing countries have similar environmental problems but with the added dimension of being directly linked to human health issues. In both Mexico City and Sao Paulo air pollution can be directly linked to human health problems. These cities are limited in their capacity to overcome the problem by fiscal restrictions, and ever growing problems in social inequality.

Although these problems exist in the megacities of today, they would not necessarily exist in Sydney or Melbourne in the year 2100. Many options are available with new technologies and strategic planning, which could avoid or minimise many of the possible problems of size and form. However a number of these issues of size, function and form are already evident in Australian cities today. These will be analysed and discussed in later chapters. While there are strong possibilities that solutions will be implemented, in the year 2002 it is worth debating the possibility of equal or better solutions in a city that might double or triple in size over the next 100 years.

Regional cities and rural Australia

Regional cities in New South Wales and Queensland would increase in size by 2050 under the base case scenario, while in most other states they would remain stable or decline slightly (Table 2.3). The zero scenario would give population declines in regional cities while the 0.67%pa scenario might give population increases of one million people in New South Wales and Queensland but relatively minor increases in the other states.

Table 2.3. Simulated population size (millions) for three population scenarios for non-capital city urban areas in states and territories in 2050 and 2100 compared to the 2001 modelled value for the base case scenario.

	Model Value 2001	Zero 2050	Base 70kpa 2050	0.67%pa 2050	Zero 2100	Base 70kpa 2100	0.67%pa 2100
New South Wales	1.500	1.572	1.930	2.526	1.260	1.937	3.915
Victoria	0.578	0.516	0.638	0.852	0.395	0.617	1.290
Queensland	1.276	1.785	2.124	2.583	1.520	2.227	4.033
South Australia	0.128	0.091	0.113	0.152	0.065	0.102	0.214
Western Australia	0.187	0.168	0.202	0.254	0.124	0.185	0.352
Tasmania	0.131	0.099	0.123	0.167	0.076	0.119	0.252
Northern Territory	0.042	0.037	0.047	0.066	0.029	0.046	0.099

By 2050, rural areas (outside regional cities) of New South Wales, Victoria, Queensland and Tasmania all show moderate population growth under the base case scenario while the other states decline marginally (Table 2.4). Under the zero scenario, by 2050 the rural population grows marginally in New South Wales, Victoria and Queensland but declines in the others. Under the

0.67%pa scenario the rural populations of New South Wales, Victoria and Queensland nearly double by 2050 with moderate increases in the other states. These patterns are maintained until 2100 with continuing population reductions under the zero scenario, and stabilisation or small increases under the base case and large increases under the 0.67%pa scenario.

Table 2.4. Simulated population size in millions for rural areas in states and territories in 2050 and 2100 compared to the 2001 modelled value for the base case scenario.

	Model Value 2001	Zero 2050	Base case 70kpa 2050	0.67%pa 2050	Zero 2100	Base case 70kpa 2100	0.67%pa 2100
New South Wales	0.781	0.822	1.009	1.321	0.662	1.017	2.056
Victoria	0.606	0.627	0.775	1.035	0.486	0.759	1.586
Queensland	0.679	0.787	0.937	1.139	0.665	0.974	1.765
South Australia	0.214	0.176	0.218	0.293	0.127	0.199	0.418
Western Australia	0.234	0.142	0.172	0.217	0.103	0.154	0.294
Tasmania	0.139	0.133	0.165	0.224	0.105	0.165	0.349
Northern Territory	0.046	0.031	0.039	0.054	0.024	0.036	0.079

Households

The numbers of people per household continues to decline from a historical value of 3.75 in 1947 (Hugo, 1999) to its current level of around 2.6 (Australian Bureau of Statistics, 2000-b) to a range of 2.3 to 2.4 people per household by the year 2050 (Figure 2.2). This is caused by a wide number of factors that relate to the changing nature of human relationships, increased affluence, the changing nature of work and the evolution of city structure and transportation systems. The change is related to social and economic issues but has important implications for the physical economy. The number of households increases from about seven million currently to 8.2 million for the zero scenario, 10.6 million for the base case and 13.6 million for the 0.67%pa scenario.

The conversion of total numbers of people to numbers of households is an important modelling construct for two reasons. Firstly the number of households is growing at a faster rate than the population itself. Hugo (1999) notes that while population grew at an annual rate of 1.21% between the 1991 and 1996 census periods, the household growth rate was 2.23% for the same period. Secondly much of the demand for houses, motor vehicles, furnishing, electrical goods and energy usage in the real world is driven by household units rather than by individual people. For example every household, whether it has one or four persons, requires a refrigerator. There is a possibility that these simulations slightly underestimate the total numbers of households by 2050. Changes in social trends, such as one parent households and people living alone, are included in improved methods of household projections developed by the Australian Bureau of Statistics (1999) but the ASFF model does not yet include them. However, the ABS estimates of number of households for the year 2021 lie in the range of 9.4 to 10 million which is similar to the base case scenario simulated at that date by the ASFF model. A number of European studies highlight the importance of the changing structure of households. Lutz (1999) showed that social trends such as increasing divorce had the potential to increase greenhouse gas emissions as family units split into two, each of them requiring a functioning household and independent transportation. Work on sustainable development in the Netherlands focuses on household consumption and behaviour rather than that of the individual (Noorman and Uiterkamp, 1998).

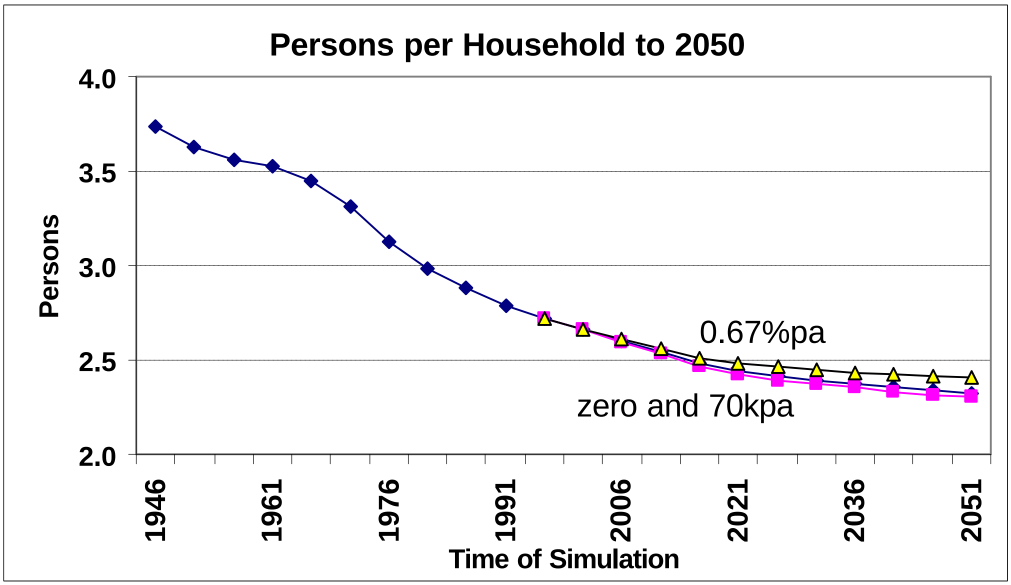
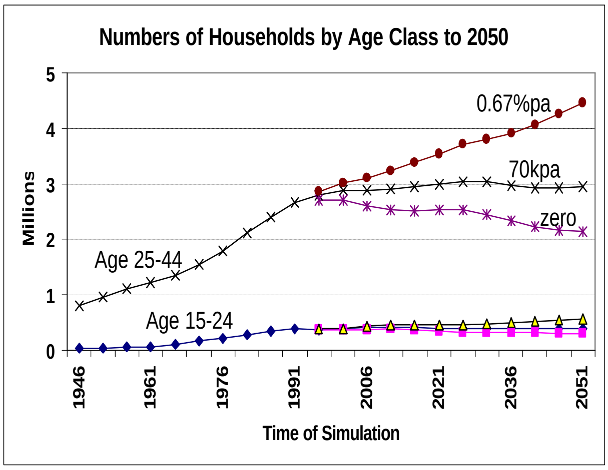


Figure 2.2. Simulated number of persons per household out to the year 2050 for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

In modelling terms, households are separated into classes described by the age of the head of the household (termed the age class of households) (Figure 2.3). There are differences between the scenarios which could signal a change for many consumption sectors of the economy. There is little difference between the three scenarios for the youngest age group of households. However the number of households in the 24-44 age group could be two, three or 4.5 million by 2050. For a range of sectors in the economy these are important differences, as this age group potentially represents the ageof prime employment, relationships and marriage, home establishment and child rearing. These factors are important drivers of economic growth and physical requirements in the economy.



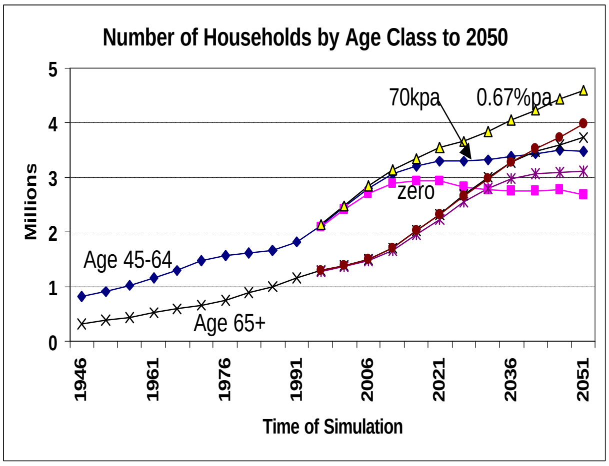


Figure 2.3. Simulated numbers of households out to the year 2050 for household age groups (15-24, 25-44, 45-64, 65+) and three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

Out to 2020, the 45-64 age group represents the most rapidly growing number of households. After 2020 the zero and base case scenarios enter a period of relative stability with around three to 3.5

million households while the 0.67%pa scenario continues to grow to 4.5 million households by 2050. By the mid-2030s the 65+ age households are potentially the most numerous in the zero and base case scenarios with between three and four million households. In the 0.67%pa scenario where the younger age cohorts are more numerous, there are about 4.5 million 25-44 and 45-64 age households, and about four million 65 and older age households. These changes in household age composition could herald large changes in type and level of consumption. For example, in the Netherlands, Noorman and Uiterkamp (1998) found that the use of cars, computers, washing machines and bathing was less important for older households than younger ones.

POPULATION AGEING AND HEALTH ISSUES

Proportion of Australians aged 65 years and over

By 2050 the numbers of Australians aged 65 years and over could be 5.7, 6.3 and 6.5 million people for the zero, base case and 0.67%pa scenarios respectively (Figure 2.4). By 2100 these numbers could be five, seven or 11 million. Figure 2.5 illustrates these numbers as a proportion of the total population. After 2050 the proportion of people aged 65 and over, stabilises around 20% for the 0.67%pa scenario and it is about 27% and 29% for the base case and zero scenarios respectively. This compares with around 12% at present. These differences could pose important demarcations between the scenarios in national policy terms, especially for the long-term policies concerning health care, superannuation and social security issues.

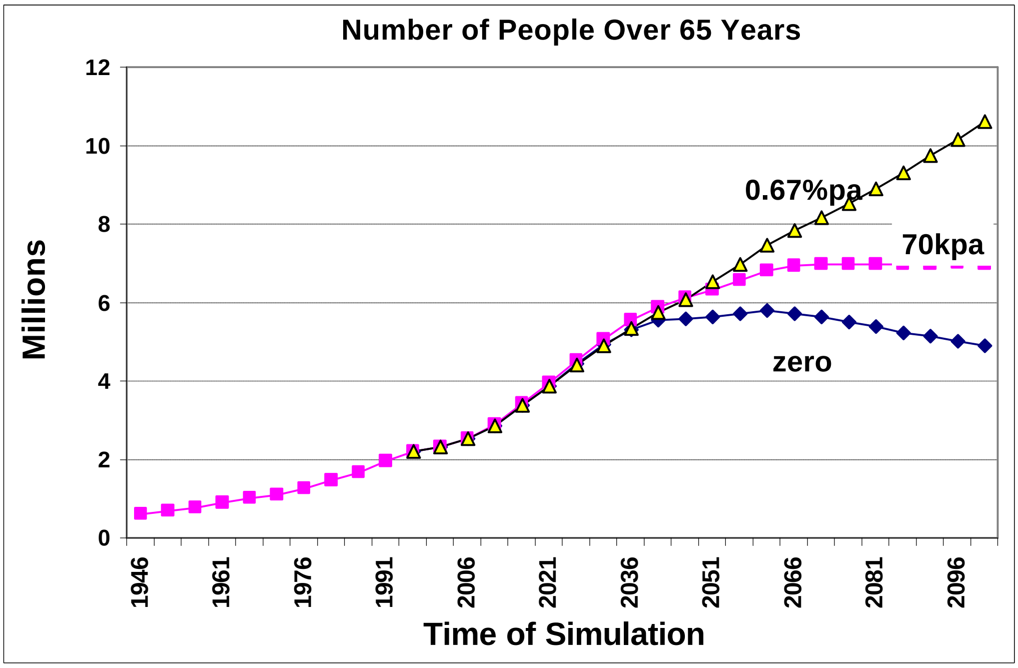


Figure 2.4. Simulated numbers of people to 2100 who will be over 65 years of age for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

These simulation results warrant further examination since they differ slightly from other analyses. The population projections of the Australian Bureau of Statistics (1998) report that the proportion of 65 years and older at 2051 varies from 23.7 to 25.6% depending on the assumptions behind the particular series of projections. This agrees well with the base case population scenario at 2051 which is the most relevant scenario for comparison (Figure 2.5). The graph then depicts this for the next 50 years to the year 2100 with a small increase in proportion.

The work of McDonald and Kippen (1999-a; 1999-b) is also important in relation to the effect of immigration on the proportion, as opposed to the absolute number, of persons aged 65 years and older. One interpretation of their work suggests that increases in immigration alone (beyond a net immigration rate of 50,000 to 100,000 per annum), have a marginal negative effect in reducing the effect of ageing which continues for the duration of their analyses. Selecting younger immigrants does have an effect, particularly when there are high levels of immigration. This feature is represented in the ASFF model since it is based on age distributions of immigrants and emigrants over the last decade. Although the proportion of people aged 65+ is maintained around 20% by the 0.67%pa scenario, this represents a constant proportion of an ever increasing number and therefore an increasing number of aged people. A recent study reported by the Business Council of Australia (McDonald and Kippen, 2000) concurs with the results developed from the 0.67%pa scenario. In simulating a number of high population growth projections, the study found that the proportion of persons aged 65 or more, fell to between 20.3 and 21.6% depending on the specific assumptions made. Thus the results from these two studies are compatible.

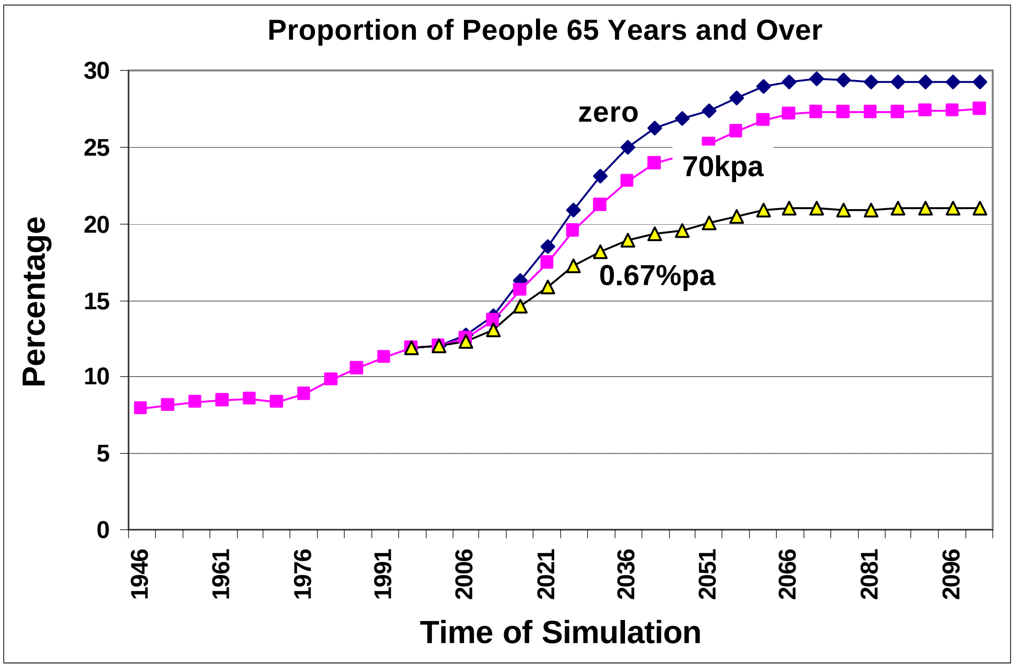


Figure 2.5. Simulated proportion of total population to 2100 who will be over 65 years of age for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

Dependency ratios

The issue of ageing can be examined further by examining the total dependency ratio which compares the sum of the 0-15 and 65+ age groups with the 16-64 age group (Figure 2.6). The total dependency ratio presents a proportional view of the young and older potentially dependent groups in relation to the age cohorts which make up the bulk of the workforce. The historic period shows a peak in the 1960s corresponding to the baby boom and then a decline to the current period before a rise for the scenario period out to 2100. The zero scenario rises to 70% in 2050 before stabilising around 80% after 2060. The base case scenario is around 68% at 2050 and stabilises at 75% soon after. The 0.67%pa scenario rises to 60% in the mid 2030s and stabilises at that level thereafter until 2100.

Lower values could be seen as better than higher ones, but this interpretation hides a number of factors. The first is that proportional values mask absolute numbers, an issue already in the discussion on ageing. In this case, the lower total dependency ratio of the 0.67%pa scenario actually represents a larger number of dependents, potentially supported by a larger population of working age. The second issue is that many of the service, infrastructure and environmental issues reported in this study are related to per capita or per household consumption issues, and how those might change over time.

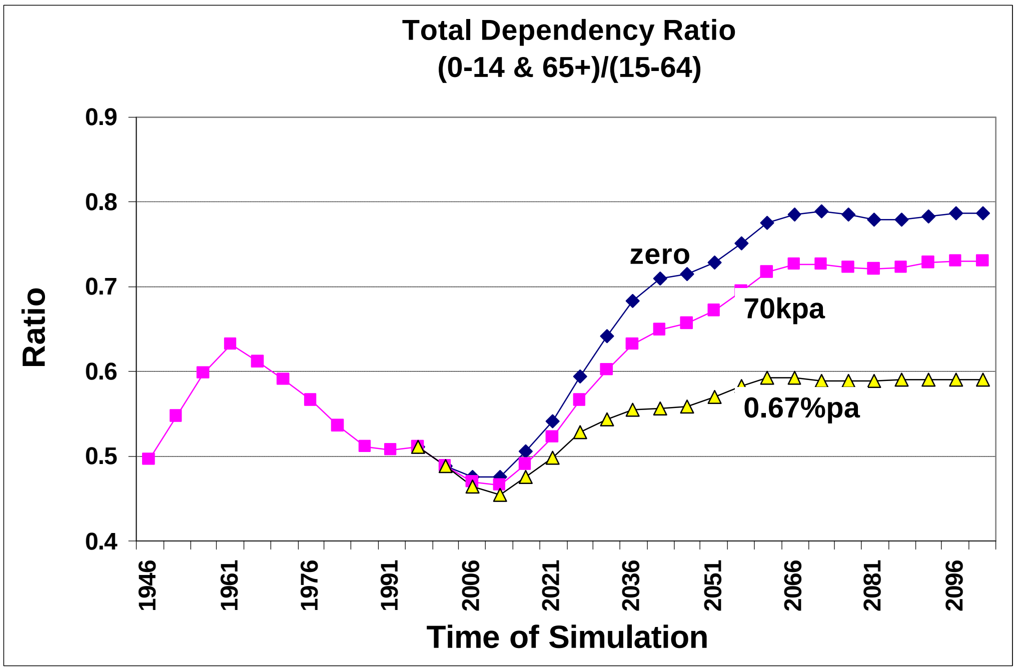


Figure 2.6. Simulated total dependency ratio to 2100 for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa). These data may differ slightly from other published data due mainly to modelling aggregations which use 5 year cohorts rather than 1 year cohorts. However the trends in the data and the differences between the scenarios are consistent and reasonably robust.

The third issue relates to the work activity and contribution to society in general of Australians in the 65 and over age bracket. Hugo (1999) discusses a number of these issues and notes that the 65 and over age group are not necessarily dependent in the traditional sense, and might continue to work and contribute. Alternatively, the demand for goods and services from this group, if they are predominantly self-funded retirees in the next 50 years, could be seen as business opportunities rather than burdens on the economy and the working population. The 75+ population are by far the heaviest users of health, welfare and specialised housing services for the aged (Hugo 1999). In assessing the effect of ageing and the dynamics of retirement incomes Bacon (1999) notes that wealth and savings potentially grow more quickly in the 55+ age groups as education and mortgage costs decrease. He also notes that lowering unemployment may increase the incentive for older people to stay in the workforce both to maintain lifestyle as well as for personal fulfilment. Increasing pressure on public outlays may be due to rising health care costs rather than pension support. Within the context of Bacon's analyses, these comments apply mainly to the base case and zero scenarios.

Long-term health care

By the year 2050, the number of people requiring aged care, could be about 500,000 and nearly stable for the zero scenario or 650,000 and continuing to grow for the 0.67%pa scenario (Figure 2.7). These results should be viewed in the context of today, where 2.3 million people or 12% of the population are in the 65+ age bracket. In 1996 about 7% of older Australians were in health care establishments with the proportion increasing with increasing age. The remainder lived within a household. About 1.2 million people in the 65+ group have a disability and 880,000 require help living their daily lives (Australian Bureau of Statistics, 2000-a).

These results have physical implications, including future requirements for facilities dedicated to the care of the aged. Some of these issues are addressed in later chapters. The results also lead to the consideration of alternative options for addressing the issues related to aged care. Many of these options are already taking place, e.g. people staying in their own homes with daily care and retrofitting of homes for health, safety and security. Some local government areas in Japan, a country already in the transition to an aged society, have invoked planning laws where all hallways in new homes must be built with wheelchair traffic in mind and provisions must be made for lifts in multilevel dwellings.

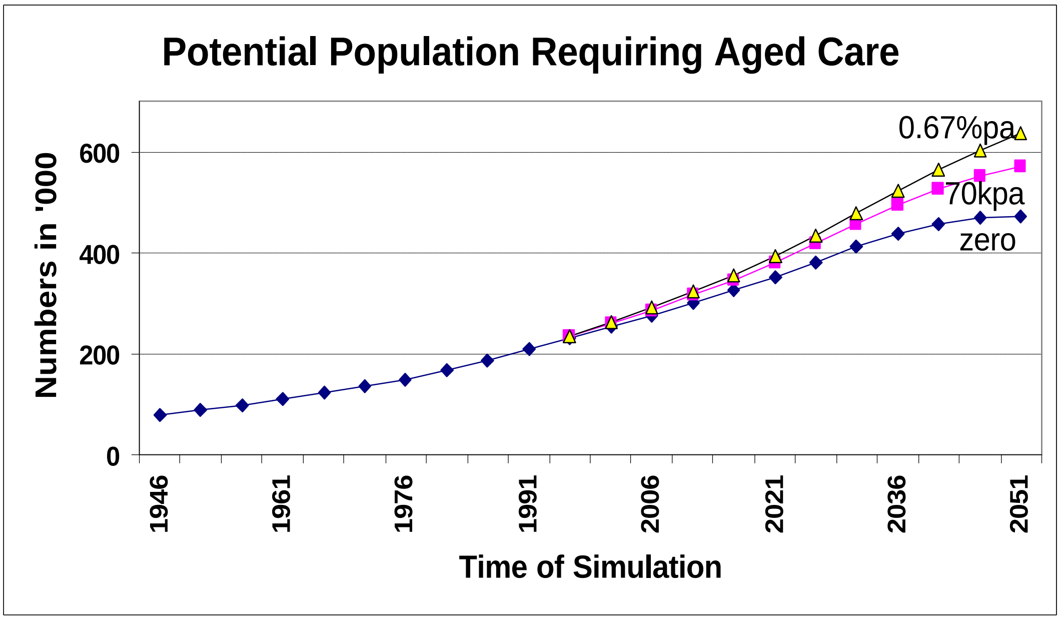


Figure 2.7. Simulated potential numbers of persons requiring aged care to 2050 for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

Health care issues in the future

As the age composition of the population changes it is possible that the incidence of chronic health problems linked to age will also rise (Figure 2.8). In health issues that relate to younger age groups, the incidence of 'pregnancy related complications' varies between the scenarios with greater incidence in the 0.67%pa scenario and lowest in the zero scenario. Due to declining birthrates the simulated results to 2050 are of the same order as the historical period. Pregnancy related complications remain a considerable health delivery task with 1.13 million patient days devoted to it in 1996 (Australian Institute of Health and Welfare, 1998). By contrast, a medical problem such as circulatory diseases becomes more prevalent with ageing and continues to expand with the ageing population and in the absence of changes in behaviour and breakthroughs in medical technology. The simulated results for this condition show a steady increase until 2030 when the zero scenario starts to stabilise while the base case and 0.67%pa scenarios continue to grow until 2050 and beyond. In 1996 this condition required 2.1 million patient days. The modelling framework reports on 18 different category areas that relate to hospital stays and thereby to the building infrastructure required. However many health conditions are treated at home or after a visit to the doctor so the simulation underestimates the medical conditions that may be prevalent in future populations.

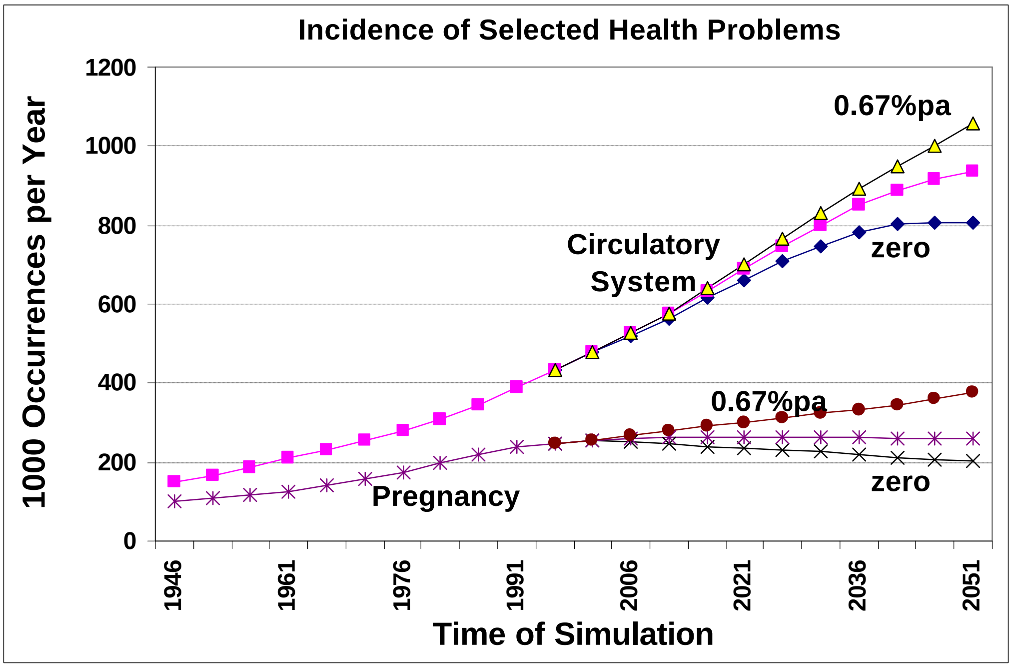


Figure 2.8. Simulated morbidity rates for two selected health conditions to 2050 for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

While the nation's citizens are living longer, the total health task will continue to grow. National priority areas include cardiovascular health, cancers, injury prevention and control, mental health and diabetes. Many of these are linked strongly to age, but also to the life and lifestyle before ageing. Bacon (1999) reports that total health costs in monetary terms are 8.5% of GDP and this proportion could rise to 16% in 2031 and 19% in 2041. According to health literature "A pension costs much the same for an 85 year old as for a 65 year old and is capped" (Bacon, 1999). Health costs on the other hand rise rapidly with age and the group with the largest increase (compared to now) is expected to be the over 80 age group. The medical literature notes the challenges of an ageing population and how services must adapt to a permanent change in population structure in many developed countries that have undergone the demographic transition. In regard to the three population scenarios under discussion, the larger populations have a larger number of ageing people and therefore larger health tasks. They also have larger physical and monetary economies, and possibly greater potential to service these needs. In parallel with these issues is the potential of a rebound effect, whereby fewer health problems earlier in life (lower morbidities due to better health programs) have the potential to concentrate health services at higher intensities in the last 10 to 20 years of life.

THE LABOUR FORCE AND THE EDUCATION TASK

The total labour force

The number of people in the labour force depends on the number of people of working age in each population scenario and labour force participation rates. By 2050 the total labour force could number nine million in the zero scenario, 11 million in the base case and 15 million in the 0.67%pa scenario (Figure 2.9). This compares to a total labour force in 1999 of 9.4 million (Australian Bureau of Statistics, 1999). By the year 2100 the zero scenario declines to 7.5 million, the base case remains relatively stable at 11 million and the 0.67%pa scenario increases to 22.6 million people. The projections made by the Australian Bureau of Statistics out to 2016 give a labour force of 10.84

million people which agrees closely with the 10.96 million people simulated for the base case scenario at that time.

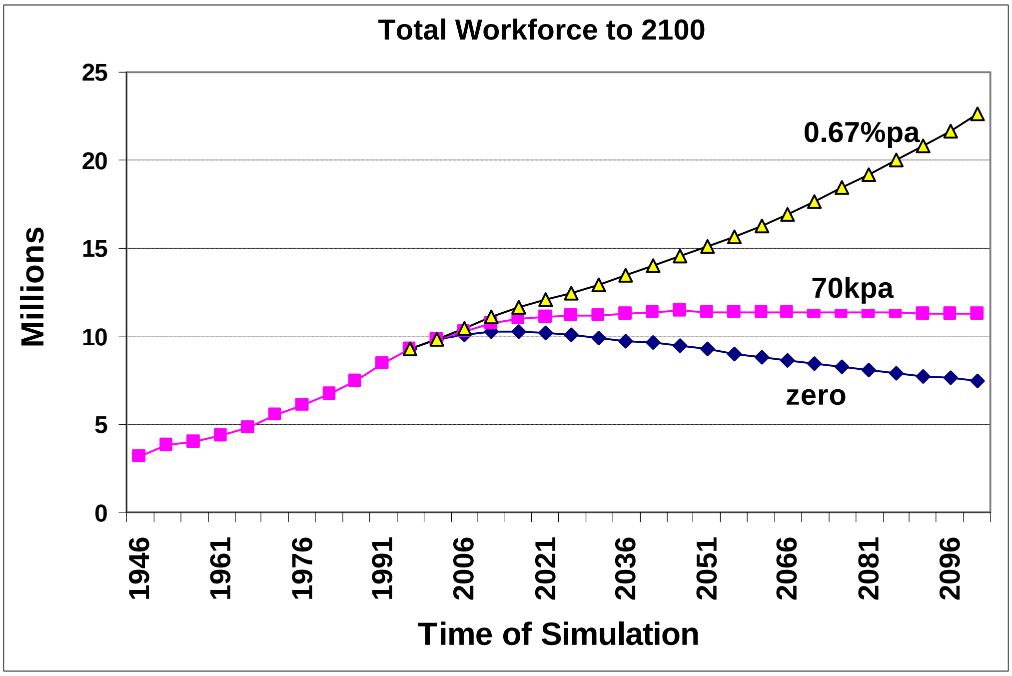


Figure 2.9. Simulated total labour force to 2100 for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

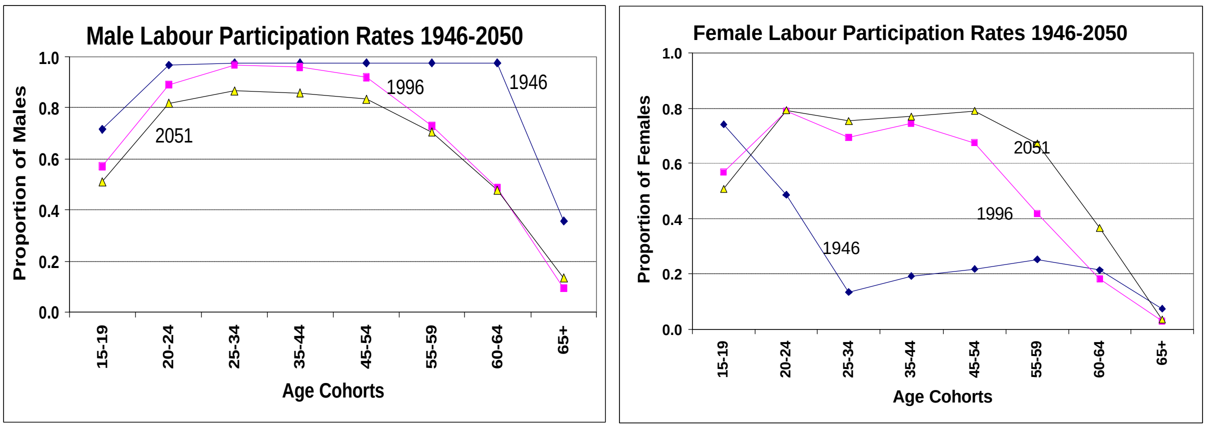


Figure 2.10. Labour force participation rates for the years 1946, 1996 and 2051 for males and females for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

While calculating the number of people of labour force age is relatively simple, defining the number of people in the labour force is complex. Within this modelling context it depends on the interaction of the demographic results already presented in this chapter with the labour force participation rates shown in Figure 2.10. For females there has been a large increase in participation rates in the period 1946 to 1996 as women have moved towards equal status and opportunity in the workplace. These rates are maintained in each of the future scenarios and increased particularly in the 45-64 year category. Male participation in the labour force has fallen from almost full participation in 1946 to lower rates in 1996 and will fall further by 2051, as the rate of male and female participation in the workforce becomes more equal. The issues of changes in the workplace and the relative mix of ages and genders in the workforce are extremely complex and treated in a relatively superficial manner in the ASFF modelling approach.

The changing nature of the workforce in relation to both technology and ageing of the population appears to be surprisingly under-researched (The Economist, 1999). While firms in many sectors and countries aim to make their workforces younger in an attempt to speed the cycle of innovation and make work practices more flexible, other views promote the advantages of age in bringing history, experience, better educational status and more strategic views to the workplace. There seems little doubt that the processes of technological innovation and the up-skilling of the workforce will continue. However, the emergence of the service economy and the change from blue collar to white collar jobs are accompanied by a number of new white collar tasks equal in drudgery to blue collar jobs (Jonsson, 1998). Job training, employee participation, inter-firm cooperation and penalising short-termism by firms are all crucial to developing attractive work opportunities in future labour markets (Marshall, 1999). Many of these issues lie outside the parameters of this study but they could pose important social boundaries to the relatively optimistic assumptions of future levels of physical productivity which are the starting point for all three population scenarios.

The national student body

Under the base case scenario, the number of students participating in the three levels of education will remain more or less stable until 2051. Low oscillations in the curve are produced by changes in the number of children being born, which is driven by the age structure of mothers and a shift in age distribution of births (Figure 2.11). The zero scenario gives a declining educational task of nearly 50 million student days lower than the base case at both primary and secondary level, but a relatively minor decline in the tertiary sector as the educational task is spread across a much wider range of ages. The 0.67%pa scenario produces a similar educational task to the current level out to the year 2020, when it rises to 500 and 400 million student days for the primary and secondary tasks respectively. The relative stability to 2020 is due to the balancing dynamics of a declining birth rate and increasing immigration which has a lag period before the increased number of immigrant mothers starts adding substantially to the total number of births. The tertiary education task increases continually from 2000 in the 0.67%pa scenario because the adult population from which the tertiary sector draws its students is continually growing.

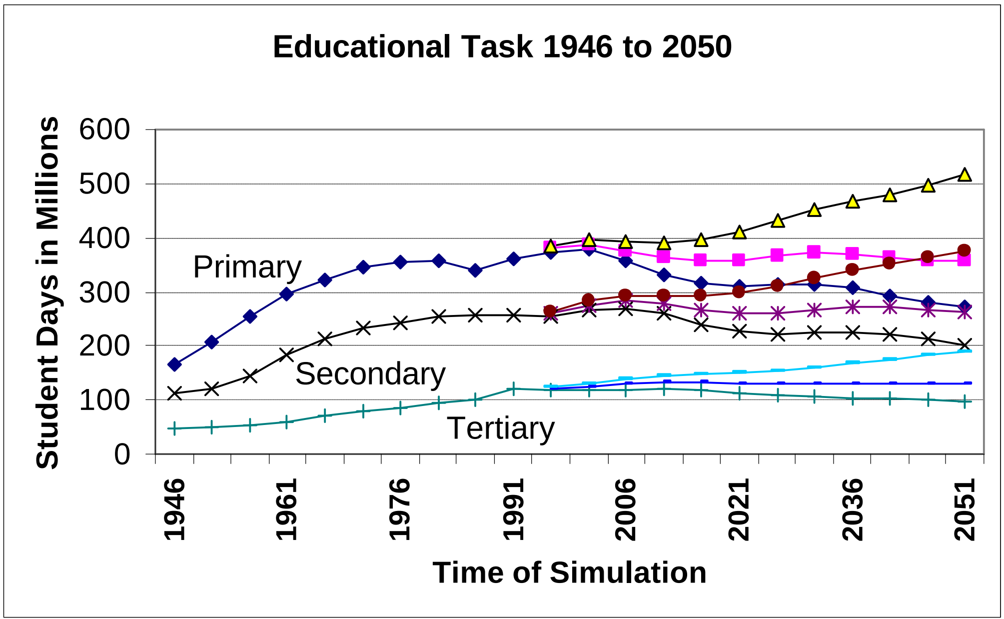


Figure 2.11. Educational task in million student days for primary, secondary and tertiary students. These are presented for three population scenarios: zero net immigration per year (lowest graph in each case), the base case of 70,000 net

immigration per year (middle graph in each case), and 0.67% of current population as net immigration per year (top graph in each case).

In 1998 there were 3.2 million students in primary and secondary levels and 0.67 million students in tertiary and higher education courses. A teaching staff of 209,000 for primary and secondary, and 76,000 at tertiary level serviced this student population (Australian Bureau of Statistics, 2000-c, 2000-d, 2000-e). In the scenarios, the educational participation rates have been increased to reflect the increasing retention rates and increased use of tertiary education. However the settings do not reflect a functional change in the nature of Australian education, such as large increases in overseas participation, although this is an increasing trend. On the basis of the zero and base case scenarios, the demand for teachers appears to be relatively constant or slowly declining in the absence of major change within the education sector. In the 0.67%pa scenario the educational task increases after 2020 which would require a scaling up of teacher training around 2015. An uneven age structure of teaching staff may necessitate increased teacher training in different 5-year periods despite a relatively even demand for teaching effort out to the year 2020.

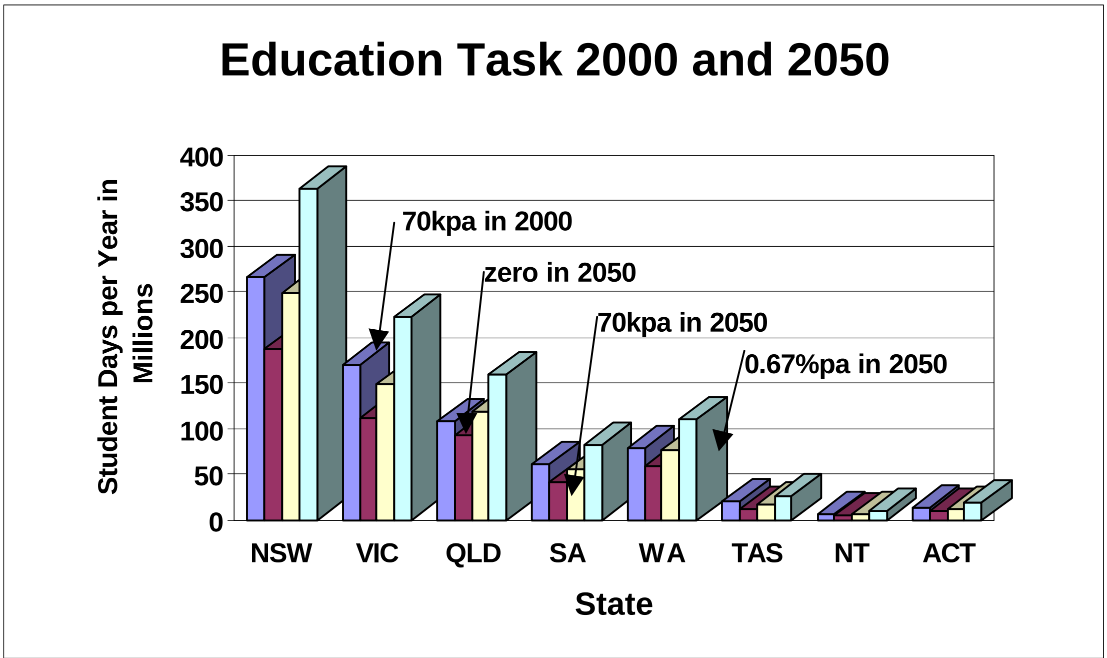


Figure 2.12. Total educational task in million student days for different Australian states and territories. These are presented for each state with a series of four bars. The bar on the left of the state group represents the base case scenario for the year 2000. Then to the right of that bar the zero, base case (70kpa) and 0.67%pa scenarios are presented for the year 2050.

The relative stability of the educational task in some scenarios obscures a number of regional dynamics that are driven by internal migration (Figure 2.12). Under the zero scenario the educational task declines in all states, while the task increases under the 0.67%pa scenario. For the base case scenario for both Queensland and Western Australia, the educational task in 2050 is similar to that in 2000 due to simulated population increases from assumptions on internal migration. It is possible that the patterns of internal migration will change markedly over the next 50 years and these educational analyses be rendered less useful. However, the analyses show that the dynamics of population policy decisions have linked effects that flow into areas such as education, its teachers and its infrastructure. Testing options such as these may allow long-term strategic planning to be undertaken with more focus and insight for the training and retraining of education professionals.

TRAVELLERS AND TOURISM

Domestic travellers

Although domestic tourists do not alter the total population of the nation, they do compound the pressures exerted by international tourists on particular locations at particular times. By 2050 domestic tourism could increase from its current level of around 300 million nights in 1998 (Australian Bureau of Statistics, 2000-f) to 700 million nights for the base case scenario or 850 million nights for the 0.67%pa scenario (Figure 2.13). The zero scenario increases to 550 million nights and then stabilises. The key driver of domestic tourism activity is the state of origin of the traveller (West Australians tend to travel within the state whereas Canberra's citizens mostly travel interstate) and their tendency to travel (characterised by age). This is relatively well known for travellers up to 50 years of age, but surprisingly under-researched for older Australians. Based on work by Benghezal et al. (2000), assumptions have been made, that the tendency to travel in the 50 to 64 age brackets is maintained until 75, declines rapidly until 85 and is zero at 90. Thus, the scenario results combine three sources of interaction (internal migration, population ageing and lowering birth rates) with changing of population size and location.

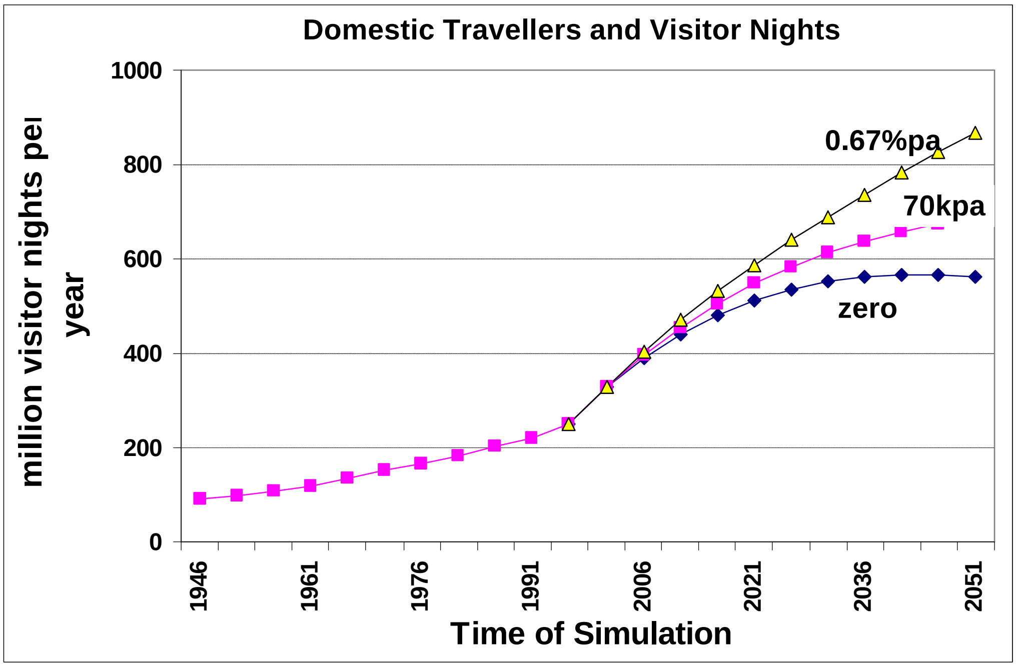


Figure 2.13. Simulated visitor nights for the domestic tourism task for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

Inbound international travellers

In addition to the domestic tourism loadings discussed above, international tourism will add to the number of people in Australia. This will have implications for the environment as well as in terms of demands for services and infrastructure. For the purposes of the current study, the future levels of inbound international tourism are considered to be the same under all of the three alternative population futures. The number of visitor nights for inbound international travellers is projected to increase from 100 million in 1998 (Australian Bureau of Statistics, 2000-g) to nearly 600 million nights by 2050 (Figure 2.14). This result is independent of the domestic population scenarios and is driven by assumptions of growth rate in international inbound numbers derived from the DIMA tourism workshop and other sources. A growth rate of 7% has been assumed for the first 10 years, stabilising at 3% per year for the rest of the simulation period beyond 2020. This is less than the optimistic forecasts offered in workshops that inbound tourism will grow at 8-10% per annum for the next 25 to 50 years. The composition of the inbound mix was derived from a study on tourism to 2020 by Foran et al. (2000) which found that the numbers of tourists from traditional sources such as

Japan, North America and Europe would stabilise and most growth could be expected from Asian countries. These possible changes in composition have important implications for physical activity within Australia. Increasing numbers of short stay visitors could increase energy and material usage per visitor day and produce knock-on effects to other physical sectors.

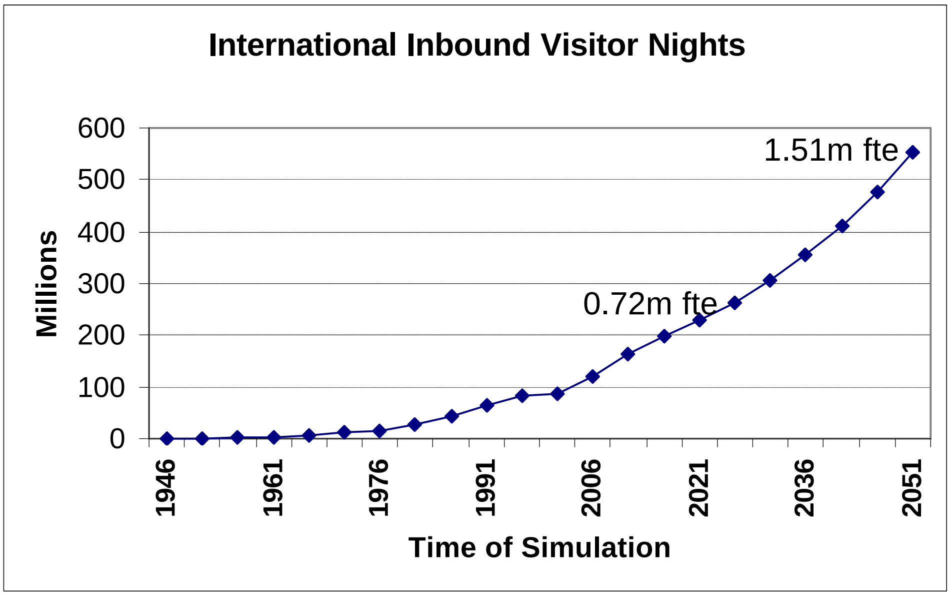


Figure 2.14. Simulated visitor nights for inbound international tourism to 2050.

Based on these assumptions, the total number of international inbound visitors in 2050 could be 34 million people with an average stay length of 16 days. This compares with 4.2 million people in 1998 (Australian Bureau of Statistics, 2000-h) with an average length of stay of 24 days. This reflects the trend towards more holidays per year, but a shorter length of stay for each holiday. In a dynamic industry such as tourism, these assumptions could easily change depending on events in the inbound country as well as the marketing and promotion efforts by Australian tourism companies and international travel firms. Both Boeing (2000) and Airbus (2000) project growth in air traffic in the Asia-Pacific region of between 4.7 and 6.1% per annum for the next 20 years, and an average growth in cargo traffic of 6.4% per year. Much of the requirement for new planes lies with the medium sized single aisle variety, although Airbus suggests that the Asia Pacific region will drive the development of aircraft larger than anything flying today.

The international inbound nights correspond to a full time equivalent population of 0.72 million in 2020 and 1.51 million in 2050 (Figure 2.14). This assumes visitors and residents have the same resource requirements and environmental loadings. Given the amount of travel and lifestyle services embodied in a typical international tourist day, this ratio could vary between 1:1 and 2:1. Using the higher value could place the equivalent environmental loading of international inbound visitors as high as 3 million people by 2050. On a 1:1 basis this represents between 5% and 7% of the population numbers in the scenarios at that time, while on a 2:1 basis it represents between 9% and 15%. Thus in comparing growth in international tourism with growth in domestic population, generally tourism (i.e. full time population equivalents) represents less than the growth in the base case scenario out to 2050. However tourism is generally highly concentrated in location and time rather than being spread equally across the landscape. In addition, tourism is an energy intensive industry and recent New Zealand analyses suggest that, on a full life cycle analysis, inbound and domestic tourism account for more than 20% of the primary energy use in that country (Patterson, pers. comm.).

Destinations

Spreading the tourism task on the basis of current patterns of visitation enables us to assess future challenges for tourism management and the development of infrastructure (Figure 2.15). By 2050, inbound international tourism could be much greater than domestic tourism in most capital cities; especially so in Sydney and Melbourne where the ratio of international to domestic visitor nights for the base case scenario varies between 5:1 and 6:1. In general, the situation for the other areas in each state is reversed, as most residents of capital cities take their holidays within their own state. The exception is for Queensland where the domestic and international visitor nights are approximately equal due to the Gold Coast and the Great Barrier Reef.

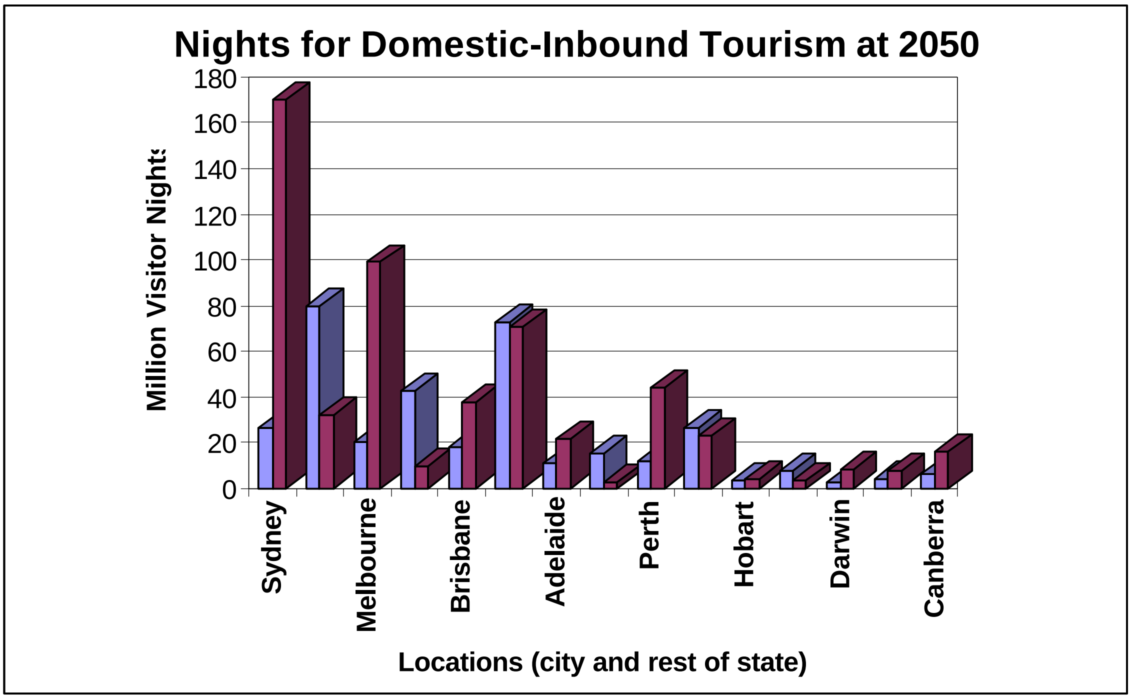


Figure 2.15. Simulated visitor nights for domestic and inbound international visitors in 2050. Domestic nights are the column on the left and international nights are on the right. The bars without a legend to the right of each capital city represent the rest of the regions within that state. Domestic nights are for the base case population scenario and inbound nights do not vary between scenarios.

The patterns presented by these analyses present some obvious opportunities and threats. The opportunities lie with the large tourism task presented to many of the capital cities and regions and the employment and development that might follow. The pattern of visitation described also presents another opportunity. When these data are disaggregated to reflect visitation to different tourism regions in each state, inbound tourism visitation is restricted to a limited number of areas. National policies which aim to spread the visitor load could reduce pressure on the main cities and bring tourism revenue to enhance regional development opportunities. The threats lie with the large concentrations of visitors in a limited number of areas and the extent to which development of key infrastructure is able to cope with them. The influence of large concentrations of visitors on the lifestyle of city inhabitants could also be an issue.

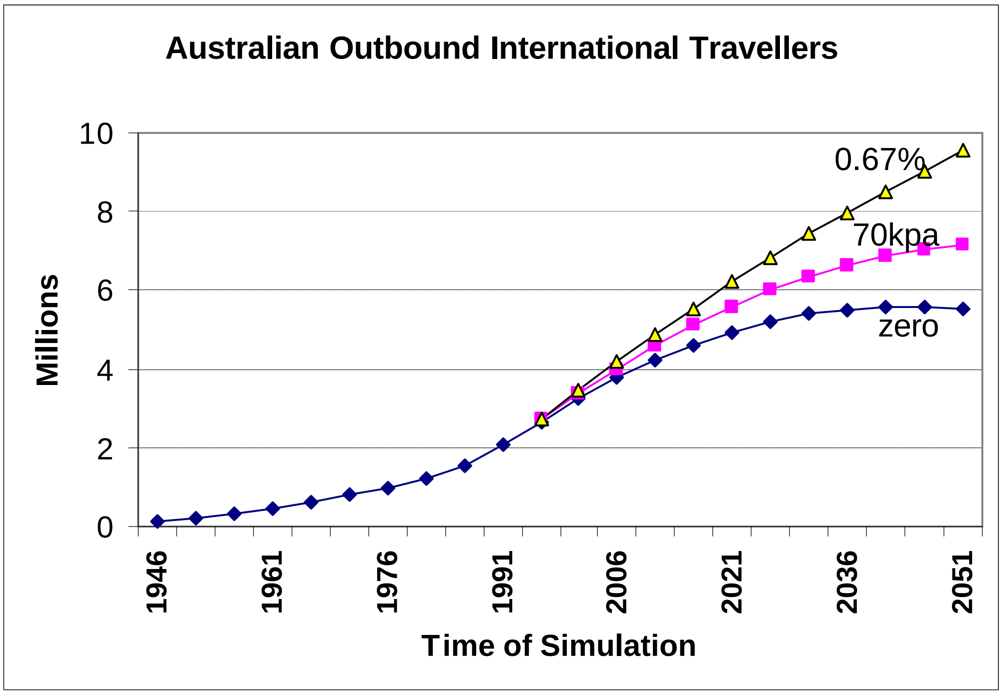


Figure 2.16. Simulated numbers of Australian outbound travellers for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

Australians travelling abroad

By 2050 the numbers of outbound international trips could be approximately six, seven or nine million per year for the zero, base case and 0.67%pa scenarios respectively (Figure 2.16). In 1998, about 3.2 million Australian residents travelled abroad (Australian Bureau of Statistics, 2000-i). The scenario results are driven by both changing population number and age structure, as well as an expected increase in outbound travel propensity over the duration of the scenario. The past decade has seen an average yearly growth in outbound travel by Australians and Hamal (1998) projects a growth rate of 4.5% per annum over the next decade. While there are many opportunities to alter the balance between domestic and outbound international tourism, the expectation of increasing affluence linked to disposable income suggests that these scenarios for outbound tourism are feasible.

Fuel uplifted for international tourism

Population influences the use of resources for tourism in two ways, both requiring the same resources and producing greenhouse emissions. In a direct influence, domestic population levels drive domestic tourism activity and Australians departing for abroad. At a more remote level, international inbound travel acts in the same way as export trade by attracting inflows of international currency that eventually become included in the nation's overall trade balance.

Aviation activity in Australia totals 26.7 billion passenger kilometres and nearly 200,000 tonnes of freight. International activity includes 7.2 million passenger departures and 340,000 tonnes of freight (Australian Bureau of Statistics, 2000-j). In the process, the industry uses 185 petajoules (10^{15}J) per year (Bush et al., 1999). When both international visitors and Australians travelling overseas depart from Australia, the aviation fuel must be sourced from the country's physical economy or be imported. By the year 2050, the energy required for international departures could exceed 400 PJ per year (Figure 2.17). There is little difference between the population scenarios as the majority of the influence is due to international travellers departing (34 million) rather than Australians leaving (5-9 million).

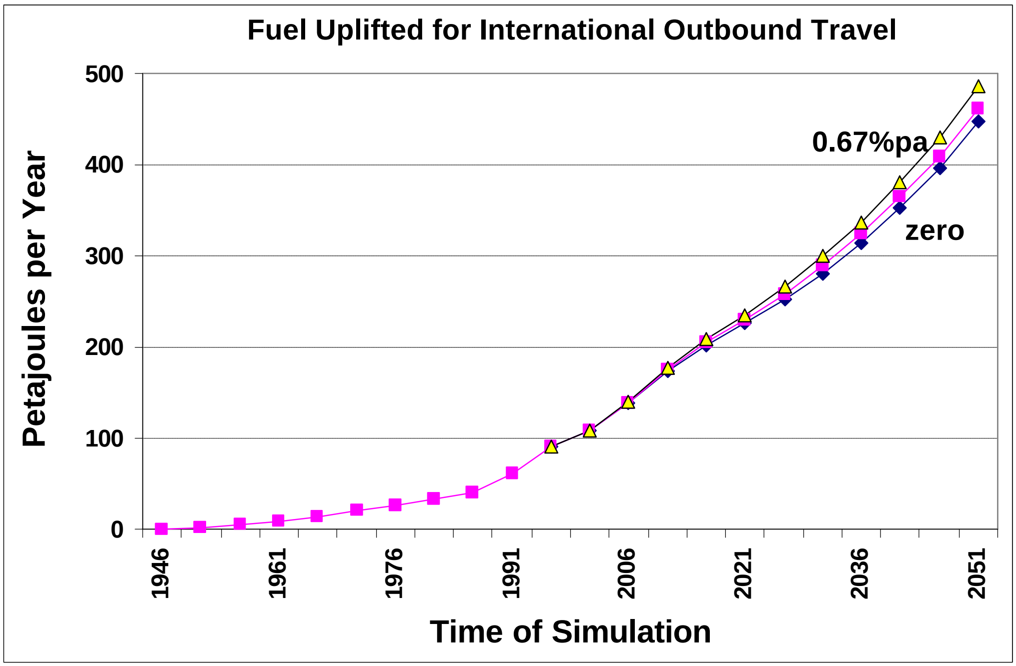


Figure 2.17. Simulated amount of fuel required for international outbound travel for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

When both international outbound and domestic air travel are combined, about 600 PJ of aviation fuel could be required by 2050, almost all of it directed towards passenger services. The total transport task in Australia currently requires approximately 1,200 PJ per year. In future, air transport could use more than 50% of the current transport energy. Given future market developments, there are unlikely to be constraints on energy for aviation, although the monetary cost of air travel may rise appreciably. The greenhouse gas implications could also be significant, in international terms. Jet fuel for international aviation is included in national energy usage, and combustion products are allocated to Australia's greenhouse gas account since the national economy benefits from visitors and their expenditure.

Few technological surprises are expected in international aviation and the scenarios have relatively optimistic settings for a decline in energy use per passenger kilometre into the future. Increases in physical efficiency could come from a mixture of better technology (slicker planes and better engines) and better management (better load management). Within Australia, shifts between modes of transport are possible. Lenzen (1999) reports the energy cost of air travel as 5.7 and 3.1 megajoules (10^6J)per person kilometre, for domestic and international air travel respectively. Values for train and bus transport vary from one to three MJ per passenger kilometre — about half that of air. There is scope for savings, but it is unlikely that other transport modes will match the timeliness and speed of air travel in many situations. Some of these issues will be examined in more depth in Chapter 5.

The total food basket

Australia has the capacity to maintain a positive food balance in all main food commodity items, apart from fish, out to 2050 and beyond for the three scenarios (Table 2.5). The primary requirement for grain in 2050 for human diet varies from two to 3.6 million tonnes per year, which is well within the 31 million tonnes of grain that was produced in 1998 (Australian Bureau of Statistics, 2000-k, 2000-l, 2000-m). The total requirement for all meats (beef, veal, lamb, chicken, pork) in 2050 varies from 2.3 to 3.8 million tonnes. In 1998 Australia produced 3.5 million tonnes of meat but over the past 30 years, sheep and cattle numbers have been up to eight percent higher than current numbers. There is capacity to increase animal numbers, depending upon allocation of land to other uses. A number of scenarios are analysed in Chapter 4. The total requirement for fish in 2050 varies from 0.35 to 0.58 million tonnes per annum compared to 0.22 million tonnes produced in 1998. This demand will present some challenges to Australia's fisheries resource which are examined in Chapter 4.

Table 2.5. Human consumption requirements in 2050 for three categories of foodstuffs for the three population scenarios compared to actual production in 1997-98 (millions of tonnes per year).

	Zero scenario in 2050	Base case scenario in 2050	0.67%pa scenario in 2050	Actual production in 1997-98 (ABS)
Total grain	2.136	2.713	3.568	31.578
Total meat	2.278	2.893	3.804	3.514
Total fish	0.346	0.439	0.577	0.223

Over the last 50 years, Australians have made significant changes to their diets, the consumption of red meat and dairy products has declined and grains, fruits and vegetables have increased. In the future scenarios out to 2050 the dietary composition is assumed to remain much the same. Major changes could take place (e.g. a widespread shift to vegetarian diet), the only constraint being large increases in fish consumption. There are however a number of important considerations that lie, hidden from view, within the food chain.

The large substitution of white meats such as chicken and pork for red meats such as beef and lamb include significant volumes of grain, embodied in the production system. To produce one kilogram of chicken requires two to three kilograms of grain, pork, four to five kilograms and feedlot cattle, eight to 10 kilograms. Fish grown under aquaculture require two to four kilograms of grain, depending on the species and management system, with the added proviso that the diet generally contains 20-30% fish meal, i.e. feeding fish to fish. Much of this fish meal is derived from productive fisheries elsewhere such as the Peruvian anchovetta fishery. Aquaculture in general requires that biological capital be transferred from a wild ecosystem to a managed one, although there are substantial opportunities for technological improvement. This is more fully discussed in Chapter 4.

When the embodied grain requirements of meat production are used with the population scenarios, an extra six, 7.6 and 10 million tonnes of grain are required for the zero, base case and 0.67%pa scenarios respectively. Using a conservative value of the current levels of total grain production as a basis, this means that under the three population scenarios, about 25 to 45% of Australia's current grain production could be required to supply internal food requirements. Meat for export would consume extra grain above this estimate if lot fed. While Australia is expected to maintain a positive grain balance well into the future on the basis of direct human requirements, the grain consumption embodied in meat products such as chicken, pork, feedlot beef and aquaculture could reduce the balance, and thus reduce the volume available for export. Analyses that relate agricultural production issues to Australia's land and water futures are explored in Chapters 4 and 6.

Paper and Plastics

A wide variety of materials underpin our contemporary lifestyle and consumption. Paper and plastic have been chosen as examples and there is a steady increase in the amount required by the three population scenarios out to 2050 (Figure 2.18). By 2050, there could be a requirement for four, five or seven million tonnes of paper under the zero, base case and 0.67%pa population scenarios respectively. Currently, Australia consumes 3.3 million tonnes of paper in all its various forms, of which 1.4 million tonnes or about 40% is recycled (Visy Recycling, 1999). The per capita consumption levels used in the scenarios gradually rise from the current level of 170 kg (2000) to 200 kg per person per year by 2030.

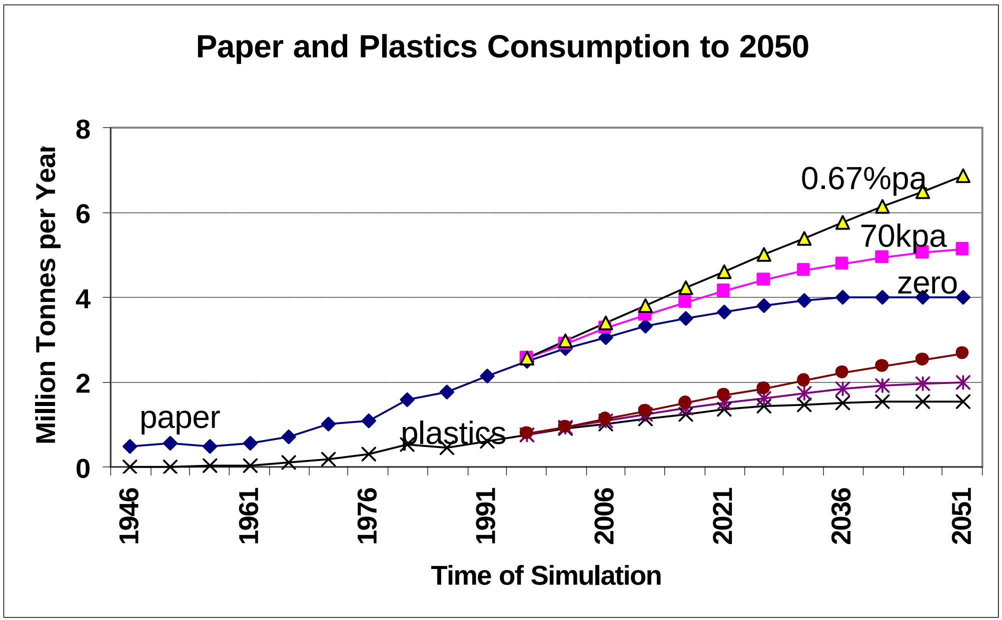


Figure 2.18. Simulated consumption of paper and plastics for three population scenarios: the base case of 70,000 net immigration per year (70kpa), zero net immigration per year (zero) and 0.67% of current population as net immigration per year (0.67%pa).

Clearly the scenario includes a strong primary driver due to population growth as well as growth in areas that relate to affluence and lifestyle. An assumption could be made that paper use is stabilised and then rapidly or gradually reduced as innovations such as the paperless office gain momentum. The new information media and paper products seem to have developed an amiable coexistence that has increased the demand for information products rather than one form replacing another (von Ungern-Sternbarg, 1999). The scenario simulations presented could potentially stabilise and decline over times scales of five to 10 years, but this remains possible rather than probable. Alternatively the use of recycling could reduce the requirement for virgin fibre. Recycling could be increased over time up to a maximum of 70% according to industry experts in the DIMA workshops. But there are two limitations: (i) the paper supply is too widely spread to allow collection above a certain level; (ii) unlike aluminium which can be continually recycled without degrading the basic material, paper fibres can only be recycled a maximum of three to four times. Each recycling step results in a 10% loss of fibres and each step requires a drop in the subsequent quality of the end product e.g. photocopy paper to newsprint to cardboard.

The consumption of plastics could continue to increase under the primary drivers of the population scenarios from about one million tonnes annually to two million tonnes by 2050 for the base case scenario. At 2050, the zero scenario is 0.4 million tonnes below, and the 0.67%pa scenario is 0.8 million tonnes above the base case. The per capita consumption level in the scenario increases from 50 to 80 kg per capita per year during the simulation period. These assumptions are open to large changes over the next 50 years particularly as regards substitution of materials. About 90,000 tonnes of plastics were recycled in 1997 and many opportunities exist to increase the proportion of recycling undertaken (SIRA, 1999). Whole economy analysis in Germany suggests that the use of plastics may quadruple in the next 25 years and that they have a mean residency time (as materials in the physical economy) of 14 years with a range of a few months to 30 years (Patel et al., 1998).

TESTING SUB-SCENARIOS

Each chapter in the report explores a number of 'sub-scenarios'. These are technological, policy or management changes, that break-out scenarios from the base case scenario to explore a set of management issues in detail. In particular, these sub-scenarios will explore interactions within the model that bring together a number of linkages. A number of population-driven effects can be comprehended without model analysis. If, in the section above, the question was asked "what would be the effect of halving paper or plastics consumption on a per capita basis", then it is relatively easy to interpolate the answer on the graph in Figure 2.18. For example, a halving of the per capita consumption of paper would allow the 0.67%pa scenario to operate with the same resource intensity for paper as the zero scenario. Other linked effects could include a loss of employment (less paper production and recycling activity), less energy use, more wood available for export and so on. However other population issues are more complicated. The following sub-scenario explores the interplay between the domestic 'total fertility rate' and the immigration rate.

What birth rate is necessary to equal the effect of immigration?

The *What-If* question relates to the increases in total fertility rate required to elevate one scenario from its population result at 2050, to the population result of the next scenario. Thus, changes to control parameters are limited to the total fertility rate in the zero scenario required to increase the population from 20 million to the 25 million target achieved by the base case in 2050. Likewise, the total fertility rate of the base case scenario is increased while retaining the net immigration rate at 70,000 per annum so that the population of 25 million is increased to the 0.67%pa scenario of 32 million by 2050 (Table 2.6; Figure 2.19).

An overall rise in the total fertility rate from 1.65 to 2.07 is required for the transition from the zero scenario to the base case scenario, to compensate for the differences in net immigration rate. For the transition from the base case to the 0.67%pa scenario, a rise from 1.65 to a steadily increasing rate which reaches 2.51 by 2050 is required. Apart from New Zealand and the USA, very few developed countries have total fertility rates in excess of 2.0 (Australian Bureau of Statistics, 1999: Hugo, 1999) and the potential that these rates might rise, seem unlikely. However McIntosh (1998) reports a number of relatively high rates in Scandinavian counties following the implementation of tax reforms and the introduction of parental insurance programs. Total fertility rates fell again in the 1990s as economic recession and cuts to social welfare made family maintenance more difficult.

The changes in total fertility which achieve population targets with lower immigration rates, also have an effect on the age structure of the population and in particular the proportion of people aged 65 years and over (Figure 2.19). Achieving a population target of 25 million by 2050 with zero net immigration also reduces the proportion of the population 65 years and over, so that it lies midway between the 26% at 2050 achieved by the base case and the 20% achieved by the 0.67%pa scenario.

For the transition from the base case to the 0.67%pa scenario, the adjustments to the aged profile are more marginal with the proportion of greater than 65 year olds stabilising about 1% below the original scenario.

Table 2.6. The changes in total fertility rate required to elevate the total population number by 2050 (a) from the zero scenario to the base case scenario and (b) from the base case scenario to the 0.67%pa scenario.

Year of Simulation	Base case scenario: total fertility rate	(a) Raising the zero scenario to the base case scenario	(b) Raising the base case scenario to the 0.67%pa scenario
1996	1.88	1.88	1.88
2001	1.74	2.06	2.07
2006	1.67	2.07	2.12
2011	1.65	2.07	2.16
2016	1.65	2.07	2.21
2021	1.65	2.07	2.26
2026	1.65	2.07	2.30
2031	1.65	2.07	2.34
2036	1.65	2.07	2.38
2041	1.65	2.07	2.42
2046	1.65	2.07	2.46
2051	1.65	2.06	2.51

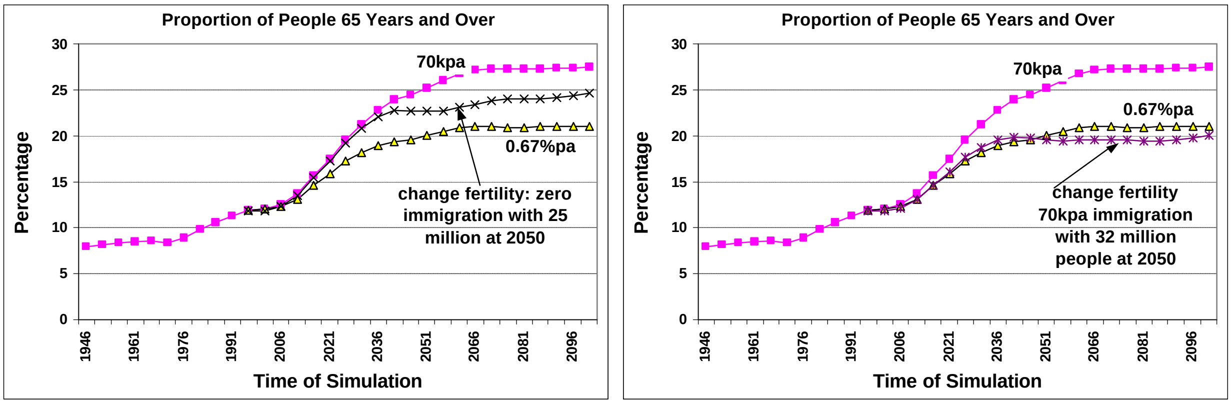


Figure 2.19. Simulated effect on proportion of people over 65 years old out to 2100, through reaching population targets at 2050 using lower immigration rates with higher domestic fertility rates. The left hand graph shows zero net immigration with changed fertility, and the right hand graph shows the base case with changed fertility.

DISCUSSING POPULATION EFFECTS

Throughout the report, an attempt will be made to highlight issues and effects that are linked directly to domestic population size, and also where those population effects are more diffuse. This chapter has set the population boundaries for the following chapters which are linked to physical transactions and the workings of the physical economy. The terminology of **primary**, **secondary**, **tertiary** and **quaternary** has been developed to describe effects of population size (Figure 2.20). The terminology is proposed whereby human population size drives the requirement for goods and services. These requirements may be direct or indirect. While the direct drivers are the key focus of this study, in reality it is impossible to ignore the 'knock-on' effects that cascade through the physical economy. This understanding is crucial to policy formulation in important areas that relate to the concepts of sustainable development, particularly in the area of fossil energy use and greenhouse gas emissions.

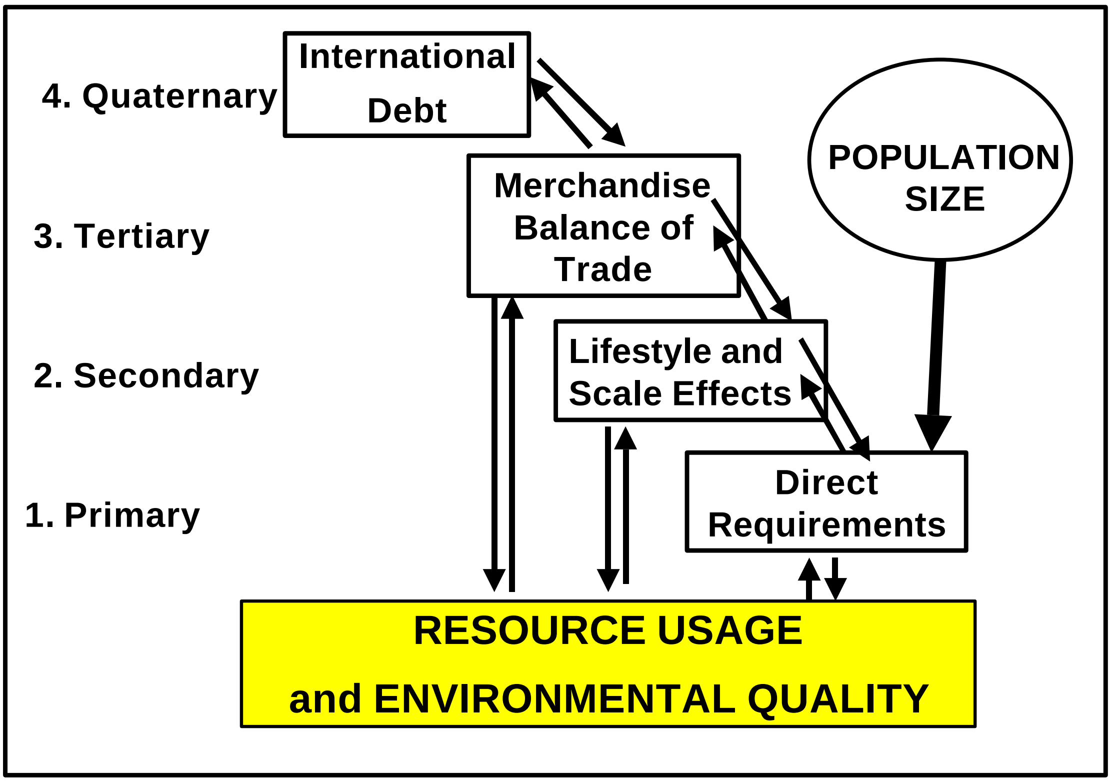


Figure 2.20. A representation of the four levels of population influence from the primary or first order influence to the more diffuse quaternary or fourth order effect.

The four levels of population influence have been defined as follows:

- **Primary** (or first order) drivers are linked directly to individuals who require food, households that require houses, cars, newspapers, televisions and refrigerators, and communities that require schools, hospitals, public transport and sporting ovals. The distinction between a 'need' and a 'want' is relevant, but is not addressed in this analysis.

- The **secondary** (or second order) drivers of population growth are linked to affluence, lifestyle and scale issues. Affluence and lifestyle issues describe the expansion of a direct requirement or need into a higher level of consumption or quality that could require more energy and materials to deliver that good or service. Thus, airline travel which allows a yearly requirement (a need) of one month's holiday at a distant location, might be expanded by higher levels of affluence into four such flights for holidays of one weeks duration. Scale issues relate threshold effects such as the presence of international airports, convention centres and five star hotels which expand opportunities for industries such as tourism and thereby transactions in the physical economy. For example the Sydney Olympics could not have been staged until that city had reached a certain level of size, sophistication, competence and complexity.

- The **tertiary** (or third order) drivers of population growth occur when the domestic requirements for imported goods and services have to be covered by revenue from the goods and services from the nation's export industries. The rising level of imports linked to consumption growth on a per capita of per household basis, have to be paid for by exporting commodities such as coal, aluminium and wheat and importing international tourists.

- The **quaternary** (or forth order) drivers occur when the lagged effects of previous population growth and economic development have contributed to issues such as international debt and weakness of currencies. These may drive the requirement for physical activity particularly in export industries well into the future until these pressures are reduced. In the function of economic, social and political systems there are many mechanisms which constrain these quaternary drivers within reasonable limits, and allow them to adjust to short-term crises. While the driver is only loosely linked to population size, its functional effect proposes that a heavily indebted nation may be more obliged to increase its physical transactions than a less indebted nation.

Most issues discussed in Chapter 2 are related to the primary influence of population number. Thus the size of the total population will directly affect the size of the major capital cities, the domestic consumption of food, paper and plastic and the requirements for urban water supply.

THE NEXT CHAPTER

The next chapter will use the population scenarios described in this chapter to analyse the range of urban issues that are derived from them. The issues addressed will include the following:

- Housing requirements for the different scenarios of population size to 2050
- Other buildings for education, health care, and institutions
- Tourism accommodation
- Personal transport and intercity transport
- Technological options for cars, houses, and industry
- Urban water
- Air emissions and waste
- Structural and environmental problems with current Australian cities

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