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Migration as a Demographic Process and its Effects on Population Growth and Age Composition

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Migration is one of the three demographic processes that contribute to changes in the size of a population, the other two being fertility and mortality. Fertility is the process by which births are added to a population and mortality is the process by which the population is reduced by deaths. Unlike fertility and mortality, migration has the additional complexity that it affects two populations at the same time: the place of origin and the place of destination.

The relative contributions of the three demographic processes to population change vary across populations and with time, in relation to other changes and processes occurring in the population. Demographic transition theory describes the changes in fertility and mortality that occur during the course of a population’s social and economic development (Coale 1972). But it is silent on the process of migration, partly because of a lack of historical data for demographic analysis.

A population may experience simultaneously both people migrating out and people migrating in. The balance between the two is referred to as net migration. When net migration is positive – the number of people moving into the population is greater than the number of people leaving the population – migration leads to an increase in the population and contributes to population growth, in the same way as natural increase – the excess of births over deaths. When net migration is negative – the number of people arriving is less than the number of people departing – migration leads to a decrease in the size of the population. If net migration is zero – the number of people migrating into the population being equal to the number of people migrating out – migration has no immediate impact on population size. However, if the characteristics of in-migrants and out-migrants differ in ways that relate to differential rates of fertility and mortality, in the longer-term, even zero net migration can affect both population size and growth. For example, if zero net migration led to an increase in numbers aged in their 20s and 30s but an equal fall in the numbers aged in their 40s and 50s, the population would experience more births in the future that it would otherwise have experienced.

Population size and growth may also be drivers of migration. For millennia, out-migration has been a safety valve for populations that have reached a point where the population size outstrips the capacity of local resources to support that population. And in-migration may occur to a region that has abundant resources relative to its population size. Governments may play a role in promoting either out or in migration as a means of producing a better balance of population and resources. The very large scale out-migration from Ireland to the United States in the 1840s and 1850s is a classic example of population size relative to resources being a driver of out- and in-migration.

The impact of migration upon the age composition of a population has been studied extensively in mathematical as well as applied demography. A review of the mathematics of the issue in the context of low fertility has been provided by Espenshade (1986). Most of this research focuses upon the stable population model. A stable population is conventionally defined as a closed (zero migration) population that maintains constant rates of fertility and mortality over a long period of time. Such a population takes on a constant age structure and has a constant rate of growth. A special case of a stable population is the stationary population which has a rate of growth of zero. The fertility rate in a stationary population is fixed at the level that replaces the generation exactly (net reproduction rate equals 1.0 or a total fertility rate just above 2.0). The age structure of the stationary population is determined solely by the level and age pattern of its mortality and, with low mortality, it has roughly the same numbers at each age until the mortality at older ages reduces the numbers more rapidly. For example, the grey shaded age distributions in Figures 1 and 2 show what the shape of the Australian stationary age distribution would be in about 100 years time if mortality remained constant at its 2010 level and fertility increased immediately to 2.08 births per woman and remained constant thereafter.

The age structure of a stable population takes on the classic pyramid shape when fertility is greater than two children per woman. The blue-lined pyramid in Figure 1 shows what the shape of the Australian stable age distribution would be in 100 years time if mortality remained constant at its 2010 level and fertility rose immediately to 3.0 births per woman and remained constant thereafter. Conversely, the stable population takes on an inverted pyramid shape when fertility is lower than two children per woman. The blue-lined pyramid in Figure 2 shows what the shape of the Australian stable age distribution would be in 100 years time if mortality remained constant at its 2010 level and fertility fell immediately to 1.3 births per woman and remained constant thereafter. Note, the shaded pyramids in Figures 1 and 2 are the same population (with a total size of 10 million), only the scale of the graphics differs. Keeping this in mind, there is evidently an enormous difference in the sizes of the two stable populations: 26 million for the standard pyramid in Figure 1 and 3.5 million for the inverted pyramid in Figure 2. As both stable populations have the same mortality rates, this shows the considerable force of fertility upon population growth or decline. The shapes of the two pyramids compared to the stationary (shaded) population's age distribution also indicate the considerable force of differences in fertility on age structure.

Mathematical demography then considers how these models change in the presence of migration. Two possibilities are considered: constant rates of migration and constant levels of migration (constant numbers). The effects of constant age-specific **rates** of migration can be modelled as variations to age-specific death rates (increases in death rates where net migration is negative; reductions in death rates – even 'positive death rates' – where net migration is positive). It is more common to consider the effects on age structure of constant **levels** of migration. The effects will vary according to the level of migration, whether migration is positive or negative and also on the age structure of the migrants. Clearly, if migrants tend to be young, in-migration would make the population younger and out-migration would make the population older. This is the situation that we observe often when young people leave rural locations to live in the cities. The rural areas age rapidly while the cities remain relatively young in age structure.

The effects on the age structure and the total size of the population of different levels of migration and fertility can be assessed by applying different levels of fertility and migration over a long period to a common starting population. The starting population for the illustration is the stationary population with 2010 Australian mortality and an initial population size of 10 million as already depicted in Figures 1 and 2. As a stationary population, after 100 years, this population would have the same population age structure and population size as it had at the beginning of the period. This population is shown in the first row of Table 1: 18.5% are aged 0-14, 60.1% are aged 15-64 and 21.4% are aged 65 and over. The other rows of Table 1 show how this initial age distribution and the size of the population would be changed after 100 years with different levels of fertility and migration. Mortality remains constant at the 2010 Australian level in all projections. The assumed age distribution of migrants (in net terms) is shown in Figure 3. In this case, migration is positive and concentrated in the ages 25-34 years with an additional concentration among younger children. Migration, therefore is characterised by young families moving in.

As already indicated in Figures 1 and 2, the different levels of fertility have a very large impact on the age distributions as indicated by comparison of the projections in which migration is set to zero. For example, the high fertility projection has 14.1 per cent of its population aged 65+ compared with 21.4 per cent for the baseline projection and 34.9 per cent for the low fertility projection. Not unexpectedly, the ultimate population sizes are also affected greatly by the different levels of fertility. Mathematical demography has long expounded the position that, of the three demographic processes and excluding bizarre migration and mortality scenarios, fertility has by far the largest effect upon age structure (Coale 1972, Smith and Keyfitz 1977, Coale 1987).

The impacts of four different levels of net international migration are considered at each level of fertility: zero, 50,000, 100,000 and 200,000. Initially, these represent 0%, 0.5%, 1% and 2% of the total population. This covers the likely range of growth rates from migration that any population is likely to experience aside from extreme occurrences. For example, in the years 2005-10, only four gulf states (Kuwait, Qatar, Bahrain and the UAR) and Singapore experienced a net migration rate above two per cent per annum (United Nations 2011).

Considering first, the four projections with fertility at the replacement level (the first four rows of Table 1), a constant 200,000 NIM would lead to a total population of 38.5 million people after 100 years. Note, in the theoretical case where there was no mixing of the migrants with the original population, we can consider this as the sum of two populations: the original stationary population which remains at 10 million and the population of migrants across the 100-year period which increases to 28.5 million. As there would be 20 million migrants (net) over this period, this indicates the natural increase of the migrants would be a substantial 8.5 million, almost as large as the original stationary population. Of course, if the migrants had a higher fertility rate than the original population, the level of natural increase of migrants would be even greater. In the United States and the United Kingdom, migrants have higher fertility than the domestic population; in Canada and Australia, the reverse situation holds (McDonald and Moyle 2011). If fertility were to increase to 3.0, the total population would increase from 10 million to 26 million over 100 years when there is no migration but to 72 million with 200,000 annual net migration. A combination of high fertility and high migration obviously has a massive impact on growth.

Mathematical demography has also proven that a stationary population (constant population size, zero growth rate and constant age structure) results from below replacement fertility in combination with a constant positive level of migration (Espenshade 1986). An empirical example of this mathematical demography is provided in Table 1; the projection in Table 1 that has fertility set at 1.3 and net migration at 100,000 leads to a stationary population after about 100 years. It is notable, however, that this stationary population, produced by a combination of low fertility and positive net migration, leads to a population after 100 years of 13 million. This is three million more than the baseline projection that has fertility set at 2.08 and zero net migration. The message from this is that a population with below replacement fertility that wished to move to a stationary situation with the lowest possible total population would do so by increasing its fertility as soon as possible to the replacement level and having zero net migration. The stationary population based on replacement fertility and zero migration would also have a younger age structure than the one with low fertility and 100,000 net migration.

Table 1 also illustrates the impacts of different levels on net migration on age structure. The most important observation from the table is that the effect of migration on age structure is contingent upon the level of fertility. Where fertility is high (3.0), the different levels of migration have only a small impact on age structure and all of the impact relates to the first 50,000 net migrants. In contrast, when fertility is low (1.3), the different levels of migration have a large effect on age structure. For example, with zero net migration, 35 per cent of the population would be aged 65 and over while with net migration of 200,000 per annum only 25 per cent of the population would be aged 65 and over. When fertility is at the replacement level, the different levels of migration have a moderate impact on age structure. At all levels of fertility, there are ‘decreasing returns to scale’, that is, increasingly higher levels of migration produce increasingly smaller effects upon age structure. The biggest impact in all cases comes with the first 50,000 migrants.

Beyond mathematical demography, there have been many applied or empirical studies of the effects of immigration upon age structure. Such studies have been particularly prominent in studies of the impact of immigration on the age structure of Australia (Beaujot 1989; Young 1990; McDonald and Kippen 1999a, 1999b, 1999c, 2001a, 2001b; United Nations 2000; Kippen and McDonald 2000, 2004; McDonald and Temple 2009, 2010). These studies applied to real populations confirm the findings described above for mathematical studies.

While both mathematical and applied studies show that the effects of immigration upon age structure are relatively small when fertility is around replacement level, in policy terms, to be discussed below, the issue is how large does a shift in age composition need to be before it is considered to be useful or meaningful. The other policy question is whether it is the additional numbers of migrants that are important to policy rather than their impact on age structure.

Migration as a demographic process and its effects on population distribution

If migrants flow much more heavily into some parts of a country compared to other parts, migration can have a substantial impact on population distribution within the country. In some situations, immigrants flow into the cities changing the distribution of population towards the cities; in other cases, immigrants take up rural work and this expands the populations of the rural areas to which they move. In 1851, 18 per cent of the Australian population lived in Victoria. By 1861, largely as a result of international migration associated with the Victorian gold rush, 47 per cent lived in Victoria. This is a spectacular example but many other examples could be provided of the impact of international migration on population distribution.

Migration as a demographic process and its effects on population composition

Migration also affects aspects of composition other than age and population distribution such as the sex composition, the labour force status of the population, education, the ethnic mix, religion and a wide range of other population characteristics. Depending on the demographic, social and economic characteristics of the in-migrants compared to those of the out-migrants, even zero net migration can affect characteristics of the population. If in-migrants are younger on average than out-migrants, or vice versa, then the population's age structure is affected. Or if there are more skilled people among out-migrants than among in-migrants, then the skills profile of the population and the labour force is affected even when the size of the population and labour force remains unchanged. A study in Australia of 'complex problem solvers' observed, for example, that while there was a flow of top-level scientists into Australia, the out-flow was even greater (McDonald and Temple 2006).

Migration also affects the size, growth and composition of two populations – those of the sending and receiving countries or localities. The former Prime Minister of New Zealand, Robert Muldoon once said famously but probably inaccurately that increased levels of emigration from New Zealand to Australia "raised the average IQ of both countries”. Certainly Trans-Tasman migration adds considerably to the Australian labour force while putting pressures upon some areas of labour supply in New Zealand. New Zealand then runs a very large immigration program partly to compensate for the losses of labour to Australia.

Many international migration movements consist of an excess of males or an excess of females. For examples, movements of asylum seekers or undocumented migrants are often skewed towards young males because they are able to endure the rigours of this type of migration. Another example was the movement of convicts to Australia in the first half of the 19^{th} century in a ratio of about six males to every female. In relation to migration policy, the sex composition of the Australian population was an issue from about 1835 to 1860 and shiploads of single women were brought into Australia in this period to compensate for the predominance of men in the population (McDonald 1974). If there is a deficit of persons of either sex in the marriage market, the migration might address the deficit. Around 40,000 spouses of Australians are granted permanent residence in Australia each year. This compares with around 120,000 marriages within Australia. Thus, Australians source about one in six of their marriage partners from overseas. Two out of every three persons granted permanent residence as a spouse are female (DIAC 2010) and they come from the main countries from which Australia's immigrants come (United Kingdom, China and India).

The impact of migration on the ethnic composition of a population is more readily observed in immigrant receiving countries such as Australia, Canada and the USA where increased immigration from non-European countries since the 1970s has resulted in an increase in the percentage of the population that is of Asian origins, and in the case of the USA a significant increase also in the percentage of the population that is of Latin American origin (Bean and Stevens 2003; Khoo 2003). In Australia in 1971, 154,000 people had been born in Asia; in 2011, the number was almost two million, a thirteen-fold increase in 40 years.

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Figure 1: Stable Population (TFR = 3.0, blue lines) compared with Stationary Population (shaded), Australian mortality 2010

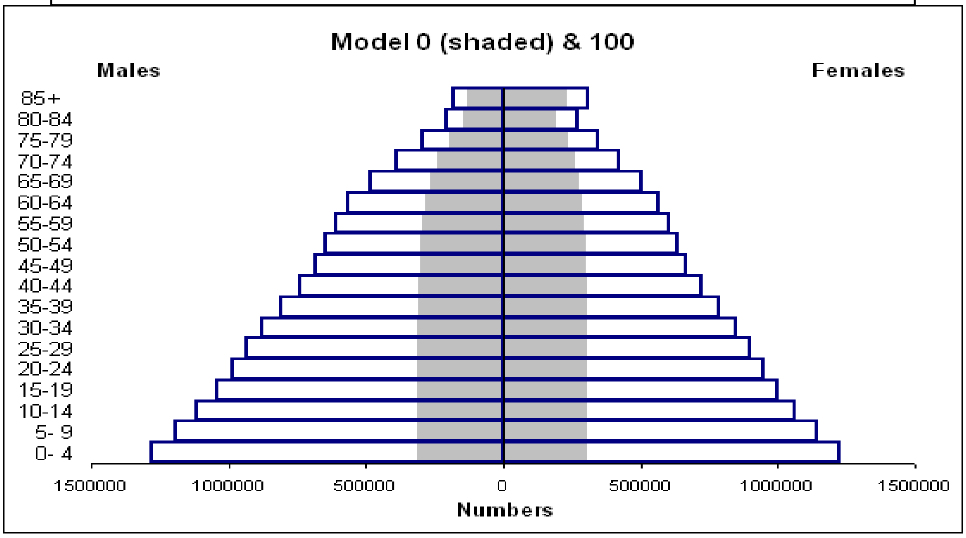

Figure 2: Stable Population (TFR = 1.3, blue lines) compared with Stationary Population (shaded), Australian mortality 2010

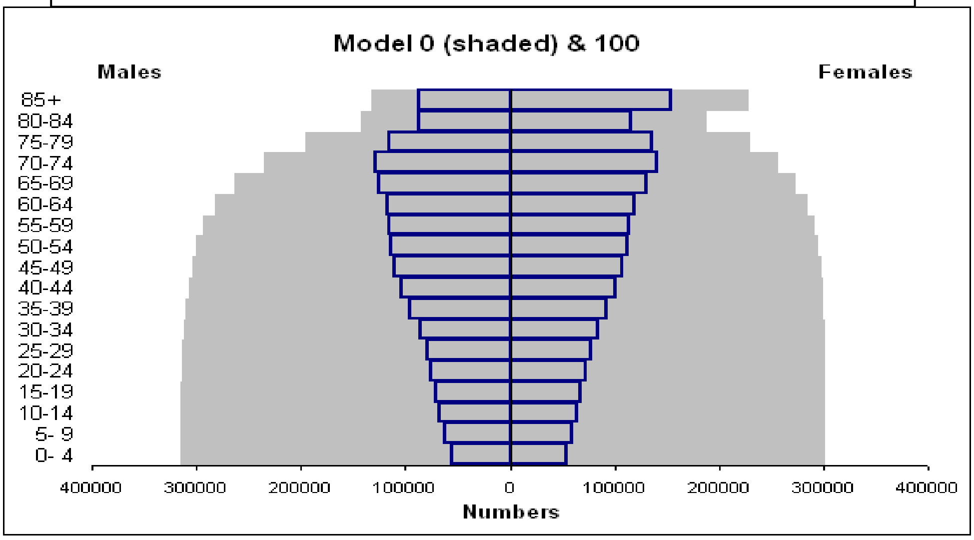

Figure 3. Assumed age distribution of migrants

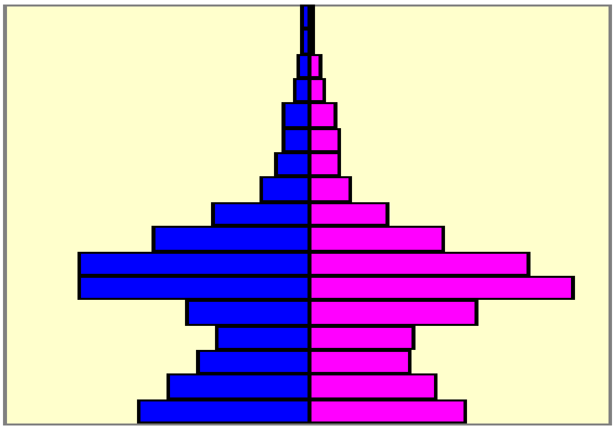

Table 1. Impacts on age distribution and total population after 100 years of differing levels of fertility and annual net international migration (NIM)*

Total Fertility Rate	Annual NIM	Percentage in age group after 100 years			Population after 100 years (millions)
		0-14	15-64	65+	
2.08 (baseline)	0	18.5	60.1	21.4	10.0
2.08	50000	19.0	61.2	19.8	17.2
2.08	100000	19.1	61.7	19.2	24.3
2.08	200000	19.3	62.1	18.6	38.5
3.0	0	26.7	59.2	14.1	26.0
3.0	50000	26.9	60.1	12.9	37.5
3.0	100000	26.9	60.2	12.9	49.1
3.0	200000	26.9	60.3	12.8	72.2
1.3	0	10.3	54.7	34.9	3.5
1.3	50000	11.8	60.0	28.3	8.2
1.3	100000	12.2	61.4	26.5	13.0
1.3	200000	12.4	62.4	25.1	22.5

* In all examples, the starting point is the baseline stationary population with zero net migration, fertility of 2.08 births per woman and Australian mortality in 2010. The age distribution of net migrants is as shown in Figure 3. Migrants are assumed to adopt the same fertility and mortality levels as the original population.