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Modelling immigrants' fiscal impacts — Part 2

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Technical Supplement D

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The Productivity Commission

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Modelling immigrants' fiscal impacts – Part 2

Technical Supplement D (Part 1) to the *Migrant Intake into Australia* inquiry details the conceptual framework and key results of a model used to derive net present value (NPV) estimates of immigrants' lifetime net fiscal impacts (included in chapter 9 of the inquiry report). These outputs meet a core objective of the model, namely to estimate what the *per person* net fiscal impacts of immigrants by visa category are, on average, based on assumptions about immigrants' characteristics.

Technical Supplement D (Part 2) presents the mathematics underlying the model as well as some illustrative model outputs based on the assumptions outlined in the inquiry report (PC 2016a). These outputs are based on a single intake of immigrants (characterised as net overseas migration, or NOM).

The fiscal model was developed to enhance the evidence base for migration policy. It has been designed specifically to highlight the differences in fiscal impacts arising from immigrants' characteristics (such as visa category, age on arrival and labour force characteristics).

The fiscal outcome associated with immigration depends on immigrants' entitlements to social welfare and other services (such as Medicare) as well as the taxes paid by migrants as they work and consume. It also depends on the underlying structural fiscal balance which reflects the general eligibility rules for access to transfer payments and the nature of the taxation regime. These policies were taken as given for the modelling exercise.

Fiscal outcomes are not the only driver of immigration policy. There are broader economic, social and environmental considerations that should shape immigration policy. However, it is important to recognise that any additional fiscal outlays associated with immigration require either raising additional taxes or forgoing government expenditure in other areas.

For a detailed overview of the model's data sources, conceptual framework, assumptions and limitations, and the per person NPV results, please refer to sections D.3, D.4 and D.5 of Technical Supplement D (Part 1) (PC 2016b). The model files are available upon request and can be used to explore the implications of a different set of assumptions to those adopted by the Commission.

The rest of this technical supplement is structured as follows. Section D.1 details the key model equations, section D.2 presents illustrative aggregate fiscal projections, and

section D.3 discusses the fiscal model's additional functionality. Data confidentiality issues are addressed in appendix A.

D.1 Key equations in the model

The model is divided into four modules covering immigrant flows and demographics, expenditures, the labour market and revenues and immigrants' net fiscal impacts (expressed in aggregate terms or in per person NPVs). This section details the key sets within the model (table D.1), and the key equations in each of the model's four main modules.

Table D.1 **Key sets in the model and model equations**

Set	*Mnemonic*	*Elements*
Visa category	v	Temporary Student Temporary Skilled Temporary Visitor Temporary Working Holiday Maker New Zealand citizens (Special Category visa) Permanent Skill (Points Tested) Permanent Skill (Employer Sponsored) Permanent Skill (Business Innovation and Investment) Permanent Skill (Other) Permanent Family (Partner) Permanent Family (Parent) Permanent Family (Dependent Child) Permanent Family (Contributory Parent) Permanent Family (Other) Permanent (Humanitarian) Permanent (Special Eligibility) Permanent (Other) Australian citizens
Age	a	Single year, ages 0-95+
Gender	g	Male (M) Female (F)
Immigrant category	m	Representative intake of NOM (Rep.) Representative intake of NOM, Births (Rep. (Births))
Revenues	r	Income tax Excises and levies Company tax GST An aggregate for other Australian Government taxes An aggregate for other state and territory taxes

(continued next page)

Table D.1 (continued)

Set	*Mnemonic*	*Elements*
Expenditure	e	Pharmaceutical Benefits Scheme (s85) Medicare Hospitals Private Health Insurance rebate Pre-school Primary and secondary school University Tertiary and Further Education Education (not elsewhere classified) Aged cage Disability Support Pension Age Pension Family Tax Benefit (Parts A and B) Unemployment benefits
NOM intake	NOM	Annual intakes, time periods 1 to 100.
Year	t	Financial years, time periods 1 to 100.

Source: Productivity Commission.

Immigrant flows and demographics

The approach to modelling immigrants' demographics is similar to the cohort-component models used by the Australian Bureau of Statistics and in previous Commission demographic modelling exercises (ABS 2013, PC 2005, 2013). These models account for growth in an observed population through natural increase (annual flows of births and deaths) and NOM (treated as a permanent addition to the population). This model differs to these approaches in that its demographic projections are not based on an observed initial population of immigrants, or of the Australian population. This is partly due to the inherent difficulty in defining what a population concept of immigrants actually constitutes, but moreover reflects an interest in estimating the fiscal impacts of policy changes (which are unlikely to be retrospective in nature).

The model therefore accounts for the *future* flows of immigrants into the country, what type of immigrant they are (their visa type and personal characteristics), and the period over which they are resident in the country.[1] As the model only projects future NOM flows, the number of immigrants in the country builds from an initial value of zero in $t=0$. The model therefore accounts for immigrant flows (based on NOM) into and out of the country based on assumptions about the size of future NOM, outward flows (based on mortality and average emigration rates), and births of immigrants (based on assumed fertility rates). This section describes each of these in turn.

[1] The model framework does not account for short-term arrivals (those that stay for less than 12 months over a 16 month period), or category jumping between visa categories.

NOM flows and visa category projections

NOM projections are specified according to one of two policy scenarios — either some fixed level (1) or a ratio to the overall population (2). The NOM projections account for any difference between the initial observed NOM (based on observed data) and the policy target, and the duration of the assumed transition period d to that target.

$$NOM_t^{\alpha} \begin{cases} if\ t < d \\ if\ t = d \\ if\ t > d \end{cases} \begin{matrix} = NOM_{\ t=1} - \gamma_t(NOM_{\ t=1} - \alpha) \\ = \alpha \\ = NOM_{t-1}.(1+\theta_t) \end{matrix} \quad (1)$$

$$NOM_t^{\beta} \begin{cases} if\ t < d \\ if\ t = d \\ if\ t > d \end{cases} \begin{matrix} = NOM_{\ t=1} - \gamma_t(NOM_{\ t=1} - \beta.POP_{t=d}) \\ = \beta.POP_{t=d} \\ = NOM_{t-1}.(1+\theta_t) \end{matrix} \quad (2)$$

Where α is some fixed NOM level (for example 190,000 persons per year), β is some ratio of NOM to the population (for example 0.6 per cent), γ_t is a user defined linear convergence parameter to account for any difference in the initial NOM value and the policy target, and θ is the aggregate NOM growth rate implied by the policy scenario being modelled (either zero if modelling α, or the population growth rate if modelling β).

To project NOM flows in each visa category of the model, the change in NOM (ΔNOM_t, from *t=1* to *100*) from either (1) or (2) is applied to the initial NOM value for each visa category in the model. This implies that the composition of NOM remains constant over the projection period regardless of whether NOM is being modelled according to α or β. Section 1.3 details results for a simulation where this assumption is relaxed.

Mortality and emigration

Initial NOM flows for each visa category can be represented in a distribution by age and gender, with the projected number of immigrants in the representative intake given by (3).[2]

$$M_{v,a,g,t}^{Rep.} = M_{v,a-1,g,t-1}^{Rep.}.(1-\varepsilon_{v,t}).(1-Q_{a,g,t}) \quad (3)$$

Where $\varepsilon_{v,t}$ is a visa-specific rate of emigration per year, and $Q_{a,g,t}$ are projected age- and gender-specific probabilities that someone aged *a,* of gender *g,* in year *t* will die over the course of that financial year. Note that $\varepsilon_{v,t}$ is assumed to be constant over *a* and *g*.

2 The model assumes that immigrants who are of a given age are turning that age at the beginning of that financial year. This simplifies the module's calculations and does away with the need to assume that an immigrant's age in a given year is in some interval $x \leq a \leq x+1$.

Fertility

Having accounted for mortality and emigration, births are derived for those immigrants remaining in the country. Total births are denoted by $M_{v,a,t}^{Rep.(Births)}$ and are derived according to (4).[3] In (4), *v* is a limited set of visa types, with temporary and permanent family stream *parent* immigrants assumed not to give birth in Australian in view of their older age profile.

$$M_{v,a,t}^{Rep.(Births)} = \left(\sum_{a=15}^{49} M_{v,a,g=F,t} \cdot \varphi_{a,t} \right) / 1000 \qquad (4)$$

$\varphi_{a,t}$ are the projected age-specific fertility rates per thousand females from ages 15 to 49 at any time *t*. These fertility rates are average fertility rates for the Australian population and are assumed not to differ between immigrant types. The gender of immigrants' births is subsequently calculated according to an assumed gender ratio of 0.5, which is treated as invariant to time and visa category. Children born in Australia to an immigrant mother are assumed not to emigrate and remain resident in the country over the 100 year projection period. Overall, four generations of births are modelled, and attributed to their corresponding visa category.[4]

The resultant $M_{v,a,g,t}^{Rep.(Births)}$ in (5) represents the sum of births for each visa category, and accounts for mortality in the same fashion as the representative intake.

$$M_{v,a,g,t}^{Rep.(Births)} = M_{v,a-1,g,t-1}^{Rep.(Births)} \cdot \left(1 - Q_{a,g,t}\right) \qquad (5)[5]$$

In reality, some fraction of male immigrants is likely to partner and have children with partners already resident in the country. However, this is difficult to capture in a model which does not explicitly account for the female resident population. One method to account for this is to attribute a 'fertility' rate to male immigrants at some fraction of the rate attributable to female immigrants (for example Deloitte Access Economics (forthcoming)). This method is not employed in the Commission model because it does not account for immigrants' household structure, i.e. the proportion of immigrants, by visa, who are single or already have children.

Representative intake projections

The projected aggregate representative intake and births for each visa category is derived by summing over age and gender according to (6) and (7):

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3 Births in a given year are assumed to occur at the start of that year, doing away with the need to assume that births in a given period *t* are an average of the fertility rate in *t* and *t+1*.

4 A fifth generation yields negligible additional births within the scope of the projection period.

5 Note that the higher rate of mortality for live births is accounted for in the estimates of $Q_{a,g,t}$.

$$M_{v,t}^{Rep.} = \sum_{g}^{M,F} \sum_{a=0}^{95+} M_{v,a,g,t} \quad \forall\, v \tag{6}$$

$$M_{v,t}^{Rep.\ (Births)} = \sum_{g}^{M,F} \sum_{a=0}^{95+} M_{v,a,g,t}^{Rep.(Births)} \quad \forall\, v \tag{7}$$

Note that $M_{v,t}^{Rep.}$ and $M_{v,t}^{Rep.\ (Births)}$ are equivalent to projections from *t=1…100* of the number of immigrants and births within each visa category *for* $NOM_{t=1}$ *only*. In the model, there is an equivalent set of projections for all subsequent $NOM_{t=2\ldots100}$.

Expenditure

The total costs attributable to a visa category in the representative intake are a function of the projected average per person expenditure for each government-funded service or benefit *e* (based on PC (2013) and updated to 2014 dollars), and the projected number of immigrants in the representative intake consuming each government-funded service or benefit.

Projected average per person expenditure (E) for each government-funded service or benefit *e* are given by (8).

$$E_{a,g,t}^{e} = E_{a,g,t-1}^{e}.(1 + \mu_{e,t}) \tag{8}$$

where $\mu_{e,t} \geq 0$ is projected growth in expenditure-specific real costs.

These per person expenditures are averages for the population and, in the majority of cases, change with age and gender, reflecting the different probabilities that someone in that age group or gender will be incurring that form of expenditure. Furthermore, some forms of expenditure are positive for certain age-groups only, and zero otherwise, reflecting their being specific to certain ages (for example the age pension), or are constant across all ages (for example 'other' education expenditure).

The projected number of immigrants eligible to consume each government-funded service or benefit in the representative intake is given by multiplying $M_{v,a,g,t}$ by immigrants' assumed aggregate uptake rates of each government-funded service and benefit, $u_{v,e,t}$, which is greater than zero if and only if the immigrant is eligible and has served the relevant waiting period. The calculation of immigrants' initial uptake rates is discussed in Part 1, with all uptake rates assumed to converge to the Australian average uptake rate for each expenditure category *e* over a period of 10 years.

A series of projected total expenditures (TE) for the representative intake are therefore given by (9), where *E* (from (8)) is a limited set of expenditures determined by the model specification.

$$TE_{e,v,t}^{Rep.} = \sum_{g}^{M,F} \sum_{a=0}^{95+} E_{a,g,t}^{e} . \left(u_{v,e,t} . M_{v,a,g,t}^{Rep.}\right) \quad \forall\, e, v \tag{9}$$

Where the term in parenthesis is equivalent to a projected number of eligible 'claimants' (by age and gender) of various expenditures.[6] Note that estimates of 'claimants' of unemployment benefits are estimated separately within the labour market and revenue module. A similar procedure is undertaken for births of the representative intake (10), with all children assumed fully eligible for all forms of government-funded services and benefits with no waiting periods.

$$TE_{e,v,t}^{Births} = \sum_{g}^{M,F} \sum_{a=0}^{95+} E_{a,g,t}^{e} . \left(u_{e,t} . M_{v,a,g,t}^{Rep.\ (Births)}\right) \quad \forall\, e, v \tag{10}$$

Labour market and revenue

The labour market module is based on the number of immigrants in the representative intake, $M_{v,a,g,t}^{Rep.}$ and their births, $M_{v,a,g,t}^{Rep.\ (Births)}$ and:

- multiplies them by assumed labour force participation ($LFP_{v,a,g,t}$) rates and employment rates (1 less the unemployment rate $U_{v,a,g,t}$) which vary by visa category, age, and gender.
  - LFP and unemployment rates for the representative intake are assumed to converge to the age- and gender-specific labour force characteristics of the Australian population averages over periods defined by the user.[7] Births are assumed to adopt the age- and gender-specific labour force characteristics of the Australian population averages.
  - The resulting estimates of employment (persons) by age, and gender, and all time-periods, for all visa categories, are multiplied by projections of median income tax revenue to derive visa-specific estimates of income tax revenue by age and gender.
- because all other revenues in the model are estimated on an equal per person basis, $M_{v,a,g,t}^{Rep.}$ and $M_{v,a,g,t}^{Rep.\ (Births)}$ are simply multiplied by projected per person revenues R_t^r, which are constant over age, gender and visa category.

Similarly, the module derives estimates of unemployment (persons) by age and gender, for all time periods and for all visa categories, which is used as an input to the expenditure

6 Eligible 'claimants' are estimated across all ages for computational simplicity. Where an expenditure is specific to a certain age group, this is accounted for in the per person cost estimate, which is imputed as positive only for relevant age-groups.

7 Detailed in Technical Supplement D (Part 1). Convergence rates differ by visa reflecting different assumed human capital.

module as the basis for visa-specific estimates of unemployment benefits.[8] These calculations account for waiting periods for immigrants to be eligible for unemployment benefits.

Average per person revenues (in 2014 dollars) for income tax revenue (*Inc.*) and other revenues (*Oth.*) are projected according to the annual rate of real output growth in the economywide modelling (11) and (12).

$$R_{a,g,t}^{r=Inc.} = R_{a,g,t-1}^{r=Inc.}.(1 + \Delta GDP_t) \tag{11}$$

$$R_{t}^{r=Oth.} = R_{t-1}^{r=Oth.}.(1 + \Delta GDP_t) \tag{12}$$

In respect of income tax, total revenues are therefore derived on the basis of growth in per person income tax revenues from (11), and employment estimates according to (13) for the representative intake, and (14) for births.

$$TR_{a,g,t}^{r=Inc.(Rep.)} = R_{a,g,t}^{r=Inc.}.M_{v,a,g,t}^{Rep.}.\left(1 - LFP_{v,a,g,t}\right).(1 - U_{v,a,g,t}) \tag{13}$$

$$TR_{a,g,t}^{r=Inc.(Births)} = R_{a,g,t}^{r=Inc.}.M_{v,a,g,t}^{Rep.(Births)}.\left(1 - LFP_{a,g,t}\right).(1 - U_{a,g,t}) \tag{14}$$

In respect of other taxes, total revenues are therefore derived on the basis of growth in per person other tax revenues from (12), and the total number of immigrants from (6) and (7). Other revenues for the representative intake are therefore derived according to (15), and for births are derived according to (16). For other taxes, R is a limited set of revenues depending on the model specification.

$$TR_{a,g,t}^{r=Oth.(Rep.)} = R_{t}^{r=Oth.}.M_{v,a,g,t}^{Rep.} \tag{15}$$

$$TR_{a,g,t}^{r=Oth.(Births)} = R_{t}^{r=Oth.}.M_{v,a,g,t}^{Rep.(Births)} \tag{16}$$

Total projected revenues for the representative intake are therefore given by (17), and for births by (18).

$$TR_{r,v,t}^{Rep.} = \sum_{g}^{M,F}\sum_{a=0}^{95+} TR_{a,g,t}^{r=Inc.(Rep.)} + TR_{a,g,t}^{r=Oth.(Rep.)} \quad \forall\, r, v \tag{17}$$

$$TR_{r,v,t}^{Rep.\ (Births)} = \sum_{g}^{M,F}\sum_{a=0}^{95+} TR_{a,g,t}^{r=Inc.(Births)} + TR_{a,g,t}^{r=Oth.(Births.)} \quad \forall\, r, v \tag{18}$$

8 This framework does not account for those unemployed who choose not draw on unemployment benefits.

Net fiscal impacts and net present values

In light of the above, it is simple to derive immigrants' net fiscal impacts NFI_t for the representative intake. It is equal to the difference between projected total annual revenues and total annual expenditures for each visa category. NFI_t is therefore given by (19).

$$NFI_{v,t}^{Rep.} = \sum_{r=1}^{R} TR_{r,v,t}^{Rep.} - \sum_{e=1}^{E} TE_{e,v,t}^{Rep.} \tag{19}$$

For the purpose of calculating *lifetime* net present values of immigrants' net fiscal impacts (20), we focus on immigrants in $NOM_{t=1}$ only and exclude births, as inclusion thereof would count over multiple 'lives' and obfuscate the NPV being 'lifetime'.

$$NPV_{v,a} = \sum_{t=1}^{t_R} \left(\frac{1}{1+r}\right)^t NFI_{v,a,t}^{Rep} \tag{20}$$

Where a refers to age on arrival, and t_R is the number of periods t until someone age a on arrival is no longer resident in the country due either to mortality or emigration. In the model, this calculation requires 'unpacking' the 95+ age category using mortality rates for that age category (because there are more time periods than there are age categories in the model).

D.2 Illustrative aggregate net fiscal impacts

This section presents illustrative aggregate net fiscal impacts for the model specification underlying the inquiry report, namely Specification 2, which includes key expenditures and revenues attributable to immigrants at both the Commonwealth and state and territory government levels. This specification underpins the results presented in chapter 9 of the inquiry report.

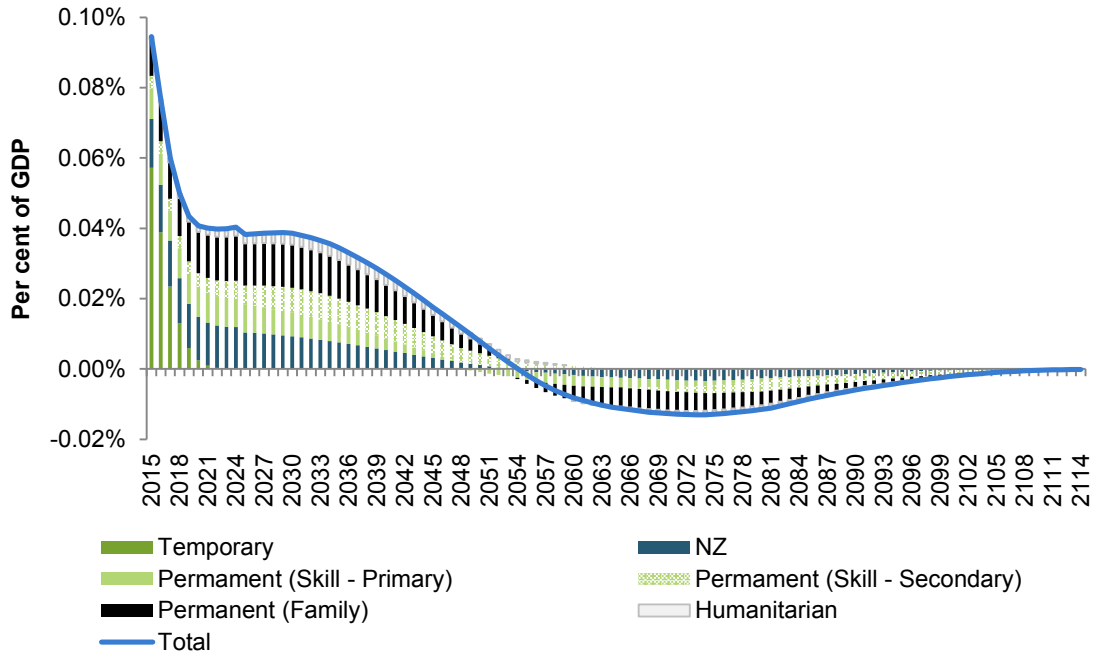
As noted in Technical Supplement D (Part 1), this specification accounts (by value) for around 50 per cent of aggregate Australian and state and territory expenditure, and 75 per cent of aggregate Australian and state and territory revenues (including GST). Overall, state expenditures on health and education represent around 50 per cent of total state expenditure, and GST represents around 55 per cent of their revenues.

This specification implies that aggregate net fiscal contributions are initially positive, driven mainly by temporary immigrants, who account for around half of the intake. These immigrants are typically not eligible to access government services or benefits and are normally in employment as a condition of their visa. Other immigrants' net fiscal impacts are also initially positive, reflecting that they tend to be young, healthy and working. Over time, temporary immigrants depart and immigrants remaining in the country age, exit the labour market, and increasingly draw on government-funded health care and benefits. As

such, immigrants' net fiscal impacts become negative, generally around 40 years into the projection (figure D.1).

A key driver of when a visa category's net fiscal impact becomes negative is the underlying age distribution, with younger visa categories (on average) taking longer to become negative. For example, permanent family stream immigrants remain positive for longer than primary applicants in the permanent skill stream. The elapsing of waiting periods for permanent immigrants to receive certain government-funded services and benefits is also visible, most notably around 10 years into the projection. Overall, the net fiscal impact of a single year's NOM as a proportion of GDP is quite small, be it positive or negative in value. Nonetheless, these impacts are not insignificant in absolute dollar terms.

Figure D.1 **Net fiscal impact to GDP (representative intake)**
Specification 2, excludes births



Data source: Productivity Commission estimates.

It is important to note that the net fiscal impacts presented below are based on a continuation of current policy settings. As noted in PC (2016a, 2016b), any changes to policy will affect these estimates and as such, these projections are highly stylised in nature. In addition to any future policy change, better estimates of immigrants' absolute net fiscal impacts require better data on immigrants' use of government funded services and benefits and contributions to government revenues over their lifetimes.

D.3 Additional model functionality

As noted in PC (2016b), the demographic and fiscal projections for a single representative intake of NOM can be used to estimate the revenues, expenditures and net fiscal impacts of all future cohorts of NOM and their descendants over the projection, by assuming that the per person revenues and expenditures generated by the representative intake (and their descendants) apply to all future NOM intakes.

This means that the fiscal model can be used to estimate the aggregate *direct* fiscal impacts of changes to immigration policy settings.[9] This could include, for example, changes in policies regarding eligibility for and waiting periods to access government-funded services and benefits, or changes to the composition of the migrant intake itself.

In addition, the model can be run assuming different coverages of government expenditures and revenues, which can be used to elucidate the fiscal impacts of immigration at different levels of government. PC (2016b) outlines three illustrative model specifications covering the Australian Government, the Australian and state and territory levels of government, and the whole-of-government level (including local government).

9 This does not include *indirect* fiscal impacts, such as impacts which may arise due to changes in labour market aggregates, capacity utilisation or labour productivity.

Appendix A A note on data confidentiality

The data used to derive age and gender distributions for certain temporary immigrants in the model are sourced from the Department of Immigration and Border Protection (DIBP).[10] These data are drawn from administrative data holdings, and reflecting privacy considerations, have been aggregated in line with the DIBP's preferences. Users of the model may wish to note that the age and gender distributions:

- for all temporary immigrants are three-year averages based on arrivals data
- for older temporary student immigrants are aggregated into either an 'age 55+' category, or from the first observed age group with fewer than five observations
- for older temporary skilled immigrants are aggregated into either an 'age 66+' category, or from the first observed age group with fewer than five observations.

This means that some older immigrants are effectively being modelled as being of the age into which they have been aggregated. However, this makes a negligible difference to the results given the small number of observations affected.

Users of the model may wish to make independent assumptions about the age and gender distributions of older immigrants in these categories. The results presented in this note are based on the aggregated distributions to prevent reverse engineering of the distributions.

[10] See Technical Supplement D (Part 1), appendix A for a full list. The DIBP's data has been used to parameterise the temporary immigrants' age and gender distributions only, and have not been used for any other purpose.

References

ABS (Australian Bureau of Statistics) 2013, *Population Projections, Australia, 2012 (base) to 2101*, Cat. no. 3222.0, Canberra.

Deloitte Access Economics forthcoming, *Migrants' Fiscal Impact Model — Results and User Guide*, Prepared for the Department of Immigration and Border Protection, Canberra.

PC (Productivity Commission) 2005, *Economic Implications of an Ageing Australia*, Research report, Canberra.

—— (Productivity Commission) 2013, *An Ageing Australia: Preparing for the Future*, Commission Research Paper, Canberra.

—— (Productivity Commission) 2016a, *Migrant Intake into Australia*, Inquiry Report No. 77, Canberra.

—— (Productivity Commission) 2016b, *Modelling immigrants' fiscal impacts — Part 1*, Migrant Intake into Australia — Technical Supplement D, Canberra.