



Australian Government  
Productivity Commission

CAPITA-B:  
A Behavioural  
Microsimulation Model

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*Daniel Marshall*

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### **Publications enquiries**

Media and Publications, phone: (03) 9653 2244 or email: [maps@pc.gov.au](mailto:maps@pc.gov.au)

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## Key points

- CAPITA-B is a behavioural microsimulation module that relies on and extends CAPITA (a static microsimulation model of the Australian Tax and Transfer system provided by the Australian Treasury).
  - CAPITA-B extends CAPITA by estimating changes to individual and aggregate labour supply caused by changes to Australia's tax and transfer policy environment.
- The design underlying CAPITA-B was selected from a range of alternatives because it allows for easily interaction with the existing CAPITA framework and had low development costs.
  - CAPITA-B was not developed for a particular application. Instead, CAPITA-B was developed as a modelling 'platform' to provide the foundation to build models designed to address specific policy questions.
  - The initial implementation of CAPITA-B is simple so that it can be easily understood and modified. For instance, in this implementation, CAPITA-B assumes that (a) each family has a single decision maker and (b) that the single decision maker is the primary earner.
  - The initial implementation includes temporary specifications for details considered to be application-specific. For instance, equations underlying wage and utility calculations are based on those used in previous Commission modelling for the Childcare and Early Childhood Learning inquiry (PC 2014).
- Applying the CAPITA-B modelling platform to a particular application requires further work to:
  - modify aspects of CAPITA (by including more policies and modifying rules relating to transfer payment eligibility for instance)
  - depending on the application, specify (a) the number of decision makers per income unit and (b) who these decision makers should be
  - update the temporary specifications of some of the module's details, such as the equations used in the utility and wage calculations.
- CAPITA-B calculates people's labour supply choices after policy change and aggregates these choices into changes in aggregate labour supply, relative to a baseline.
  - Aggregate results should be interpreted as labour supply changes and not changes to equilibrium employment (which depends on interactions with labour demand that are not reflected in CAPITA-B).
  - Similarly, budgetary effects calculated with CAPITA-B do not relate to equilibrium employment outcomes.

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## CAPITA-B

Like other behavioural microsimulation models, CAPITA-B provides the means to take people's labour supply responses into account when evaluating the effects of policy change.<sup>1</sup> Unlike other behavioural microsimulation models, CAPITA-B is not designed with a specific policy application, rather as a 'platform' to facilitate the development of application-specific models.

Behavioural microsimulation models built to answer specific policy questions must be adjusted before they can be applied to other policy questions. This is the case when, for instance, their database only captures information on a specific subset of the population relevant for the application. For example, the behavioural microsimulation model used in the Commission's Childcare and Early Childhood Learning report restricted the database to focus on parents of children below the age of 12 (PC 2014). This was the relevant population for the Childcare and Early Childhood Learning report, but it may not be a valid population when answering other policy questions.

Most behavioural microsimulation models have some common elements. While application-specific details vary, behavioural microsimulation models usually estimate labour supply choices by: defining a set of discrete labour supply alternatives that people can choose from, estimating wages (particularly for those who are enticed to begin working by the policy change and for whom no employment or wage history is available), calculating gross and net income for each labour supply alternative; and applying a calibrated utility function to determine the labour supply decision. These common elements can be found in, for instance, STINMOD-B, the Melbourne Institute Tax and Transfer Simulator (MITTS) and previous Commission microsimulation models.

CAPITA-B replicates the common elements inherent in behavioural microsimulation models while keeping to a minimum details that would be required to model a particular policy application<sup>2</sup>. This makes it easier to extend CAPITA-B to answer future policy questions.

This document describes CAPITA-B by (i) focusing on design considerations that influenced CAPITA-B's development, (ii) discussing the behavioural module's theory and implementation (implementation is illustrated using a hypothetical policy experiment), and (iii) identifying aspects of CAPITA-B that should be revised when developing an application-specific model.

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<sup>1</sup> For example, MITTS-B or STINMOD-B, see below.

<sup>2</sup> Aspects of the model that could be considered application-specific — such as the utility function, utility and wage parameters; and database sample — have generic specifications. The specifications are simple, and should be updated when developing an application-specific model. Initial wage and utility parameters are informed by the Childcare and Early Childhood Learning report (PC 2014).

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## Box 1      **CAPITA**

CAPITA is a static microsimulation model provided by the Australian Treasury that forms the foundation for CAPITA-B. CAPITA relies on the 2011-12 Survey of Income and Housing to describe income unit's demographic and economic characteristics so that their interactions with the Australian Tax and Transfer System can be accurately modelled. CAPITA-B uses CAPITA to estimate an income unit's disposable income, given: observed characteristics (such as family type and gross income), and the rules governing the Australian Tax and Transfer System. While not containing all taxes and transfers, CAPITA includes over 40 major policies (reported in table 4) administered by the Australian Government in 2014-15.

The main payments in CAPITA are pensions, such as the Aged Pension and Disability Support Pension; and allowances, such as Newstart Allowance and Youth Allowance. CAPITA also models Family Tax Benefits and supplementary payments, such as Commonwealth Rent Assistance and the Telephone Allowance. A detailed representation of the personal income tax system that takes into account deductions and tax offsets is also modelled.

While CAPITA is a useful tool, some aspects of the model could be refined. For instance, CAPITA does not include some policies — such as Childcare benefits — that are likely to be material for analysing some policy changes. Additionally, CAPITA assumes a person is eligible for transfer payments only if they are observed as having received that payment in the underlying database. To the extent that the underlying survey data does not capture payments accurately, this could misrepresent eligibility.

*Source:* CAPITA documentation.

## Design considerations

The Commission considered three ways to build CAPITA-B to provide a framework for examining the dominant impacts<sup>3</sup> of policy changes in a simple manner. A simple model is favoured because they are: more transparent, more easily interpreted, easier to operate and modify to future needs; and solve quickly. The three alternatives were to:

1. adapt an existing behavioural microsimulation model (STINMOD-B) to interface with the static microsimulation model CAPITA (box 1)
2. write a behavioural module alongside a new static microsimulation model in the R programming language
3. write a behavioural module that interfaces directly with CAPITA in the SAS programming language.

STINMOD-B, developed by the National Centre for Social and Economic Modelling, is a behavioural microsimulation model that could be made to interface with CAPITA. It estimates the behavioural response of primary and secondary earners in each income unit, and includes a range of other detail (such as including five dependent children).

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<sup>3</sup> As a general principle, only factors that have been shown to have a significant impact on behaviour should be considered for inclusion, with the magnitude of the impact the determining factor.

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The Commission did not use STINMOD-B because it is complex (which reduces accessibility for analysts not familiar with the model), and significant work is required before STINMOD-B and CAPITA could interface correctly. This would have involved building a comprehensive concordance between variables — itself a significant task — that would add a layer of complexity and increase overall run time.<sup>4</sup>

The Commission considered reproducing CAPITA and building the behavioural module in the R programming language. Developing a simple behavioural module and static microsimulation model using R would: improve run times, further reduce costs of adapting the module and better suit the programming skills of several Commission staff. However, using R to develop behavioural and static modules could reduce accessibility to analysts familiar with CAPITA and SAS, and would have required significant development resources beyond those allocated to this project.

The Commission opted to build a simple behavioural module in SAS that could interface with the existing CAPITA model without a concordance and be a platform for future models. This platform approach has some disadvantages, including that it requires additional work before it can be used for a specific application, and that it may be a less efficient approach when decision makers face many alternatives for a given decision or face many decisions. The advantages of building a simple behavioural platform in SAS include that the model: interacts with CAPITA without a concordance; is simple and transparent for non-Commission staff familiar with SAS; and had relatively low development costs.

## **How many and which labour supply decision makers should be included?**

The initial implementation of CAPITA-B models the labour supply behaviour of the primary earner in each income unit<sup>5</sup> only (the primary earner is the sole ‘decision maker’ in other words). This approach clears the way for the easy development of future-application specific models and is a reasonable *starting point* for the analysis of future policy questions.

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<sup>4</sup> A concordance would not be needed if STINMOD-B was modified to adopt CAPITA naming conventions. This would, however, incur development costs as STINMOD-B would need to be extensively modified. This once-off development cost would need to be weighed against the overall development and run time costs of using a concordance.

<sup>5</sup> An income unit is a ‘group of two or more people who are usually resident in the same household and are related to each other through a couple relationship and/or parent/dependent child relationship; or a person not party to either such relationship’ (ABS 2014). In other words an income unit can be thought of as a family.

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## **Application-specific model design**

Modifying models is easiest when they are free of unnecessary complexity. For instance, in the Commission’s recent work for the Tax and Transfer Incidence in Australia study (PC 2015), childcare policies, GST and lifetime analysis were added to CAPITA. Because CAPITA is a simple model these extensions were relatively straight forward. If the Commission was to undertake other work using CAPITA, then the best strategy would probably be to revert to the original version of CAPITA before making further changes (discarding developments made during the Tax and Transfer study if they are unnecessary for the application).

Assuming a single decision maker per income unit is one way to ensure that the initial implementation of CAPITA-B is simple. To include both earners as decision makers would require:

1. adjusting the core decision module and utility specification
2. a different treatment for single and coupled households.

There are policy applications where assuming a single decision maker is a valid simplification. For example, the behavioural microsimulation model developed by the Commission for the Childcare and Early Childhood Learning report incorporated secondary earners as sole decision makers because they were felt to be most responsive to childcare policies (PC 2014). Including primary earners was assessed as providing only limited additional insight into the drivers of behavioural responses while adding a third decision to the core model — alongside the labour supply and childcare decisions of primary carers — which would be costly in terms of model run time and complexity.

CAPITA-B can be modified if a future policy application calls for a secondary decision maker (or examines more than just labour supply decisions).

## **Primary earner as the sole decision maker**

Having opted for a single decision maker, identifying who they are is a contentious design issue. On the one hand, some argue that a secondary earner is more likely to adjust their behaviour in response to changes in tax and transfer policies — this is especially the case if a policy targets secondary earners. On the other hand, the primary earner faces high effective marginal tax rates (an indicator of disincentives to work) and focusing on the primary earner may provide the required insights into an income unit’s response to policy change in many circumstances. For this reason, the Commission adopted the primary earner as the sole decision maker for CAPITA-B’s initial implementation (box 2).

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## Box 2      **Primary earners as decision makers**

While just an initial implementation, the assumption that primary earners are the sole decision makers in each income unit is influenced by some initial observations about the nature of (a) primary earners and (b) possible future applications of CAPITA-B. Specifically, the choice of decision maker is influenced by the fact that:

1. primary earners often earn more labour income per hour worked than secondary earners, so increasing their labour supply is associated with higher returns
2. primary earners already face high policy-induced disincentives to work (as measured by high effective marginal tax rates) because they tend to face higher tax rates and an increase in their income often reduces an income unit's overall transfer payments. This means that there is:
  - (a) scope for some policies to reduce primary earner's disincentives to work
  - (b) scope for other policies to exacerbate a primary earner's disincentives to work.
3. primary earners have some capacity to change their hours of work: around 40 per cent of primary earners work less than full time and could increase their hours (assuming there is sufficient demand for labour), while around 60 per cent work full time and could reduce their hours (see appendix)
4. future applications of the CAPITA-B platform may examine a wide range of policy scenarios that could either increase or decrease labour supply.

Taken together, these observations suggest that a variety of tax and transfer policy changes designed to affect incentives to work (by changing effective marginal tax rates) could likely cause a change in the labour supply choices of primary earners.

Initially assuming that primary earners are the sole decision makers seems a reasonable *starting point*. This is not to deny that in some cases the behaviour of secondary earners is of interest (this was the case in the Childcare and Early Childhood Learning study (PC 2014)). Rather, it reflects that focusing on primary earners may provide the required insights into the behavioural responses of income units in a variety of policy applications.

## **Inside the behavioural module**

The behavioural module functions by:

1. defining a set of discrete labour supply choices common to all decision makers
2. calculating disposable income at each labour supply choice, based on a given level of gross income and the rules of the tax and transfer system
3. applying a utility function to a set of discrete labour supply choices, and calibrating this utility function to match observed data
4. recalculating disposable income under a policy reform scenario
5. using the calibrated utility function to estimate post-reform labour supply.



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The calibrated utility function determines the post-reform labour supply responses of decision makers in CAPITA-B. In the initial implementation, calibrated utility depends on disposable income and hours worked at each labour supply choice, as well as estimated parameters and a random utility term drawn from the Extreme Value (type one)<sup>6</sup> distribution. As a result, calibrated utility accounts for the impact of policy reform by calculating how a decision maker's labour supply choices change in the face of changes to their disposable income caused by changes to tax and transfer policy rules.

## Income

Decision makers take disposable income into account when they evaluate the relative attractiveness of labour supply alternatives. CAPITA-B therefore models the disposable income that each decision maker receives at their possible labour supply alternatives. Estimating disposable income relies on estimating wages (see box 3) and gross income for each decision maker at each labour supply alternative, and on the rules of the tax and transfer system.

### Box 3      **Imputing wages**

Wages must be imputed because some decision makers have no observed income and/or labour supply<sup>7</sup>. CAPITA-B imputes wages using demographic data from the 2011-12 Survey of Income and Housing and parameters previously estimated in a Heckman two-stage procedure.

The Heckman two-stage approach is a common approach for estimating wages that is preferred over standard regression techniques because it overcomes issues of sample selection bias.<sup>8</sup> The Heckman two-stage estimation involves:

1. estimating a participation equation relating whether or not an individual is employed to their observable characteristics
2. using imputed values from the participation equation to estimate a sample selection correction term — the inverse Mills Ratio — and using this term to directly account for bias in a second equation linking wages to observed characteristics.

Estimated parameters from the two-stage wage regression can then be used to impute wages for each decision maker, and these wages can be used to calculate gross income at each labour supply choice.

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<sup>6</sup> MathWorks Australia (2016) provide a discussion of the Extreme Value (type one) distribution.

<sup>7</sup> In this implementation, parameters for the wage imputation are from previous modelling that the Commission undertook for the Childcare and Early Childhood Learning study (PC 2014). A wage regression should be estimated if CAPITA-B is to be used to answer specific policy questions.

<sup>8</sup> Wage regressions link observed wages with reported demographic and economic characteristics. Sample selection bias occurs when those who report observed wages (and are included in the regression) differ in characteristics from those who do not report wages (and are not included in the regression) and these characteristics determine wages.

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CAPITA-B uses the CAPITA model to estimate taxes paid and transfers received for each decision maker, given their: demographic characteristics from the 2011-12 Survey of Income and Housing, and gross income at each labour supply alternative calculated from imputed wages. CAPITA-B then uses resulting estimates of a decision maker's disposable income as a key input for the evaluation of their labour supply alternatives.

## Utility

CAPITA-B adopts a quadratic utility function with hours worked and disposable income as the main arguments. Despite having a common functional form, the utility function captures some variation in preferences across decision makers by allowing the value each places on hours worked and disposable income to vary in relation to their observed characteristics (using demographic variables). Each decision maker's utility function has the form:

$$U_h^i = \alpha_y (y_h^i - \delta^i)^2 + \alpha_h (h^i)^2 + \alpha_{y,h} ((y_h^i - \delta^i)h^i) + \beta_y^i (y_h^i - \delta^i) + \beta_h^i h^i + \varepsilon_h^i$$

Where  $U_h^i$  represents total utility of decision maker  $i$  at labour supply alternative  $h$ ,  $y_h^i$  represents disposable income of  $i$  at labour supply alternative  $h$ ,  $\delta^i$  is a fixed cost of working that varies across decision makers based on their sex,  $h^i$  represents hours worked/labour supply, and  $\varepsilon_h^i$  is a random utility term drawn from the Extreme Value (type one) distribution that takes different values for each labour supply alternative evaluated. Total utility is therefore composed of deterministic and stochastic components. Parameters  $\alpha_y$ ,  $\alpha_{y,h}$  and  $\alpha_h$  are common to all income units, whereas  $\beta_y^i$  and  $\beta_h^i$  vary with observed, mainly demographic, characteristics. Therefore, only some of the parameters of the utility function are specific to different types of income units.<sup>9</sup>

## Random utility and calibration

Though flexible, the quadratic utility function cannot replicate observed labour supply choices for all decision makers. This is addressed by incorporating random utility terms (see box 4) that adjust the relative total utility at each labour supply alternative to replicate observed behaviour. While useful for ensuring consistency between the model and underlying data, inclusion of random utility terms may influence a decision maker's optimal labour supply choice. To offset this dependence on the generated stochastic terms, multiple sets of these terms (with each set containing a random utility value for each labour supply alternative) are drawn for each decision maker and are assigned equal weight when generating results.

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<sup>9</sup> Parameters relating to quadratic terms ( $\alpha_y$ ,  $\alpha_{y,h}$  and  $\alpha_h$ ) do not vary with demographic characteristics. This utility specification is inherited from modelling for the Commission's Childcare and Early Childhood Learning report (PC 2014). Further application-specific models developed from this platform could include quadratic terms that vary with demographic characteristics of different decision makers.

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Random utility terms are generated once per model run and are used consistently in the pre and post-reform policy scenarios. The model is therefore consistent with the underlying data and the utility function does not change between runs.

#### **Box 4      Generating the random utility terms**

The traditional approach to calibrating this type of model is through trial and error; drawing repeatedly from an Extreme Value (type one) distribution and accepting sets of random utility terms if the resulting total utility places highest value on observed labour supply. This approach can be computationally intensive; so CAPITA-B uses an alternative approach guaranteeing an acceptable set of random utility terms using a two stage closed form solution. This alternative approach is outlined in appendix two of (Bourguignon, Fournier and Gurgand 1998)<sup>10</sup>.

Random utility terms are drawn from the Extreme Value (type one) distribution for two reasons:

1. it allows utility parameters to be estimated using simple econometric techniques (a multinomial logit model). This is not necessarily the case if random utility terms are drawn from other distributions.
2. it permits the use of the more efficient calibration technique outlined in (Bourguignon, Fournier and Gurgand 1998) that relies on the functional form of the distribution.

## **Generating results**

Reporting results from a behavioural microsimulation model like CAPITA-B is complicated by the random utility terms; since decision makers are assigned multiple sets of random utility terms (with each set containing a random utility value for each labour supply alternative) they can be assigned multiple optimal decisions in a given policy scenario. CAPITA-B addresses this issue by treating post-reform outcomes for each decision maker as the average of outcomes across all sets of random utility terms. Alternative approaches are possible (such as by reporting the outcomes associated with all sets of random utility terms and assuming each set term belongs to a separate decision maker), but taking the average is a simple and common approach<sup>11</sup>.

## **An example to explain the mechanics of CAPITA-B**

The mechanics of CAPITA-B are illustrated by estimating the labour supply response of a particular decision maker to a hypothetical policy experiment. In this instance, a 55 year old male decision maker who is in a coupled relationship with a 47 year old spouse and

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<sup>10</sup> The Commission is aware of technical issues that make electronic versions of this paper difficult to read. A more legible version is available from the Commission website.

<sup>11</sup> Like CAPITA-B, MITTS-B calculates a decision maker's labour supply after a policy change as the average labour supply choice for all sets of random utility (Creedy et al. 2004). In contrast, STINMOD-B reports the results associated with each set of random utility terms but with adjusted population weights (effectively assuming each set of random utility terms belongs to different decision maker).

without any dependent children has been selected from the model’s database. The experiment is a five per cent increase in the marginal tax rate for income units in the lowest two tax brackets, and a ten per cent increase in the marginal tax rates for income units in the highest two tax brackets (table 1).

**Table 1 Benchmark and reform parameters**

<i>Income range</i>	<i>Benchmark marginal tax rates (%)</i>	<i>Reform marginal tax rates (%)</i>
\$0 – \$18 200	0.0	0.0
\$18 201 - \$37 000	19.0	24.0
\$37 001 - \$80 000	32.5	37.5
\$80 001 - \$180 000	37.0	47.0
\$180 001+	45.0	55.0

*Source:* Australian Taxation Office (ATO 2016).

## Benchmark and reform runs

The benchmark run provides a reference point for comparison and generates key inputs needed for the reform run (such as imputed wages and gross income, and calibrated random utility terms). Specifically, the benchmark run:

1. calculates imputed wages
1. uses imputed wages to calculate gross income at each labour supply choice
2. calculates disposable income using imputed gross income and the tax and transfer rules represented in CAPITA
3. uses disposable income and hours worked to calculate utility<sup>12</sup> at each possible labour supply choice
4. generates and calibrates the random utility terms so that the model’s estimated optimal hours equal observed hours, and saves the calibrated terms for use in the reform run.

The reform run implements the parameters in the last column of table 1. By combining elements of the baseline run with post-reform tax and transfer rules, CAPITA-B can estimate decision maker’s expected response to policy reform. Specifically, for each decision maker, the reform run:

1. takes gross income from the benchmark run and applies static CAPITA with updated reform parameters to calculate post-reform disposable income
2. recalculates deterministic utility at each labour supply choice using post-reform disposable income

<sup>12</sup> Utility parameters used in this exercise are presented in table 5, and are based on estimates used in modelling for the Commission’s Childcare and Early Childhood Learning Report (PC 2014).

3. uses the calibrated random utility terms calculated in the benchmark run along with updated deterministic utility to calculate updated total utility
4. selects post-reform optimal labour supply based on updated total utility, and reports results.

## The benchmark run

CAPITA-B estimates a decision maker’s hourly wage using observed characteristics and parameters from the wage equation. The selected decision maker’s wage is estimated at \$45 per hour based on the fact that — amongst other things — they are 55 years old, have no dependent children, reside in Victoria and are employed in the manufacturing industry. Table 2 illustrates the annual gross wage income associated with this hourly wage at each possible labour supply choice.

**Table 2**      **Gross and net income for each possible labour supply**  
Benchmark run

<i>Hours worked per week</i>	<i>Annual gross wage income</i>	<i>Annual disposable income</i>
0	\$0	\$0 <sup>a</sup>
10	\$23 226	\$22 839
20	\$46 451	\$39 624
30	\$69 677	\$54 515
40	\$92 903	\$69 203
50	\$116 129	\$83 370

<sup>a</sup> Zero disposable income for this labour supply choice results from the eligibility criteria inherent in the static CAPITA model. That is, eligibility for a payment depends on whether a decision maker is observed in the SIH as having received a payment. In this case, the person selected was not recorded as having received any payment.

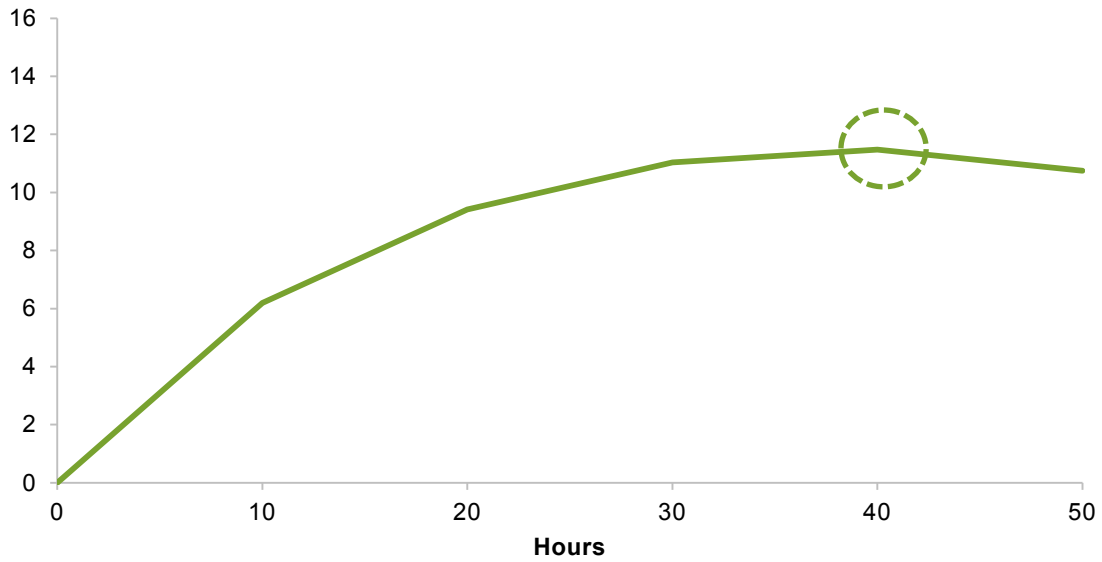
Source: Authors estimates.

Deterministic utility depends on disposable income and hours worked; and follows a quadratic form (figure 1). Disposable income at a specific labour supply choice is calculated using the decision maker’s gross income and their demographic characteristics, as well as rules of the tax and transfer system.

The selected decision maker is observed to be working 50 hours per week, but their deterministic utility function produces a labour supply of 40 hours. This suggests that the deterministic utility function in figure 1 does not accurately represent their preferences. To address this, the random utility term is added to deterministic utility at each labour supply choice. An example of successful calibration is illustrated in figure 2, where total utility produces the observed labour supply of 50 hours. After calibration, the random utility terms are stored and used again to calculate total utility in the reform run.

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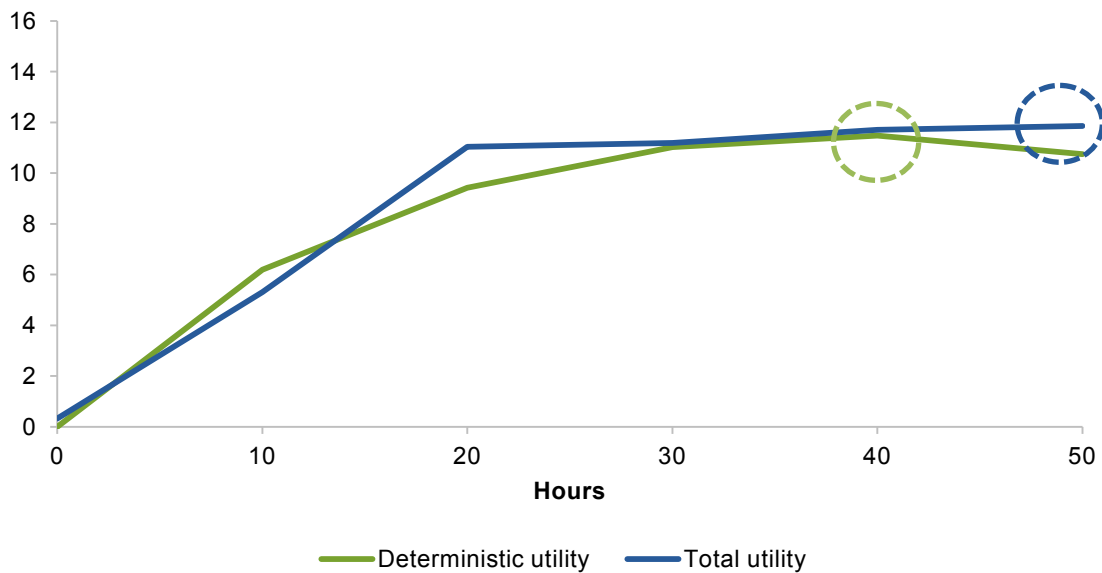
Figure 1 **Deterministic utility**  
Benchmark run



Data source: Authors estimates.

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Figure 2 **Total utility**  
Benchmark run



Data source: Authors estimates.

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## The reform run

In this run, the marginal tax rates are increased for all tax payers, with the marginal rate for those in higher tax brackets increasing more than for those in lower tax brackets. This means that, all else equal, disposable income is lower than in the benchmark run at most labour supply choices. This is illustrated in table 3.

Changing marginal tax rates affects labour supply choices by changing disposable income, a key argument in the labour supply decision. The deterministic utility values for the benchmark and reform runs are shown in figure 3. As expected, deterministic utility is lower in the reform run at all non-zero labour supply choices, since disposable income is lower.

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**Table 3      Annual disposable income for each possible labour supply**  
Benchmark and reform runs

<i>Hours worked per week</i>	<i>Benchmark</i>	<i>Reform</i>
0	\$0	\$0 <sup>a</sup>
10	\$22 839	\$22 649
20	\$39 624	\$38 273
30	\$54 515	\$52 003
40	\$69 203	\$64 945
50	\$83 370	\$76 790

<sup>a</sup> See note a in table 2.

Source: Authors estimates.

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The total utility associated with one set of random utility terms (the same random utility terms as presented in figure 2) is presented in figure 4. Total utility is maximised at 40 hours in the reform run. The increase in tax rates has decreased labour supply by 10 hours.

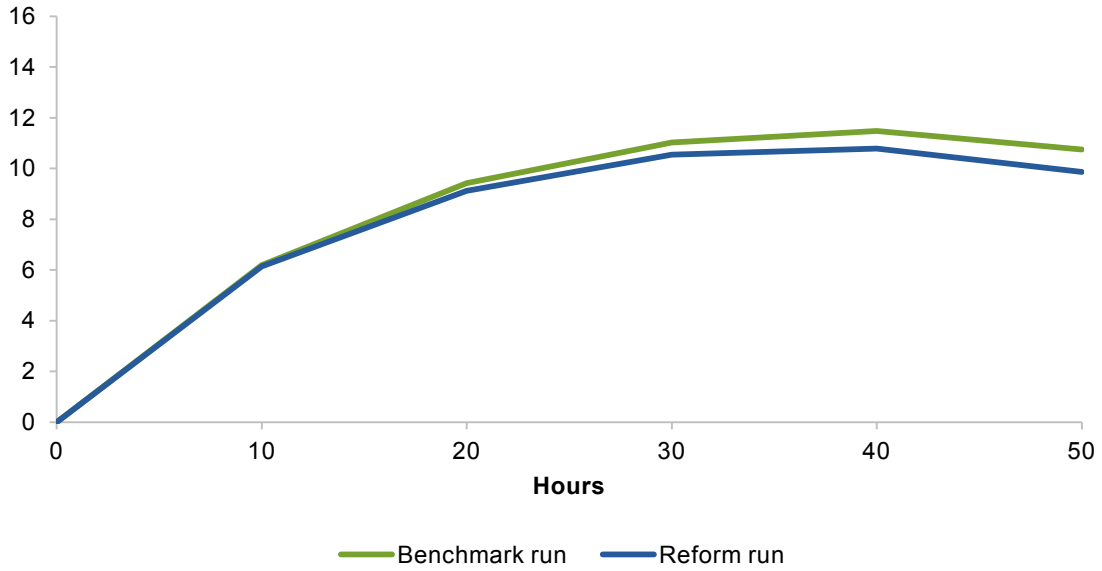
Several sets of random utility terms are consistent with observed outcomes and are retained from the benchmark run. An expected change in labour supply is calculated as the average of the outcomes across the different sets of terms. In this case, the expected change in labour supply was calculated to be a reduction of 7 hours, based on ten sets of random utility terms.

While this hypothetical example has focused on the response of one decision maker to policy reform, CAPITA-B calculates equivalent results for thousands of decision makers. Aggregate results are calculated by summing all decision maker's responses in accordance with their population weights. In this instance, the hypothetical reform to marginal tax rates causes a fall in aggregate labour supply of around 1.6 per cent<sup>13</sup>.

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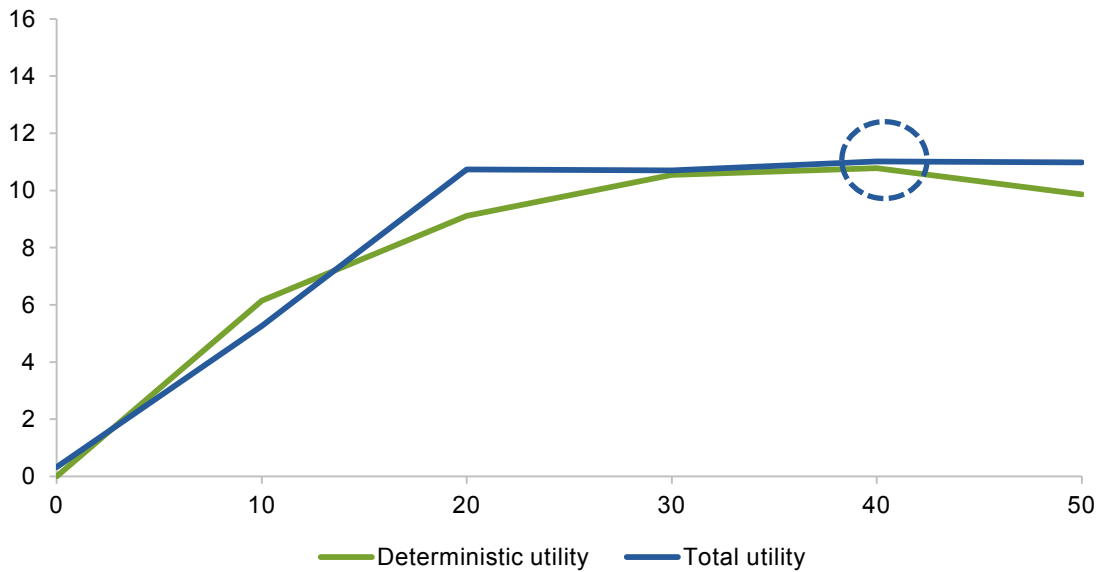
<sup>13</sup> While no weight should be placed on this aggregate result, the model produces a negative relationship between increases in marginal tax rates and labour supply, as might be expected.

**Figure 3**      **Deterministic utility**  
 Benchmark and reform runs



<sup>a</sup> Parameters underlying these utility functions are reported in table 5.  
*Data source:* Authors estimates.

**Figure 4**      **Total utility**  
 Reform run



*Data source:* Authors estimates.



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For an economy that is initially in equilibrium, aggregate labour supply results from CAPITA-B should not *usually* be interpreted as changes in aggregate employment. For changes in aggregate labour supply to equate with changes in aggregate employment, demand for labour must be perfectly elastic (although small changes to labour supply might approximate changes to employment in other circumstances). If demand is not perfectly elastic then changes to aggregate labour supply estimated from behavioural microsimulation models will be greater than any changes to employment that might be expected.

The distinction between aggregate labour supply and employment illustrates why it is important to be careful when interpreting aggregate results from CAPITA-B. While being a reasonable approximation for short term effects, aggregate results are unlikely to produce accurate insights into long term changes as an economy moves to a new equilibrium.

## **From CAPITA-B to an application-specific model**

### **Application-specific utility and wage specifications**

The utility and wage equations in CAPITA-B will usually need to be revised in applying the platform as an application-specific model. Particularly, in developing an application-specific model, analysts should specify:

1. utility function(s) that account for differences in the way that people belonging to different family types (singles, couples and lone parents for instance) make decisions
2. utility function(s) that better account for non-wage income.<sup>14</sup>

For the initial implementation, the utility and wage equations use parameters based on estimates from modelling for the Childcare and Early Childhood Learning study (PC 2014). In developing an application-specific model utility parameters should be estimated using a multinomial logit and wage parameters using a two-stage Heckman estimator. If the parameters are estimated using the same database as CAPITA-B, then the parameter estimates will be internally consistent.

### **Expenditure application**

Further work is needed before CAPITA-B can be used to estimate behavioural responses to policy changes that directly affect decision maker's expenditure behaviour (such as changes to the GST). Considering a decision maker's expenditure decisions would require specifying a utility function that incorporates preferences over consumption items, a substantial extension.

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<sup>14</sup> The current utility function is not designed to model the decisions of individuals who have significant sources of nonwage income. This is currently addressed by setting these sources of nonwage income to zero. This is unlikely to be a satisfactory approach when conducting policy analysis.

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The CAPITA-B database does not include income units' consumption expenditure, so further development of the database would be required. These developments would require either modifying the model to run with the 2009-10 Survey of Income and Housing/Household Expenditure Survey, or statistically matching 2009-10 Household Expenditure Survey expenditure data to income units in the 2011-12 Survey of Income and Housing.

## **Eligibility criteria**

Eligibility for a transfer payment in CAPITA only occurs if a decision maker is observed as having received the particular payment in the database. This means that some decision makers cannot receive transfer payments although they would be eligible for these payments if they were to lower their labour supply.

An alternative approach to modelling transfer payment eligibility would be to remove the requirement that an income unit receive a payment in the survey data in order to be eligible. This would assume that anyone who is eligible would be modelled to receive a payment (which could overstate total transfer payments) and would ensure that CAPITA more accurately models a decision maker's disposable income at each possible labour supply alternative.

## **Decision makers**

Choices regarding the number of decision makers in an application-specific model should be carefully considered on a case-by-case basis. In some circumstances it may be appropriate to incorporate a secondary decision maker, and in other circumstances a focus on the decisions of a single decision maker is sufficient. Inclusion of a secondary decision maker requires adjusting existing CAPITA-B code.

The single decision maker model could retain the primary earner as the sole decision maker, or replace them with the secondary earner (as in the modelling for the Childcare and Early Childhood Learning report (PC 2014)).

## **Additional policies**

CAPITA does not model some policies that may affect labour supply choices, such as childcare<sup>15</sup> and housing subsidies. Developing the model to assess these policies will require making specific assumptions about decision maker's current outcomes (hours of childcare used, for instance).

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<sup>15</sup> CAPITA includes childcare payments in a cameo mode, but not in the distributional mode that forms the basis for CAPITA-B.

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## References

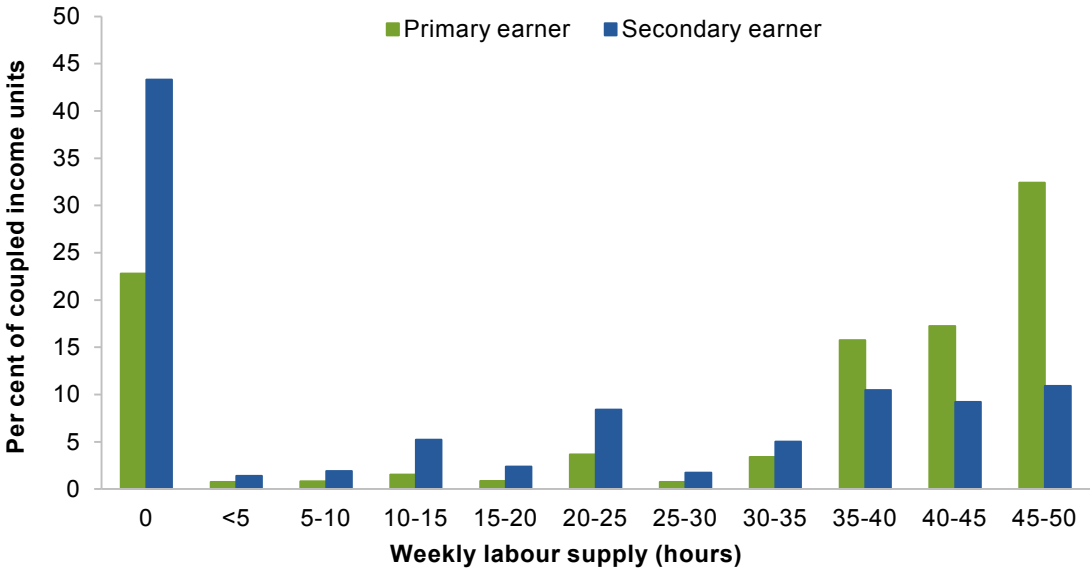
- ABS (Australian Bureau of Statistics) 2013, *Microdata: Income and Housing, Australia, 2011-12*, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/6541.0.30.001Main+Features12011-12?OpenDocument> (accessed 26 June 2014).
- 2014, *Family, Household and Income Unit Variables*, <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/1286.0Glossary12014?OpenDocument> (accessed 27 October 2015).
- ATO (Australian Taxation Office) 2016, *Income tax rates*, <https://www.ato.gov.au/rates/individual-income-tax-rates/> (accessed 15 February 2016).
- Bourguignon, F., Fournier, M. and Gurgand, M. 1998, *Distribution, Development and Education: Taiwan, 1979-1994*.
- Creedy, J., Duncan, A., Kalb, G., Kew, H. and Scutella, R. 2004, *The Melbourne Institute Tax and Transfer Simulator (MITTS)*, The Melbourne Institute of Applied Economic and Social Research.
- MathWorks Australia 2016, *Generalized Extreme Value Distribution - MATLAB & Simulink*, <http://au.mathworks.com/help/stats/generalized-extreme-value-distribution.html> (accessed 31 January 2016).
- PC (Productivity Commission) 2014, *Childcare and Early Childhood Learning*, Canberra.
- 2015, *Tax and Transfer Incidence in Australia*, Canberra.

# Appendix

Primary and secondary earners vary in their ability to increase their hours of work. Analysis of data on couples in the 2011-12 Survey of Income and Housing (figure 5) suggests that primary earners work more than secondary earners generally, and so secondary earners can increase their hours to a greater extent provided there is demand for the extra labour. Having said this, a significant proportion of primary earners (around 40 per cent) work less than 38.5 hours per week and have the capacity to increase their hours (ABS 2013) if the demand exists; and those working full time could work ‘overtime’.

Conversely, primary earners might decrease their hours. Around 25 per cent of secondary earners work at least 38.5 hours per week and have significant scope to reduce their hours; so most secondary earners can only reduce their already lower hours by a small amount. In contrast, around 60 per cent of primary earners work full time and have more scope to reduce their hours (ABS 2013).

Figure 5 Working hours of primary and secondary earners<sup>a,b,c</sup>



<sup>a</sup> Couples only. <sup>b</sup> The primary earner is the adult with the highest income from all sources. When there is no clear primary earner (when both adults receive the same income), the primary earner is assumed to be the reference person as defined by the ABS. <sup>c</sup> 0 hours of work implies that a person is either unemployed or not in the labour force.

Data source: Authors estimates from the 2011-12 Survey of Income and Housing (ABS 2013).

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## Annex

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**Table 4      Transfer and tax policies modelled in CAPITA**

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*Policy*

Age pension  
Austudy  
Carer allowance  
Carer payment  
Carer supplement  
Clean energy supplement  
Disability support pension  
Income support bonus  
Newstart allowance  
Parenting payment partnered  
Parenting payment single  
Pension supplement  
Pensioner education supplement  
Pharmaceutical allowance  
Rent assistance  
Seniors supplement  
Telephone allowance  
Utilities allowance  
Widow allowance  
Wife pension (age and DSP)  
Youth allowance (full time and apprentice)  
Youth allowance (other)  
Family tax benefit part A and B  
Large family supplement  
Newborn upfront payment  
Schoolkids bonus  
Single income family supplement  
Service pension – DVA  
Beneficiary tax offset  
Dependent spouse tax offset  
Single parent supplement  
Partner allowance<sup>a</sup>  
Low income tax offset

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(Continued next page)

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**Table 4** (continued)

*Policy*

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Income tax  
Mature age worker tax offset  
Medicare levy  
Medicare levy surcharge  
Senior and pensioner tax offset  
War widow pension<sup>a</sup>  
Special benefit<sup>a</sup>  
Sickness allowance<sup>a</sup>  
Abstudy<sup>a</sup>  
Baby bonus  
DVA disability pension<sup>a</sup>  
Dependent invalid and carer tax offset  
Superannuation tax offset  
Temporary budget repair levy

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<sup>a</sup> Eligibility rules not modelled, rather inflation adjusted values from the survey database are reported.

Source: CAPITA documentation.

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**Table 5 The specification of utility**  
The utility function's variables and parameters

<i>Variable</i>	<i>Parameter</i>
<i>Quadratic parameters</i>	
Labour supply × income × 10 000	-0.617
Labour supply squared × 100	-0.243
Income squared × 100 000	-0.179
<i>Parameters for income coefficient<sup>a</sup></i>	
Constant	0.006
Child aged 0 to 2	0.004
Child aged 3 to 4	0.001
Child aged 5 to 9	0.001
Number of children × 10	-0.003
Age × 10	0.003
Age squared × 1 000	-0.003
Vocational education	0.001
Degree	-0.005
Female	-0.006
<i>Parameters for labour supply coefficient<sup>a</sup></i>	
Constant	0.100
Child aged 0 to 2	-0.088
Child aged 3 to 4	-0.044
Child aged 5 to 9	-0.019
Number of children × 10	0.050
Age × 10	0.024
Age squared × 1 000	-0.067
Vocational education	-0.004
Degree	0.058
Female	-0.021
<i>Fixed cost parameters<sup>a</sup></i>	
Constant	-4.880
Female	1.860

<sup>a</sup> Parameters in these groups indirectly impact utility by influencing the sensitivity of utility to labour supply and income for each individual; and by influencing the fixed cost associated with working

*Source:* Based on parameter estimates used in modelling for the Childcare and Early Childhood Learning study (PC 2014).