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## Melbourne Institute Report

*No. 9*

Disaggregation of CGE Results into Household  
Level Results through Micro-Macro Linkage:  
Analysing Climate Change Mitigation Policies  
from 2005 to 2030

*Hielke Buddelmeyer, Nicolas Hérault, Guyonne Kalb  
and Mark van Zijl de Jong*

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Published by  
Melbourne Institute of Applied Economic and Social Research  
The University of Melbourne

## **Acknowledgements**

This report uses CGE Modelling from the Garnaut Climate Change Review as inputs into the Melbourne Institute Tax and Transfer Simulator (MITTS) to disaggregate economy wide macro level results into results at the household and individual level. However, this work is not part of the Garnaut Report and is not endorsed by the Garnaut Review. All responsibility for the specification and outcomes of this work lies with the authors and all questions regarding this should be directed to them. However, we would like to thank Ana Markulev, Helen Morrow, Jonathan Chew, Philip Adams, Matthew Clark, Naomi Lewis, Jyothi Gali and Nicholas Stoney for their comments, suggestions and help in using the CGE output.

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ISSN 1832-6250 (Print)

ISSN 1832-6269 (Online)

ISBN 978-0-7340-3294-2

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## **Abstract**

This report details a specific methodological approach to micro-macro linkage allowing disaggregation of economy-wide results into household and individual level results. It provides an overview of the relevant assumptions and limitations. As an illustrative example, the approach is applied to the macro-economic outcomes of two alternative climate change mitigation policy scenarios which are compared to the outcomes in the reference case. The report uses the results from a computable general equilibrium (CGE) model reporting the economy-wide outcomes in the absence of effective mitigation action as well as the economy-wide impacts of two climate change mitigation policies from 2005 to 2030.

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# 1. Introduction

This report outlines an approach to disaggregate the results of a dynamic economy-wide computable general equilibrium (CGE) into results at the household and individual level. Specifically, it uses CGE results predicting the economic effects arising from climate change policies. These CGE results were produced for the Garnaut Review and are used as exogenous inputs in our research. The CGE results used as inputs are reported and discussed only where appropriate in aiding the interpretation of the disaggregated results. See Garnaut (2008) and the accompanying technical papers for a discussion of the CGE modelling used by the Garnaut Review.

This report presents an overview of the relevant assumptions and choices made in the process and presents a number of predicted economic outcomes for the reference case scenario from 2005 to 2030. Following the CGE modelling, it is assumed that climate change itself will not have a direct economic impact before 2030. Therefore, the reference case up to 2030 is a projection starting from the current situation without taking into account the possibility of any climate change effects. The economic outcomes for two alternative mitigation policy scenarios are compared to the outcomes in the reference case. The only difference between the two mitigation scenarios and the reference scenario is the introduction of a mitigation policy. The economic cost of each mitigation policy is determined by the relative reduction in emissions it aims to achieve.

The main objective of this report is to detail a specific approach of disaggregating the output from MMRF-Green (see Commonwealth of Australia, 2008) into impacts at the household and individual level for the period from 2005 to 2030. The specific results obtained are a useful addition to the debate. However, the main focus of the report is on methodological issues. A number of assumptions used in this report were imposed by the specific CGE results we use (and in theory, these could be changed to be made more suitable for the distributional analysis). Nevertheless, this analysis can be seen as a test to examine whether further work is viable, possibly based on alternative assumptions. Despite the limitations necessarily imposed by the assumptions, the results are highly suggestive that further work is warranted and is likely to be productive. This work could be based on alternative CGE analyses designed to capture the effects of greenhouse mitigation policy changes (and associated compensation arrangements) on the income and welfare of individual households in an improved way.

MMRF-Green is the CGE framework (see Adams *et al.* 2002, 2007) used for the economy-wide modelling to assess the economic impacts of climate change in the absence of effective mitigation action (the baseline run or reference case) as well as the economic impacts, in terms of costs and benefits, of a range of alternative climate change mitigation policies (the policy runs). In the period up to 2030, climate change itself is assumed to have little economic impact. Therefore, the difference between the reference case and the two scenarios is

primarily due to the cost of the proposed mitigation policies. The assumption is that the benefits from the mitigation policies in reducing adverse climate change effects will only become noticeable after 2030. The two scenarios are as follows (Garnaut, 2008):

- Scenario 1 involves reducing emissions for Australia to a level of 80 per cent below 2000 levels by 2050 as part of a coordinated global effort to stabilise carbon dioxide equivalent concentrations at 550 ppm by 2100 (the 550 ppm stabilisation scenario); and
- Scenario 2 involves a reduction to 90 per cent below 2000 levels by 2050 as part of a coordinated global effort to stabilise carbon dioxide equivalent concentrations at 450 ppm by 2100 (the 450 ppm stabilisation scenario).

Both mitigation policies introduce an Emissions Trading Scheme on 1 July 2013, which results in all scenarios being identical prior to this date.

The distributional modelling uses the Melbourne Institute Tax and Transfer Simulator (MITTS) and focuses on the impact of these two climate change mitigation policy scenarios on real disposable household income and inequality; the share of expenditure on basic necessities (including food), fuel, energy and water and on an energy bundle separately as part of total expenditure; and on labour supply in hours worked. The main interest is in the distribution of these economic impacts. The overall basic assumption is that the CGE results direct the overall effects to be imposed on the microsimulation model, which disaggregates the overall effects to individual effects. This implies that all underlying assumptions from the MMRF-Green model are very important and relevant to this analysis as well.

The structure of the report is as follows. A detailed survey of all CGE output that is transferable to the microsimulation model is given in Section 2. Central to this project are the variables used in making the link between the CGE model MMRF-Green and the microsimulation model MITTS. A full list of these variables ensures all required information is exchanged between the two models. Section 3 discusses and describes the role of these variables and the methodological approach followed in the actual linking of the two models. Section 4 briefly describes MITTS, including some comparisons of aggregate income and consumption to highlight any differences in the starting point of the CGE model and the microsimulation model. Section 5 presents the results for the reference case and the two policy scenarios. All monetary values of the results in this report are expressed in 2005/2006 (base year) dollars. The report concludes with a brief discussion in Section 6.

## **2. Survey of the MMRF-Green Output Relevant to MITTS**

Central to this analysis are the variables to be used in making the link between the CGE model MMRF-Green and the microsimulation model MITTS. All variables from the CGE model affecting the structure of the Australian population, household incomes or expenditures

are relevant. This section discusses the MMRF-Green output relevant to MITTS and the exogenous assumptions on the evolution of the population. Appendix A summarises this information (Table A.1).

## **2.1 Population and labour force**

The Australian population is not explicitly modelled in MMRF-Green. Instead, changes in the population as predicted by Treasury (Commonwealth of Australia, 2008; Commonwealth Treasury, 2008) based on ABS data (2005, series B) are used to derive changes in the labour force, which in turn determine changes in labour supply. Treasury predicts the Australian population by age and gender up to 2050 starting from ABS (2005, series B) projections for the Australian population by age, gender and region up to 2050. However, the Treasury projections diverge from the ABS projections over time. Treasury's projections form the base of the underlying population projections in MMRF-Green. ABS projections are only used in order to derive regional populations using the projected ABS proportions by region together with the Treasury projections, since the latter are only available at the federal level.

The population projections in the MMRF reference case are Australian Treasury projections based on the framework used to develop the Intergenerational Report (IGR) coupled with ABS migration and State population projections (Commonwealth Treasury, 2008). In the two policy scenarios considered, interstate migration is approximated by allowing the supply of labour by state to vary to equate the percentage change in nominal wages across States. State populations are the same across the reference case and the two scenarios, but of course vary over time.

MMRF-Green also estimates changes in employment levels by industry and region in a general equilibrium framework. The assumption in the CGE modelling is that employment levels by industry and region are determined by the model (that is, they are endogenous to the model) and the long-run rate of unemployment is assumed to be fixed.

Changes in population by age and gender are provided by Treasury. ABS (2005, series B) provides the breakdown by region. The percentage changes in employment by industry and region are provided by MMRF-Green for each policy run and baseline run, and for the five points in time.<sup>1</sup> The industry classification is more aggregated in MITTS than in MMRF-Green. Therefore, the changes in employment by industry provided by MMRF-Green are combined into 13 industry groups which are identifiable in MITTS, as shown in Table 2.1. The mapping of MMRF-Green industries into MITTS industries is presented in Table B.1 in Appendix B. In addition, MMRF-Green provides the number of unemployed persons by region.

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<sup>1</sup> Although occupation would be potentially more interesting due to its link to workers' skill levels, the fact that changes in the labour force's skill level are ignored in MMRF-Green means that if there is an increase in wage for one occupation, the same wage increase applies to all occupations. Therefore, no relevant information can be communicated by MMRF-Green regarding changes in the occupational or skill dimension of the workforce.

The base data in the microsimulation is the 2003/2004 Survey of Income and Housing Cost (SIHC), which has been updated to 2005/2006 within MITTS (using the CPI to inflate incomes and male and female wage indices to adjust wage rates). Population projections, interstate migrations, employment by industry and region and unemployment by region are used to reweight the base data from year to year, up to 2030.

**Table 2.1 MITTS industry groups**

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1	Agriculture, Forestry and Fishing
2	Mining
3	Manufacturing
4	Electricity, Gas and Water Supply
5	Construction
6	Wholesale Trade & Retail Trade
7	Accommodation, Cafes and Restaurants
8	Transport and Storage
9	Communication Services
10	Finance and Insurance
11	Property and Business Services
12	Government Administration and Defence & Education & Health and Community Services
13	Cultural and Recreational Services & Personal and Other Services

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## **2.2 Labour income**

In the base year of 2005/2006, MMRF accounts for wage differences by industry and region. In policy runs, the wage rates for different industries are presumed to move proportionally, that is, the pre-existing wage differential between industries is held constant. However, regional wage differentials are assumed to be flexible. As a result, MMRF-Green generates changes in average wages by region but not by industry (nor occupation). As mentioned before, this has the disadvantage that there is no opportunity for skill levels to affect wage growth in MMRF Green, and therefore current wage differentials between low- and high-skilled individuals are held constant in relative terms. Therefore, the information transferred to MITTS cannot account for changing wage differentials by skill level, which would otherwise have been likely to contribute to changes in income inequality.

## **2.3 Non-labour income**

Information about non-labour income is available at the aggregate level in MMRF-Green. It is only available at the regional level and the various non labour income components are aggregated into two broad components:

1. non-labour factor income (mainly capital income);
2. personal benefit payments from the government with four subcategories: unemployment, disability, age and other.

Following MMRF assumptions, all personal-benefit payments are indexed to the Consumer Price Index (CPI) in order to be held constant in real terms.

## **2.4 Consumption prices**

MMRF-Green distinguishes 63 different commodities.<sup>2</sup> The national CPI is the numéraire; hence it is fixed. However, the relative prices of the 63 commodities are endogenous and can change over time. Moreover, these changes can differ from one region to another and from one policy run to another.

## **2.5 Consumption**

In MMRF-Green, each of the eight representative households (one for each region) has its own consumption function. As a result, changes in consumption patterns are region-specific. That is, following changes in relative prices (and incomes) the adjustments in the 63 budget shares are determined at the regional level.

## **2.6 Income taxes**

In MMRF-Green, the same income tax rate is applied to all representative households. In the base year, the income tax rate is equal to the average national income tax rate. This income tax rate is held constant over time and across the scenarios. It is also considered to be exogenous.

# **3. Linking MITTS to MMRF-Green: Methodology**

The changes in the MMRF variables, as mentioned in Section 2, occur over time and are likely to differ across policy runs. Households derive most of their income from labour market activities, so any changes affecting wages or employment are particularly important. The impact of mitigation policies on household expenditures are driven by changes in commodity prices and consumption patterns. In addition to transferring this information for each point in time considered (that is, years 2010, 2015, 2020, 2025 and 2030) and for each policy run, MITTS needs to replicate the assumptions made by MMRF-Green about the evolution of the population and the labour force.

## **3.1 Population and employment changes: the reweighting approach**

MITTS needs to be benchmarked based on the information from MMRF-Green so that the initial population and labour force in the starting year in MITTS are consistent with MMRF-Green. The 2003/2004 Survey of Income and Housing Cost collected by the Australian Bureau of Statistics (2007) forms the base file used in this MITTS analysis. In addition to reweighting this data for the base year, the base file used in MITTS needs to be reweighted separately for every year for which a simulation is run, benchmarking the MITTS input data

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<sup>2</sup> See Appendix C for an overview of the commodities and the mapping into the commodities distinguished in the Household Expenditure Survey (HES).

against MMRF-Green output to reproduce the required employment and population changes over time. A reweighting approach is used to map the base levels and changes as predicted by MMRF-Green to the MITTS environment. This approach relies on adjusting the household weights in the SIHC so that changes in the relative and absolute size of various subgroups of the population are accounted for.

Consistency between MITTS and MMRF-Green is ensured in two reweighting steps as explained below. The structure of the population by age, gender and region provided by Treasury+ABS projections is altered by the interstate migration as predicted by MMRF-Green. This results in differing regional composition of the population by age and gender. Hence, MITTS cannot be benchmarked to both projections.<sup>3</sup> Ideally, MITTS should be benchmarked to MMRF-Green but the information available from MMRF-Green is too aggregated to provide MITTS with a sufficiently detailed description of the Australian population. Instead, the approach used first ensures consistency with Treasury+ABS population projections and then in a second reweighting step ensures consistency with MMRF-Green's employment and unemployment projections and updated interstate migration estimates.

In the first step, the underlying MMRF-Green population projections are imposed on MITTS using Treasury population projections, supplemented by the ABS regional decomposition (2005, series B). This is achieved by reweighting our basic sample from 2003/2004 to reflect updated benchmarks in terms of age and gender by region as predicted by Treasury+ABS.

Following the approach by Deville and Särndal (1992), Cai *et al.* (2006) also reweighted a base file in MITTS, and the same approach is used here. In order to calculate the new weights, benchmarks from the Treasury and ABS are used; these include the population size and composition by age, gender and region. The reweighting approach aims to achieve specified population totals for selected variables, subject to the constraint that the adjustments to the original weights are as small as possible. Technical details are provided in Appendix D.

In the second step, the reweighting needs to take into account changes in employment levels by industry and region, unemployment levels by region, and interstate migrations as estimated by MMRF-Green. Employment levels in MITTS are benchmarked against employment levels by industry and region in MMRF-Green using the same reweighting procedure as in the first step. As explained in Section 2.1, MMRF-Green industries are grouped such that they can be mapped to the 13 industries distinguished in MITTS (see Table 2.1). The reweighting process is based on a number of constraints (representing the various benchmarks with regard to employment, unemployment and State populations) which ensure that MITTS reproduces the

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<sup>3</sup> In addition, it should be noted that even if MMRF-Green was fully consistent with Treasury+ABS projections, two steps might still be required since there are limitations on the number of constraints that can be used in calibrating the new weights.

changes predicted by MMRF-Green in terms of interstate migrations, and employment and unemployment levels by region.

However, imposing all these constraints while not controlling for continued consistency with the Treasury projections could result in substantial discrepancies. For example, reweighting with regard to unemployment levels could affect the structure of the total population by age and gender since the unemployed are likely to have different characteristics compared to the rest of the population. To avoid such discrepancies, benchmarks for age and gender composition at the national level are also imposed at the second stage of the reweighting. Although these constraints ensure that MITTS remains consistent with the Treasury population projections by age and gender at the national level, in practice, discrepancies can still occur at the regional level. Hence, there may be inconsistencies with Treasury+ABS projections regarding the structure of the population by age and gender in each region. This is the case essentially because Treasury+ABS projections are altered by MMRF-Green, but MMRF-Green does not provide information about the new age and gender structure of regional populations. The two-step reweighting approach ensures that MITTS is consistent with MMRF-Green and that the deviations between MITTS and Treasury+ABS projections are minimal.

### **3.2 Labour and non-labour incomes**

The information on income in MITTS is very detailed. This information on all income components is available either at the household or individual level. In MITTS, labour income is determined at the individual level whereas MMRF-Green only estimates average changes in wages by region. The average changes estimated by MMRF-Green affect gross wages and these are used to update gross hourly wage rates in MITTS. The use of updated gross wages and other non-labour income, combined with observed labour supply for each individual, enables the calculation of income tax and social security payments using the tax and social security system of January 2006 (this is in the middle of the base year used in MMRF Green).

For non-labour factor income, MMRF-Green only generates average changes by region as well. In MITTS, the average change corresponding to their region of residence is applied to each household. The four components of non-labour income, that is income from own unincorporated business, total income from investments, income from child support or maintenance, and other regular payments, are increased (or decreased) by the same percentage, as estimated by MMRF-Green.

Personal benefit payments from the government are fixed in real terms in MMRF-Green. Hence, this same assumption is made in MITTS.<sup>4</sup> However, changes in personal benefit

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<sup>4</sup> This is different to the current practice where allowances such as NewStart or Sickness Allowance are indexed using the CPI, but pensions, such as the Disability Support Pension, and Parenting Payment Single are indexed using wage indices (which usually increase by more than the CPI).

payment levels can still occur at the individual level because eligibility to all personal benefit payments is determined endogenously by MITTS taking into account gross incomes. MITTS only uses gross income (both labour and non-labour income) from households as an exogenous input, from which it calculates income tax paid and income support received according to a set of taxation and social security rules. These rules are programmed in MITTS and can be changed to accommodate policy changes. The rules usually vary by household composition (also exogenous to the model). Using gross income combined with the computed amounts of income tax and income support payments, net income can be calculated.

Only income changes in real terms are used so that other eligibility criteria do not have to be updated to account for inflation. However, income tax thresholds are indexed to real wages in order to hold the national average tax rate constant, in accordance with MMRF-Green assumptions.<sup>5</sup>

Tax and transfer microsimulation models are particularly strong on the calculation of net (or disposable) income starting from individuals’ gross incomes. As a result, establishing the link with the MMRF-Green model then allows for the calculation of individuals’ gross incomes — based on their wage, labour supply and other non-labour income—, total income tax and social security payments. Therefore, it is possible to calculate households’ disposable incomes under each of the policy runs. Real incomes adjusted for household-specific consumption patterns are computed for each scenario and the reference case, using price and consumption changes from MMRF-Green and the information from HES. Net incomes are expressed in 2005/2006 or base year prices. Table 3.1 describes the approach used in calculating household-specific CPIs. The cumulative price changes combined with the previous period’s budget shares are used. This approach accounts for changes in consumption patterns over time.<sup>6</sup>

**Table 3.1 Computation of household real income for one particular household**

	2005 (base)	2010	2015	2020	2025	2030
Nominal household income	y0	y1	y2	y3	y4	y5
Cumulative price changes (63x1 vector)		P1	P2	P3	P4	P5
Budget shares (63x1 vector)	B0	B1	B2	B3	B4	B5
Real household income	y0	$\frac{y1}{B0 \cdot P1}$	$\frac{y2}{B1 \cdot P2}$	$\frac{y3}{B2 \cdot P3}$	$\frac{y4}{B3 \cdot P4}$	$\frac{y5}{B4 \cdot P5}$

<sup>5</sup> Fixed income tax thresholds would lead to a substantial increase in the average income tax rate since real wages increase over time.

<sup>6</sup> Using only the budget shares of the base year is clearly unrealistic because it ignores changes in consumption patterns over time as predicted by MMRF. Using the current budget shares is not more appropriate because it would imply a ‘double counting’ of the price effects (via their effects on consumption patterns, on top of the price effects). Alternatively, average budget shares from all previous points in time could be used. The use of the budget shares from the previous point in time is preferred because it indicates who would have been most affected by a change before behaviour was adjusted.

The impact on real disposable income per adult equivalent and inequality (Gini coefficient<sup>7</sup>) for each of the policy scenarios over time is considered by income quintile, household type and region. Income quintiles are determined at the income unit level where each of the five quintiles contains 20 per cent of all income units, but possibly more or less than 20 per cent of the population, depending on the average income unit size in each quintile. Income quintiles are based on the ranking of income units according to real disposable income per adult equivalent. Equivalising of incomes is achieved using the Whiteford equivalence scale reported by Binh and Whiteford (1990).<sup>8</sup> New income quintiles are computed for each year of the analysis since it cannot be assumed that income units belonging to a particular quintile will still belong to the same quintile five years later. In addition, income quintiles differ across scenarios because changes in incomes and employment are different across scenarios.

### **3.3 Price and consumption changes**

Price changes by commodity from MMRF-Green are used to compute household-specific CPIs. As already mentioned in the previous subsection, the latter are utilised to deflate household nominal incomes so that household real incomes are computed while accounting for the specific consumption pattern of each household. This is an important aspect of the approach because price changes will affect households differently depending on their consumption pattern.

The consumption patterns (on which household-specific CPIs are based) also change over time and across policy scenarios. Households' behavioural responses in consumption are driven by changes in relative prices as well as changes in disposable income. These consumption changes are determined by MMRF-Green at the regional level and used as input into MITTS. While households in MITTS still have different consumption patterns (derived from consumption as observed in 2003/2004), changes in consumption from year to year only differ by region as predicted by MMRF-Green. In addition, aggregate consumption patterns are also affected by the changes in the structure of the Australian population over time as households may have different consumption patterns depending on, for example, which age group they belong to. Therefore, if the age composition of the population changes, then aggregate consumption will change as a result as well.

#### **3.3.1 Price changes**

Although MITTS has no consumption component, information on consumption is available using the combined Household Expenditure Survey (HES)/SIHC. For a subsample of the

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<sup>7</sup> The Gini coefficient is a measure of income inequality, where a value of 0 represents full equality (that is, everyone has exactly the same income) and a value of 1 represents the maximum possible inequality (that is, one person has all income while everyone else has no income). A decrease in the Gini coefficient thus indicates an increase in equality.

<sup>8</sup> The weight of the first adult in each income unit is 1. The weight of each additional adult member is 0.56, and each child (under 18) is given a weight of 0.32.

SIHC, information on expenditure is collected as part of the usual HES. Using the HES expenditure information, the price effects on categories of consumption goods are translated into household price effects. For each household, separate price effects (or CPI) related to the households' specific consumption patterns are calculated. This approach generates detailed information on how different households are affected by price changes and how this affects their real disposable income.

The price changes estimated by MMRF-Green are also used to compute household-specific consumer price indices. This approach appears the most logical for comparing the cost of living at an individual level over time. Household incomes are deflated by these household-specific CPIs to compute changes in real household incomes, taking 2005/2006 as the starting point.

The commodities listed in the HES are mapped to the 63 commodities included in MMRF-Green (the concordance table to translate the HES categories into the 63 MMRF categories is provided in Appendix C).

### **3.3.2 Consumption changes**

Given that MITTS does not model consumption, the changes in consumption patterns as predicted by MMRF-Green are required as input, and this basically captures all behavioural responses with regard to consumption. In MITTS, the initial budget shares of the 63 commodities are based on household-specific information. In MMRF-Green, changes in consumption patterns are only available at the regional level and therefore the same budget share changes (in percentage points) are applied to all households' budget shares within the same region. However, this approach leads to negative budget shares for some households. This occurs if MMRF predicts a percentage point decrease in a particular budget share that is larger than the observed starting budget share for some households. Assuming that households who have zero expenditure on a specific group of commodities cannot reduce their expenditure on this group of commodities, all negative budget shares are replaced by zero. To correct for the fact that the budget shares now no longer sum up to 100 per cent, all budget shares are evenly scaled down if they add up to more than 100 per cent.

This approach allows MITTS to be consistent with the average changes in consumption patterns by region as predicted by MMRF-Green while retaining the household differences due to the different starting point in consumption of each household. If there were a consumption component in MITTS, the model could determine changes in consumption patterns at the household level, depending on changes in disposable income and relative prices. That is, the changes in budget shares would be different for each household, whereas we choose to apply the same changes to a large group of households (that is, everyone

residing in the same State).<sup>9</sup> However, since the initial budget shares of each household are allowed to be different and are obtained from the HES, there remains a large degree of heterogeneity in consumption and consumption changes.

The use of changes in consumption patterns from MMRF-Green allows for the assessment of percentage change in the share of expenditure on basic necessities as part of total expenditure for each of the policy runs over time by area, household type and income. In addition, the share of an energy bundle (petrol, electricity and gas) as part of total expenditure is also considered. For each subgroup, we consider the average share of basic necessities and the average share of expenditure on the energy bundle. The definitions of basic necessities and the energy bundle are restricted to groupings of MMRF-Green commodities since price changes and consumption level changes are only available by this type of commodity. In general terms, basic necessities consist of shelter, food, clothing and transport plus the expenditures on the energy bundle. See Appendix Table C.2 for details on basic necessities and the energy bundle.

### **3.4 Tax and social security system**

Consistency needs to be ensured between the tax and social security system assumed in MMRF-Green and in MITTS. Since MMRF-Green is based on the 2005/2006 financial year, the tax and social security system of January 2006 is used in MITTS. Given that there is no change in the tax and social security system in MMRF-Green, the same assumption is made in MITTS. The only exception is the indexation of income tax thresholds to real wages.

### **3.5 Summary overview of assumptions and limitations**

It is important to remember that since the distributional analysis uses the MMRF-Green data as input, any assumption or limitation within MMR-Green equally applies to the distributional analysis. A second point to emphasise is that although the distributional analysis is based on unit record data for individual households, and is therefore very flexible, this flexibility is not fully utilised in all the analyses. For example, changes in wages are available only at a highly aggregated level in MMRF-Green (changes in wages only differ by region). As a result, although the full heterogeneity of the Australian population is accounted for, the same changes over time predicted by MMRF-Green are applied to large groups of households. So for wages, all households within the same region have the same percentage wage increase. The use of microsimulation may create an illusion of more data variation than there is in reality, due to the dependence on MMRF-Green results for changes over time.

Third, the MMRF-Green model does not distinguish between skilled and unskilled workers, which is a limitation with regard to wage and employment developments. Similarly there is

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<sup>9</sup> Note that the use of a microsimulation model with a consumption component would require additional consistency checks with the CGE model regarding consumption changes (unless additional constraints are applied to the microsimulation model).

no distinction in consumption responses to price changes between low and high income households. This is in particular relevant for the energy price changes which are expected to be very high. Fourth, the assumption that all benefit payments are indexed to the CPI leads by construction to the outcome that all benefit recipients experience zero real income growth. As a result, since wage earners are predicted to experience income growth by the higher wage index, predicted inequality in Australia increases by design. If benefit payments were indexed to the wage index, the increase in inequality would have been lower. Nevertheless, inequality would probably still have increased to some extent due to an increase in factor income which is more likely to be received by households in the higher income quintiles. Finally, several assumptions are needed since the real world from 2009 onwards is basically unknown and becomes more uncertain in the more distant future. For example, we assume an unchanged relationship between education level (or other characteristics, except the State of residence) and wage rates. This relationship, observed in the 2003/2004 data, is used to increase all wages in one State by the same percentage from year to year as predicted by MMRF-Green. Similarly, if the size of an industry increases then we assume that the new workers' characteristics have the same distribution as those of the workers that were already in the industry.

Appendix F gives an overview of all assumptions and some of the important limitations discussed in this report in bullet point format.

## **4. The Melbourne Institute Tax and Transfer Simulator**

### ***4.1 A brief description of the MITTS model***

MITTS is a behavioural microsimulation model, but for this analysis only the non-behavioural component is used.<sup>10</sup> Therefore, this description of MITTS focuses on the non-behavioural component. The reason for not using the behavioural component is that we use the labour supply response as predicted by MMRF-Green to ensure the two models are consistent with each other (since micro and macro predictions are not automatically the same). In principle, it is possible in a more complex approach to use the behavioural component of MITTS and calibrate the responses to correspond to the MMRF aggregate responses. However, given the time frame of this analysis and the novelty of this approach using MITTS, the simpler approach of adopting all of MMRF-Green's predicted changes in a non-behavioural microsimulation through a reweighting of the base data observations and adjustment of real wages was preferred.

A non-behavioural microsimulation model is sometimes also called an accounting or arithmetic microsimulation model, or a static model. This component imputes net household incomes for a representative sample of households, for both incumbent and counterfactual

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<sup>10</sup> The majority of large-scale tax simulation models are non-behavioural or arithmetic. That is, no allowance is made for the possible effects of tax changes on individuals' consumption plans or labour supplies.

tax-benefit regimes. A major advantage of microsimulation modelling is that such modelling retains the full extent of the heterogeneity contained in the survey data used.

This section first describes the arithmetic microsimulation model in subsection 4.1.1, followed by a discussion of the data required to build this type of model in subsection 4.1.2. This is followed in subsection 4.1.3 with discussion of an important component of any tax policy microsimulation model, the tax and transfer system. Section 4.1.4 describes the assumptions regarding eligibility and take up of social security payments by households.

#### **4.1.1 The Arithmetic Model**

When examining the effects of policy changes, these models generally rely on tabulations and associated graphs, for demographic groups, of the amounts of tax paid (and changes in tax) at various percentile income levels. The more sophisticated models have extensive ‘back end’ facilities allowing computation of a range of distributional analyses (such as the Gini coefficient) and tax progressivity measures, along with social welfare function evaluations in terms of incomes. Arithmetic models are typically used to generate profiles, again for various household types, of net income at a range of gross income levels. These profiles are useful for highlighting certain discontinuities, and are helpful when trying to redesign tax and transfer systems in order to overcome or prevent discontinuities and excessively high marginal tax rates over some income ranges.

Since the first version was completed in 2000, and described in detail in Creedy *et al.* (2002), it has undergone a range of substantial developments and data updates. In the present version of MITTS, SIHC data from 1994/1995, 1995/1996, 1996/1997, 1997/1998, 1999/2000, 2000/2001, 2002/2003 and 2003/2004 can be used. Results are aggregated to population levels using the household weights provided with the SIHC.

In MITTS, the arithmetic tax and benefit modelling component is called MITTS-A. The tax system component of MITTS contains the procedures for applying each type of tax and benefit. Each tax structure has a data file containing the required tax and benefit rates, benefit levels and income thresholds used in means testing. In view of some data limitations of the SIHC, it is not possible to include within MITTS all the complexity of the tax and transfer system. However, all major social security payments and income taxes are included in MITTS.<sup>11</sup> Pre-reform net incomes at the alternative hours levels are based on the MITTS calculation of entitlements, not the actual receipt. Hence in the calculation of net income it is assumed either that take-up rates are 100 per cent, or a simple rule is used whereby a benefit is not claimed if it is less than a specified amount.

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<sup>11</sup> For details of the different payments, see Payment Guides published by the Commonwealth Department of Family and Community Services (of several years), DVA Facts and the annual report published by the Department of Veterans’ Affairs (of several years).

Changes to the tax and benefit structure, including the introduction of additional taxes, can be modelled by editing the programmes in this component. MITTS stores several previous Australian tax and transfer systems, which can be used as base systems for the analysis of policy changes. In this report it is assumed that benefit rates and benefit threshold incomes remain the same in real terms. However, alternative systems are still required in this analysis to account for the indexation of income tax thresholds to real wages.

The various components of the tax and benefit structure are assembled in the required way in order to work out the transformation between hours worked and net income for each individual under each tax system. For example, some benefits are taxable while others are not, so the order in which taxes and transfers are calculated is important.

#### **4.1.2 The Data**

The distinguishing feature of microsimulation models is the use of a large cross-sectional dataset giving information about the characteristics of individuals and households, including their labour supply, earnings and (possibly) expenditure. Microsimulation models are therefore able to replicate closely the considerable degree of heterogeneity observed in the population. The two large-scale household surveys that are potentially useful are the Household Expenditure Survey (HES) and the Survey of Income and Housing Costs (SIHC). The former does not contain sufficient information about hours worked by individuals while the latter does not contain information about expenditure patterns. The SIHC is a representative sample of the Australian population, containing detailed information on labour supply and income from different sources, in addition to a variety of background characteristics of individuals and households. The measurement of income in the HES is known to be unreliable, so that in developing models for the analysis of direct taxes and transfer payments, it is not surprising that reliance has been placed on the SIHC.<sup>12</sup> This means that it is not straightforward to include indirect tax in Australian direct tax models. The extension of models to cover consumption taxes would require some elaborate data merging.

When analysing actual or proposed policy changes, it is preferred to use data which are as close to the relevant time period as possible to avoid having a starting point that is too different from reality. When this is not possible, MITTS updates all financial information to the relevant year; that is, for example, in our analysis the amounts of income in 2003/2004 are increased to reflect January 2006 amounts or January 2010, 2015 etc. amounts. To update non-labour incomes, the Consumer Price Index is used. To update wage rates, the average

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<sup>12</sup> The survey of 2003/2004, which we use in the analysis, is uncommon in that it actually combines these two data sets, and these data would in fact be ideal to develop a consumption model together with a labour supply model. However, this combination of the two surveys will not be a regular feature; the next combined data collection is planned for 2009/2010 (ABS, 2007).

male and female wage indices are used for 2005, while MMRF-Green regional wage indices are used in subsequent years. Wage indices usually increase at a faster rate than the CPI.

### **4.1.3 The Tax and Transfer System**

Detailed knowledge of the tax and social security system is required to build a microsimulation model. This sometimes involves several government departments and the full details are rarely codified in accessible forms. Actual tax and transfer systems are typically extremely complex and contain a large number of taxes and benefits which, being designed and administered by different government departments, are usually difficult to integrate fully. The complexity increases where several means-tested benefits are available, because of the existence of numerous eligibility requirements. It is only when a great deal of detailed information about individuals is available that it becomes possible to include the complexities of actual tax and transfer systems in a simulation model.

However, it is unlikely that household surveys contain sufficient information to replicate realistic tax systems fully. In some cases, for example where asset values are required in the administration of means tests, it may be necessary to impute values, which may not always be possible. Furthermore, regulations regarding the administration of taxes and transfers often leave room for some flexibility in interpretation. In particular, the administration of means tests or other benefits may allow a degree of discretion to be exercised by benefit officers who deal directly with claimants. Changes in the interpretation of (possibly ambiguous) rules, or the degree to which some rules are fully enforced, can take place over time. Furthermore, there may be changes in people's awareness of the benefits available, and the eligibility rules, thereby affecting the degree of take-up. Although even large-scale models may not be able to replicate actual systems entirely, they should come close.

### **4.1.4 Eligibility for Benefits**

The information in the SIHC is used to calculate eligibility for the different social security payments. Detailed information on the different sources of income is available, helping to determine this eligibility. However, not all requirements for eligibility can be checked with the available data. For example, information on assets is not available and the amount of assets may also influence eligibility. Fortunately, the group of households who would not be eligible based on their level of assets (which excludes the home), but would be deemed eligible based on their level of income, is relatively small. In particular, because the SIHC records income from investments (such as dividends or interest) and superannuation income, which are incorporated in the calculations, the absence of asset data is unlikely to be a major problem. Other requirements for eligibility, which cannot be checked, are whether someone has been a resident for at least two years and is actively looking for work. One of the requirements for this may be that the unemployment benefit recipient is not working more

than a certain number of hours. The number of hours of work may preclude individuals from unemployment-related benefit receipt, if this level of labour supply precludes effective job search. However, there seems no particular hours level available that could be seen as the cut-off point above which no one would receive benefit payments.

The version of MITTS used in this report does not allow for individuals who decide not to take-up the benefits for which they are eligible. Therefore, a 100 per cent take-up is assumed. This is likely to cause overestimation of government expenditure on some of the payments. It is argued that when interest is in the differences from the reference case, this approach is quite satisfactory. Both the amounts in the reference case and in the mitigation scenarios will be overestimated, and the predicted percentage differences are expected to be informative.

## **4.2 Consistency of aggregate amounts in MMRF-Green and MITTS**

In this section the consistency of a number of outputs from MMRF with the inputs and outputs from MITTS is checked. Section 4.2.1 provides a comparison of income components (labour, non-labour, benefits) as predicted and used in MMRF and MITTS respectively. Consumption components are compared in Section 4.2.2.

### **4.2.1 Household income**

First, it should be noted that full consistency cannot be expected given that MITTS and MMRF-Green draw on different sources of information. While MITTS is based on a household survey (the 2003/2004 SIHC), the base values in MMRF-Green are derived from various sources, including National Accounts and Supply and Use Tables.

The main components of household income in both models are presented in Table 4.1. A few remarks can be made. First, non-labour factor income is overestimated in MMRF-Green because it includes a large share of ‘enterprise income’ (which explains why taxes on enterprises are paid by households in MMRF-Green) as well as imputed rents. Hence, a substantial proportion of non-labour factor income appearing in MMRF-Green is actually not returned to households (or not returned in the year it is earned). This explains why total income and disposable income are much higher in MMRF-Green than in MITTS. Likewise, the estimate for total household consumption is much lower in MITTS than in MMRF-Green.<sup>13</sup> Since non-labour factor income is more likely to be present in high-income households than in low-income households, this implies that income in higher-income

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<sup>13</sup> It should be noted that total household consumption is reported in 2003-04 prices in MITTS. It would have to be increased by 5.4 per cent (based on the CPI in March 2004 compared to the CPI in March 2006) to account for inflation between 2003-04 and 2005-06. However, this would assume that household consumption was fixed in real terms during this period. To make MMRF and MITTS consumption figures fully comparable, it would be necessary to further inflate consumption in MITTS to account for the increase in real incomes between 2003-04 and 2005-06. In addition, changes in saving rates should be taken into account. However this is not central to the analysis carried out in this report, which focuses on consumption patterns and not on aggregate expenditures.

households is more likely to be underestimated as a result of this than income in low-income households.

Second, estimates for total labour income in MMRF-Green are higher than in MITTS because they include employer social contributions, which are not included in MITTS. In addition, labour (and non-labour) incomes are usually underestimated in household surveys. Third, estimates of total personal benefit payments and its various components are similar in MMRF-Green and MITTS; they are only somewhat lower in total in MITTS than in MMRF-Green. Finally, total income taxes paid by households are very similar in the two models.

**Table 4.1: Household income (in millions of dollars)**

<b>2005/2006</b>	<b>MMRF</b>	<b>MITTS</b>
Total household income	886,422	562,478
Labour	447,962	371,716
Non-labour factor income	361,125	121,770
Personal benefit payments	77,336	68,992
Unemployment benefits	5,665	5,758
Disability support pension	8,257	7,148
Age pension	21,407	22,477
Other personal benefit payments	42,007	33,609
Direct taxes on individuals	114,624	113,795
Direct taxes on enterprises	45,435	NA
Household disposable income	726,363	448,683
Household consumption (2003-04 prices)	543,152	381,155

#### **4.2.2 Consumption patterns**

Table 4.2 reports the levels of expenditure on 63 MMRF-Green commodities as estimated by MMRF and as reported by the ABS Household Expenditure Survey (HES). The aggregate HES expenditure is based on updates of the weights provided in the HES. That is, the actual weights provided in the HES are updated in accordance with the population reweighting procedure explained in detail in Appendix D. Our linking approach requires each of the 600+ household expenditure items of the HES to be mapped into one of the 63 MMRF-Green commodities. The last three commodities in the MMRF list are aggregate commodities that capture many of the expenditures one would expect households to make with regard to energy use, i.e. expenditures on petrol, diesel and LPG used for private transport, electrical equipment and heating. The classification of the 600+ HES expenditure items into the 63 MMRF-Green commodities is described in detail in table C.1 in Appendix C. This table also includes detail on the recoding of some of the original commodities, such as petrol and diesel, into the three aggregated private services commodities at the end of the list. Each HES expenditure, with the exception of a few expenditures listed as categories 96, 97, 98 and 100 at the bottom of Table C.1, is linked to an MMRF-Green commodity and none of the

expenditures is counted twice. Because the expenditure in levels does not necessarily correspond between MMRF-Green and HES, the budget shares are also reported in Table 4.2.

**Table 4.2: Household consumption patterns in the base year**

	MMRF-Green		MITTS	
	Level (in \$m)	Share (in %)	Level (in \$m)	Share (in %)
Sheep and cattle	78	0.01	0	0.00
Dairy	2	0.00	0	0.00
Other animals	520	0.10	0	0.00
Grains	1,196	0.22	0	0.00
Biofuel	0	0.00	0	0.00
Other agriculture	7,511	1.38	1,839	0.48
Agricultural services and fishing	1,284	0.24	191	0.05
Forestry and logging	22	0.00	0	0.00
Coal mining	17	0.00	0	0.00
Oil mining	0	0.00	0	0.00
Gas mining	0	0.00	0	0.00
Iron ore mining	0	0.00	0	0.00
Non-ferrous metal ores	181	0.03	0	0.00
Other mining	24	0.00	0	0.00
Meat products	9,247	1.70	8,569	2.25
Other food and drink products	65,240	12.01	54,939	14.41
Textiles, clothing and footwear	20,101	3.70	18,157	4.76
Wood products	46	0.01	578	0.15
Paper products	1,063	0.20	1,803	0.47
Printing and publishing	5,161	0.95	3,526	0.93
Gasoline	309	0.06	0	0.00
Diesel	96	0.02	0	0.00
LPG	11	0.00	0	0.00
AirFuel	0	0.00	0	0.00
Other petroleum products	661	0.12	384	0.10
Other chemicals	10,110	1.86	9,333	2.45
Rubber and plastic products	1,643	0.30	2,052	0.54
Non-metallic construction materials (not cement)	534	0.10	1,106	0.29
Cement	0	0.00	0	0.00
Iron and steel	50	0.01	0	0.00
Alumina	0	0.00	0	0.00
Aluminium	0	0.00	0	0.00
Other non-ferrous metals	0	0.00	0	0.00
Other metal products	874	0.16	213	0.06
Motor vehicle and parts	0	0.00	0	0.00
Other manufacturing products	14,810	2.73	24,602	6.45
Electricity - coal	0	0.00	0	0.00
Electricity - gas	0	0.00	0	0.00

**Table 4.2: Continued**

	MMRF-Green		MITTS	
	Level (in \$m)	Share (in %)	Level (in \$m)	Share (in %)
Electricity - oil products	0	0.00	0	0.00
Electricity - nuclear	0	0.00	0	0.00
Electricity - hydro	0	0.00	0	0.00
Electricity - non-hydro renewable	0	0.00	0	0.00
Electricity supply	0	0.00	0	0.00
Gas supply	0	0.00	0	0.00
Water supply	3,893	0.72	2,583	0.68
Construction services	0	0.00	0	0.00
Trade services	20,270	3.73	19,546	5.13
Accommodation and hotels	41,735	7.68	27,345	7.17
Road transport - passenger	637	0.12	1,329	0.35
Road transport - freight	3,761	0.69	0	0.00
Rail transport - passenger	540	0.10	852	0.22
Rail transport - freight	1,552	0.29	0	0.00
Other transport (includes water transport)	5,209	0.96	1,259	0.33
Air transport	7,983	1.47	4,474	1.17
Communication services	15,691	2.89	15,841	4.16
Financial services	25,346	4.67	27,146	7.12
Business services	2,583	0.48	7,367	1.93
Dwelling ownership	95,236	17.53	26,061	6.84
Public services	48,505	8.93	24,965	6.55
Other services	66,585	12.26	33,365	8.75
Private transport services	41,783	7.69	38,162	10.01
Private electrical equipment services	11,382	2.10	8,287	2.17
Private heating equipment services	9,671	1.78	15,281	4.01
<b>TOTAL</b>	<b>543,152</b>	<b>100</b>	<b>381,155</b>	<b>100</b>

Overall, the match between MMRF-Green and the recoded HES expenditures is relatively close, especially in terms of budget shares. At the aggregate level, a total expenditure in MMRF-Green of about \$543bn compares to a total of about \$381bn according to HES. The following compares the expenditures at a more disaggregate level.

In the HES, expenditure on agriculture-related items is lower than under MMRF-Green, but these expenditure items are only a very small portion of the budget in either data source. Three important items in the category of basic necessities are meat products; other food and drinks products; and textile, clothing and footwear. MMRF-Green and the HES show similar budget shares for these three commodities with relative budget shares of 1.7, 12.0 and 3.7 per cent under MMRF-Green and 2.3, 14.4 and 4.8 per cent under HES. Another important basic necessity is shelter, for which there is a relatively large discrepancy between MMRF-Green and the HES, due at least partly to imputed rents being included under MMRF-Green.

Especially relevant in the context of climate change mitigation policy is household expenditure on energy and water. In Table 4.2, expenditure related to water usage is identified separately. It shows that the budget share for this commodity under MMRF-Green and HES is approximately 0.7 per cent. Other energy items such as motor vehicle fuels, and electricity and gas for the home are re-allocated to three aggregate commodities: private transport services, private electrical equipment services, and private heating equipment services.<sup>14</sup> HES is fairly consistent with MMRF-Green regarding these three aggregate commodities, with budget shares of 7.7, 2.1, and 1.8 per cent for MMRF-Green and 10.0, 2.2, and 4.0 per cent for HES.

## **5. Microsimulation Results**

Before discussing the microsimulation results for our illustrative example over time and across the two scenarios in comparison to the reference case, the first subsection checks the transmission of changes from MMRF-Green to MITTS. Section 5.2 discusses the effects on income distribution. All income and other financial information are presented in 2005/2006 dollars. The effects of mitigation policies on the budget shares of basic necessities and the energy bundle are reported in Section 5.3. The final subsection presents the results on hours worked. The discussion in Sections 5.2 to 5.4 focuses on a number of graphs, with the corresponding tables presented in Appendix G.

### **5.1 Comparison of Aggregate Changes**

The effects of the changes over time (for example in the wage rate) are calculated separately for each individual in a sampled household. These individual effects are aggregated to the population level through use of the sample weights. Household size, structure and income level, as well as the age, gender and income level of individual household members are observed at the individual level in the sample. Therefore, it is possible to aggregate the individual results by any of these characteristics to obtain the effects for a number of subgroups in the population.

The aggregate results in terms of total household income, taxes and benefit payments, employment and budget shares are reported in Tables 5.1 to 5.3.<sup>15</sup> The changes to labour and non-labour incomes as predicted by MMRF-Green are transferred to MITTS. As a result, MITTS can reproduce the changes in gross income estimated by MMRF-Green with reasonable accuracy. There is a slightly higher growth according to MITTS compared to

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<sup>14</sup> The energy items gasoline, diesel, LPG, air fuel, all the electricity items and gas supply, reported in Table 4.2, are all zero in the HES (and therefore in the results from MITTS) since there are no expenditures relating to the LPG or diesel industries directly purchased by households. Similarly, no household expenditures are observed in the HES for the coal, oil and gas mining industries. That is, HES households buy petrol, but not petrol pumps.

<sup>15</sup> This section discusses the changes. See Section 4.2.1 for a comparison of MMRF-Green and MITTS base values.

MMRF-Green, and this difference accumulates over time. This may be due to the fact that MMRF-Green predicts an average wage growth by State only, which is then applied to all individuals in that State independent of their current wage level. However, at the same time the structure of employment changes as well (that is, employee numbers by industry). These changes are also transferred from MMRF-Green to MITTS through reweighting of households. It is likely that higher wage industries experience larger increases in employee numbers than lower wage industries. Given that the wage growth predicted by MMRF-Green includes both an increase in wage levels for different types of employees and this change in employment structure, MITTS is likely to double count some of the wage growth by applying the full wage growth and the new employment structure.<sup>16</sup>

**Table 5.1 Aggregate income results: Reference case**

	2005 (base)	2010	2015	2020	2025	2030
	\$m/year	Cumulative percentage changes				
Gross income	494,341	23.9	39.8	59.7	82.5	106.4
Benefit payments	65,936	1.0	8.6	16.9	25.5	34.1
Income taxes + Medicare levy - rebates	123,195	24.0	39.1	57.8	79.7	102.7
Net income	440,137	20.3	35.0	53.4	74.3	95.9
Gross income + benefits	560,277	21.2	36.1	54.7	75.8	97.9
<i>Gross income + benefits (MMRF)</i>	886,422	20.9	33.4	49.6	68.6	88.7
<i>Employment in 1000s (MMRF)</i>	10,058	12.4	20.0	25.9	31.2	36.4
<i>Basic necessities (MMRF)<sup>(a)</sup></i>	48.4	-1.4	-2.8	-4.6	-6.2	-7.7
<i>Energy bundle (MMRF)<sup>(a)</sup></i>	11.6	-0.1	-0.5	-1.2	-1.7	-2.2
		<b>Percentage</b>				
Average tax rate	24.9	24.9	24.8	24.6	24.5	24.5
Benefit payments/ Gross income	13.3	10.9	10.4	9.8	9.2	8.7

Note: (a) Aggregate budget shares at the national level (in per cent). Changes are expressed in percentage points.

**Table 5.2 Aggregate income results: 550ppm scenario**

	2005 (base)	2010	2015	2020	2025	2030
	\$m/year	Cumulative percentage changes				
Gross income	494,341	23.9	38.1	56.0	76.7	98.2
Benefit payments	65,936	1.0	10.2	18.5	27.4	36.2
Income taxes + Medicare levy - rebates	123,195	24.0	35.7	52.6	72.4	93.3
Net income	440,137	20.3	34.3	51.0	70.1	89.7
Gross income + benefits	560,277	21.2	34.8	51.6	70.9	90.9
<i>Gross income + benefits (MMRF)</i>	886,422	20.9	31.7	46.6	64.2	82.5
<i>Employment in 1000s (MMRF)</i>	10,058	12.4	19.1	25.4	30.7	35.8
<i>Basic necessities (MMRF)<sup>(a)</sup></i>	48.4	-1.4	-2.7	-4.6	-6.2	-7.8
<i>Energy bundle (MMRF)<sup>(a)</sup></i>	11.6	-0.1	-0.7	-1.4	-2.0	-2.5
		<b>Percentage</b>				
Average tax rate	24.9	24.9	24.5	24.4	24.3	24.3
Benefit payments/ Gross income	13.3	10.9	10.7	10.1	9.6	9.2

Note: (a) Aggregate budget shares at the national level (in per cent). Changes are expressed in percentage points.

<sup>16</sup> If wage growth were available by skill level this issue would be less relevant.

Income growth is expected to be particularly strong between 2005 and 2010, while it is expected to slow down between 2010 and 2015 in both scenarios and the reference case. Growth is expected to increase again after 2015. Results are the same across scenarios for 2010 so that differences are only observed from 2015 onwards. However, income projections remain very similar across scenarios up to 2030. Mitigation policies have a small dampening impact on aggregate income, with the largest effect being found under the 450ppm scenario. Under that scenario, total gross income is reduced by about five per cent by 2030 compared to the reference case level. Nevertheless, all scenarios lead to a substantial increase in aggregate gross income between 2005 and 2030, while the introduction of mitigation policies only slightly lowers this growth.

**Table 5.3 Aggregate results: 450ppm scenario**

	2005 (base)	2010	2015	2020	2025	2030
	\$m/year	Cumulative percentage changes				
Gross income	494,341	23.9	37.1	55.1	75.4	96.6
Benefit payments	65,936	1.0	11.0	18.9	28.0	36.6
Income taxes + Medicare levy - rebates	123,195	24.0	34.0	50.8	70.1	90.7
Net income	440,137	20.3	33.8	50.6	69.4	88.6
Gross income + benefits	560,277	21.2	34.0	50.9	69.9	89.5
<i>Gross income + benefits (MMRF)</i>	886,422	20.9	30.6	45.5	62.8	81.1
<i>Employment in 1000s (MMRF)</i>	10,058	12.4	18.8	25.4	30.7	35.9
<i>Basic necessities (MMRF)<sup>(a)</sup></i>	48.4	-1.4	-2.6	-4.6	-6.2	-7.9
<i>Energy bundle (MMRF)<sup>(a)</sup></i>	11.6	-0.1	-0.7	-1.5	-2.1	-2.6
		Percentage				
Average tax rate	24.9	24.9	24.4	24.2	24.2	24.2
Benefit payments/ Gross income	13.3	10.9	10.8	10.2	9.7	9.3

Note: (a) Aggregate budget shares at the national level (in per cent). Changes are expressed in percentage points.

Employment increases steadily over time at a slightly higher rate than the increase in the population size. Employment growth is only slightly lower under the two mitigation policy scenarios than under the reference case. The budget shares of basic necessities and the energy bundle decrease over time, at about the same rate relative to the starting value of the budget share.

Benefit payments exhibit a much slower growth than the other income components. This growth is almost entirely due to the increase in population size and the changing structure of the population, since the assumption made in MMRF-Green is that benefit payments are indexed to the CPI. In other words, benefit payments are fixed in real terms for all benefit recipients. Given that gross incomes grow at a faster rate than the CPI, the share of benefit payments in household incomes is declining over time. This is the main explanation to the substantial increase in overall inequality discussed in Section 5.3 because low-income households rely much more on benefit payments than high-income households. Finally, the average tax rate on labour income in MMRF-Green is fixed at 25.6 per cent. Tables 5.1 to 5.3 show that the average tax rate calculated from MITTS results follows this rather closely. As

explained in Section 3.4, this result is obtained in MITTS by indexing income tax thresholds to real wages.

To ensure consistency with MMRF-Green, two types of lump sum transfers are included in households’ incomes in MITTS. The first lump sum transfer is a government handout or tax, which is required in MMRF-Green to preserve the balance of the government’s budget as a fixed percentage of GDP. As a result, this lump sum transfer could be negative, implying a transfer from households to the government (a lump sum tax), but overall the lump sum transfer is positive and increases over time. The second lump sum transfer redistributes the carbon permit revenue generated by the introduction of the Emission Trading Scheme (ETS) as calculated in MMRF-Green. For both lump sums, the assumption made in MITTS is that both are equally distributed across the entire population on a per capita basis.<sup>17</sup> The levels of these transfers are reported in Table 5.4. Of course, this is just one way of redistributing these transfers. It would be straightforward to experiment with alternative distribution schemes.

**Table 5.4 Lump sum transfers to households (amounts in \$ per year per capita)**

		2005	2010	2015	2020	2025	2030
Government handout/tax	Reference Case	0	274	475	855	1,149	1,411
	Scenario - 550ppm	0	274	303	546	760	948
	Scenario - 450ppm	0	274	190	437	650	845
Exogenous change in household income from carbon permit revenue	Reference Case	0	0	0	0	0	0
	Scenario - 550ppm	0	0	495	584	663	699
	Scenario - 450ppm	0	0	727	844	928	939
Total transfer	Reference Case	0	274	475	855	1,149	1,411
	Scenario - 550ppm	0	274	798	1,130	1,423	1,647
	Scenario - 450ppm	0	274	917	1,280	1,577	1,785

The levels of the lump sum transfers to households are of particular importance to low-income households. The choice of how to redistribute this revenue is a political choice. An alternative approach to the redistribution would be to distribute the lump sum transfer mostly or entirely to the lowest income households, which would have the effect of reducing income inequality and could be of interest. The lump sum transfer to balance the government’s budget is also substantial. In 2030, the total amount in the reference case is close to 40 billion dollars, expressed in 2005 dollars. It is somewhat lower in the two mitigation policy scenarios, where it is close in value to the carbon permit revenue. It seems likely that the government would change taxation or social security payments, or introduce other schemes instead of distributing non-taxable lump-sum amounts to households. This is an issue that could be investigated in

<sup>17</sup> For each year, the values provided by MMRF-Green on the aggregate lump sum amounts are divided by the corresponding population sizes to obtain the lump sum transfers per capita. These per capita lump sum amounts are then added to that year’s net income of the individuals and households.

future studies, making alternative assumptions in the microsimulation modelling and possibly in the CGE modelling as well.

## **5.2 Income effects**

The changes in average real net income (RNI) per adult equivalent by income quintile<sup>18</sup>, household type and State are presented in Figures 5.1, 5.2 and 5.3.<sup>19</sup> The mitigation policies are not introduced until 2013, which is why the reference case and the two scenarios coincide in 2005 and 2010. The strong income growth between 2005 and 2010 is followed by a slowdown (between 2010 and 2015), after which the increase picks up again although not to the extent of the increase in the first five years.<sup>20</sup> The slowdown is essentially due to a reduction in the growth of average earnings, which is more pronounced under both mitigation scenarios than under the reference case.

The large increases in income between 2005 and 2030 occur due to significant increases in both labour and non-labour incomes. The growth in labour income is driven by the increase in the wage index as indicated by MMRF-Green results. The reallocation of workers across sectors following changes in the sectoral composition of employment also contributes to the growth in labour income. Indeed, the sectors expanding the most are found within the service industry which is an industry that tends to provide relatively high wages.

The graphs show clearly that between 2005 and 2030 the highest income quintiles experience the largest increases in real incomes. Compared to the other quintiles, the bottom quintile sees moderate growth, which is somewhat improved in the mitigation scenarios, due to the returned permit revenue, which is a relatively large amount for this low-income group and appears to overcompensate this group for the introduction of the mitigation policies. The low growth in income in the bottom decile is due to a large extent to the imposed assumption in MMRF-Green that all benefit payments (making up a large part of the bottom quintile's incomes) increase by the CPI only, which implies zero real growth for benefit recipients. As expected, income growth at the national level is slightly lower under the 450ppm scenario than under the 550ppm scenario due to slower growth in employment and the wage index. However, the lowest quintile has a higher RNI under the mitigation scenarios than under the

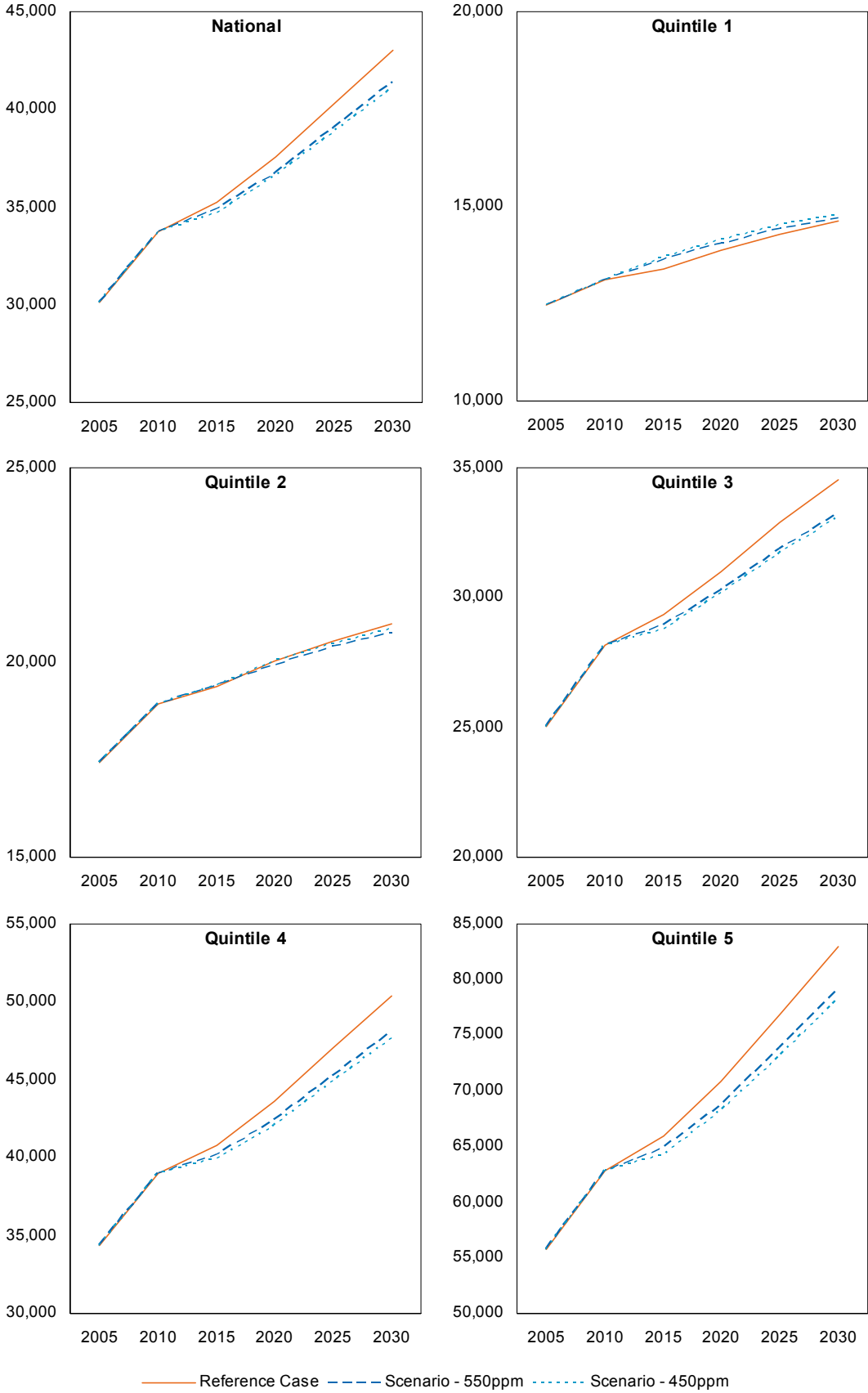
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<sup>18</sup> Income quintile 1 represents the 20 per cent of income units with the lowest equivalised income unit net incomes and income quintile 5 represents the 20 per cent of income units with the highest equivalised income unit net incomes.

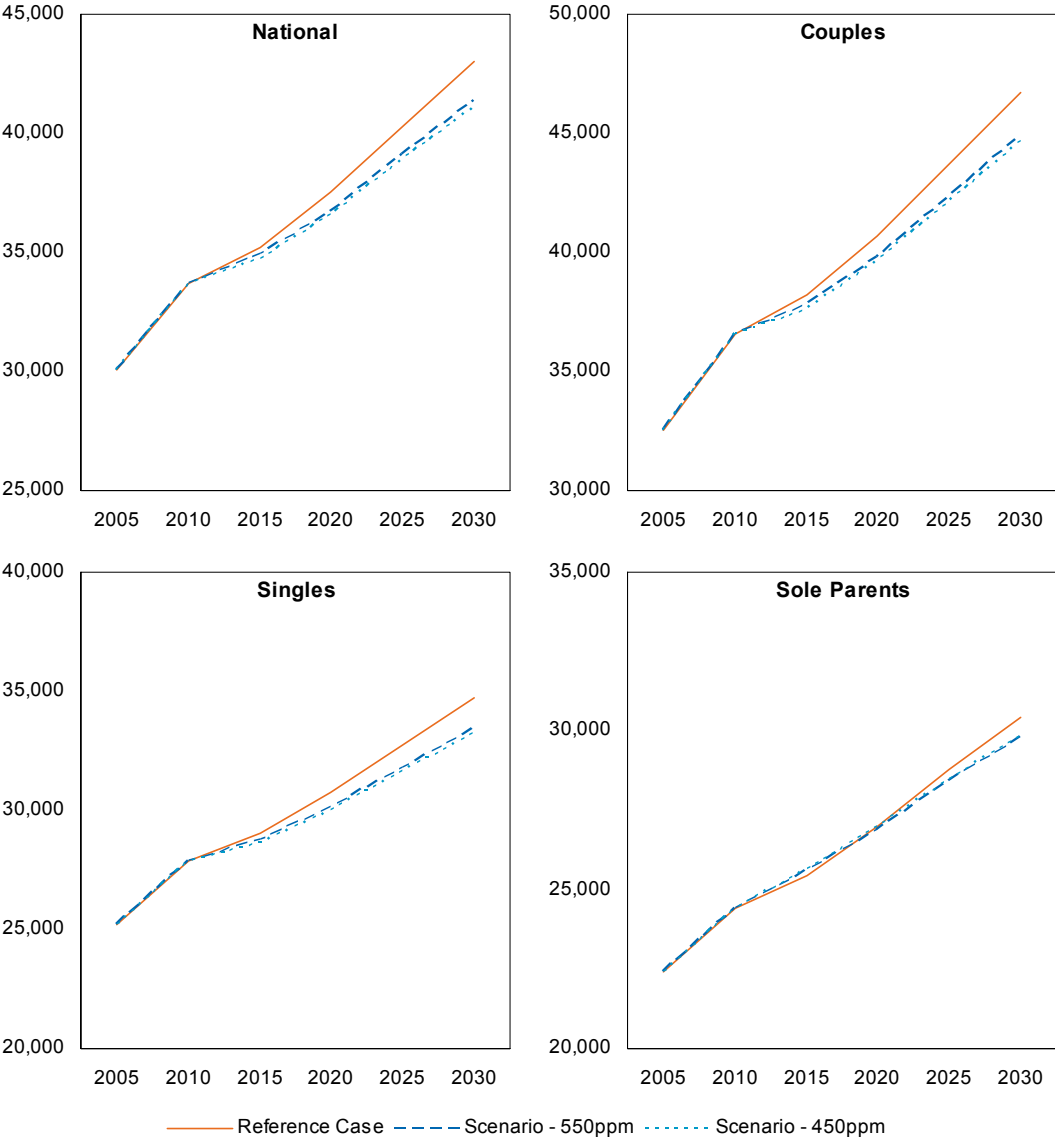
<sup>19</sup> Real net income is gross income plus government transfers minus income tax adjusted for inflation, using the household-specific CPIs as described in Table 3.1 in Section 3.2. Income units are used to construct the quintiles but each individual in the income unit is used to calculate the average real net equivalised income. For example, the bottom quintile is constructed by selecting the 20 per cent of income units who had the lowest real net income per adult equivalent, but the average real net equivalised income is based on all individuals in these 20 per cent of income units.

<sup>20</sup> The actual growth of real net income per person between the two financial years 2003/2004 and 2005/2006 was 8.4 per cent, which translates into an annual growth of 4.1 per cent and on average between 1996/97 and 2007/08 growth per year was 2.9 per cent (ABS, 2008). The increase from 2005 to 2010 in Figure 5.1 corresponds to an annual increase of 2.3 per cent per equivalent adult and 2.2 per cent per person. It therefore implies a slight slowdown in growth compared to the past decade.

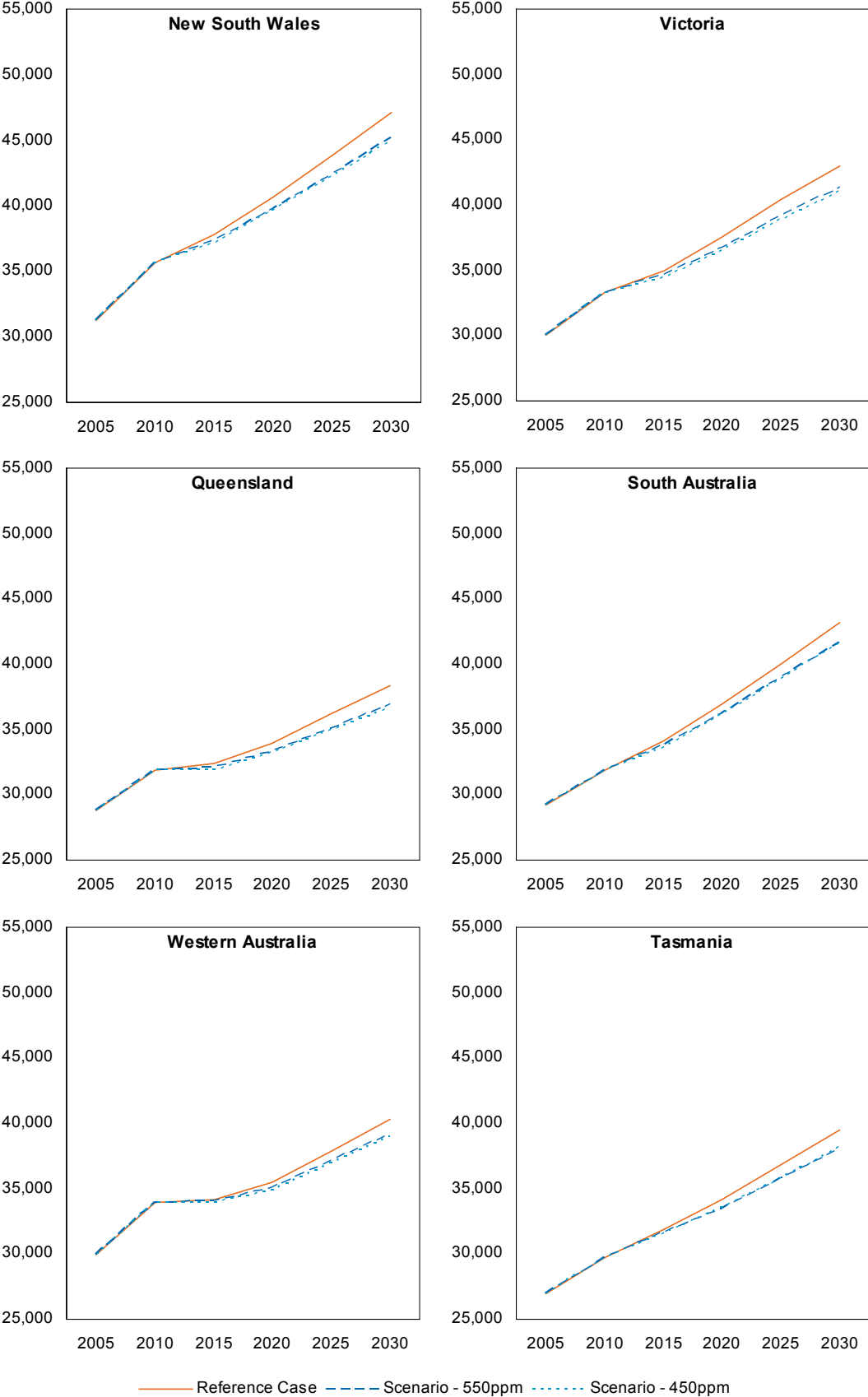
**Figure 5.1 Average real net income per adult equivalent by income quintile (in 2005/2006 dollars)**



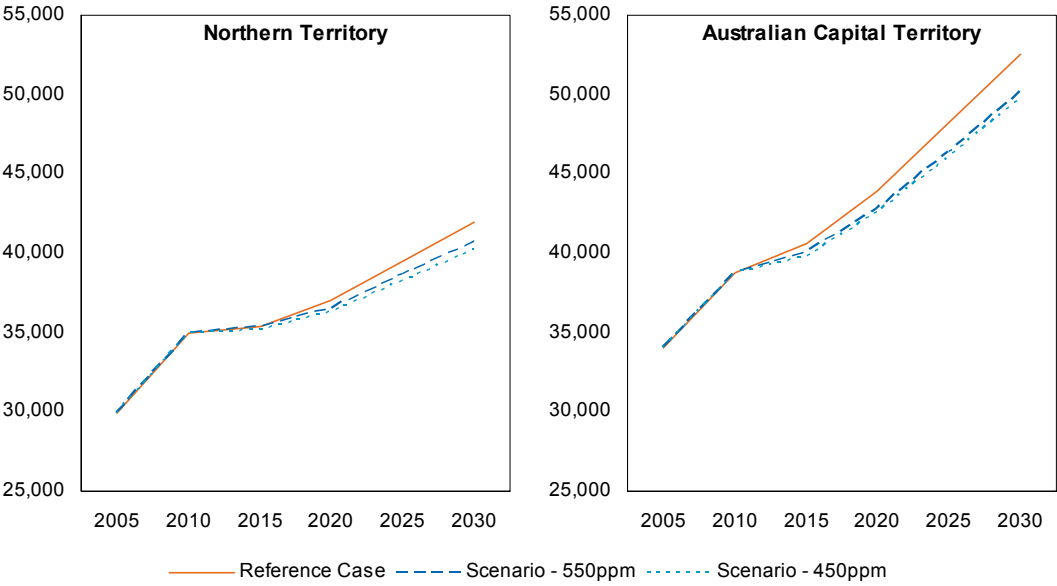
**Figure 5.2 Average real net income per adult equivalent by household type (in 2005/2006 dollars)**



**Figure 5.3 Average real net income per adult equivalent by State (in 2005/2006 dollars)**



**Figure 5.3 Continued**



reference case due to the returned permit revenue. Indeed, the 450ppm scenario is the most favourable scenario for this quintile due to the larger lump sum transfers.

Overall, however, it is clear that households in quintiles 1 and 2 benefit much less from economic growth than the other three quintiles under all scenarios. For quintiles 3, 4, and 5 there is a clearly reduced income growth between 2010 and 2015 but then RNI increases in a similar manner as the reference case, although the income levels attained by 2030 remain clearly lower than under the reference case. When all quintiles are taken together, the RNI per adult equivalent is dominated by the effects observed for quintiles 3, 4, and 5. Figure 5.2 shows that both RNI levels and RNI growth are highest for couple families (this group includes couples with and without children) and lowest for single parents. There is a dip in the increase in income for singles and couples from 2010 to 2015, although on average the income of all groups still increases in this period. From 2015, real income growth accelerates again, although it remains at a slightly lower rate under the 550ppm and 450ppm scenarios than under the reference case for couples with or without children and singles. As a result, the gap in RNI between the reference case and the two mitigation scenarios increases over time for these two demographic groups. The situation is different for sole parents because their RNI increases more under the mitigation scenarios than under the reference case up to 2015. From 2020 onwards the RNI for sole parents is lower under the mitigation scenarios. Low-income households are overrepresented in the sole parents group, so similar to the lowest quintiles in Figure 5.1, the sole parent group appears to be better off, at least for a while, under the mitigation policy scenarios than under the reference case.

RNI levels by State are presented in Figure 5.3. RNI levels in 2005 and growth are highest in the ACT, followed by New South Wales. RNI levels are lowest in Tasmania followed by Queensland. The gap in average RNI between the States widens between 2005 and 2030.

South Australia is predicted to overtake Western Australia, Victoria and the Northern Territory in terms of RNI between 2005 and 2030, moving up the ranks from third last to third best with regard to RNI. Tasmania is predicted to overtake Queensland. The mitigation policies appear to have a relatively small effect in all States, although the higher income States have a larger reduction in average RNI compared to the lower income States.

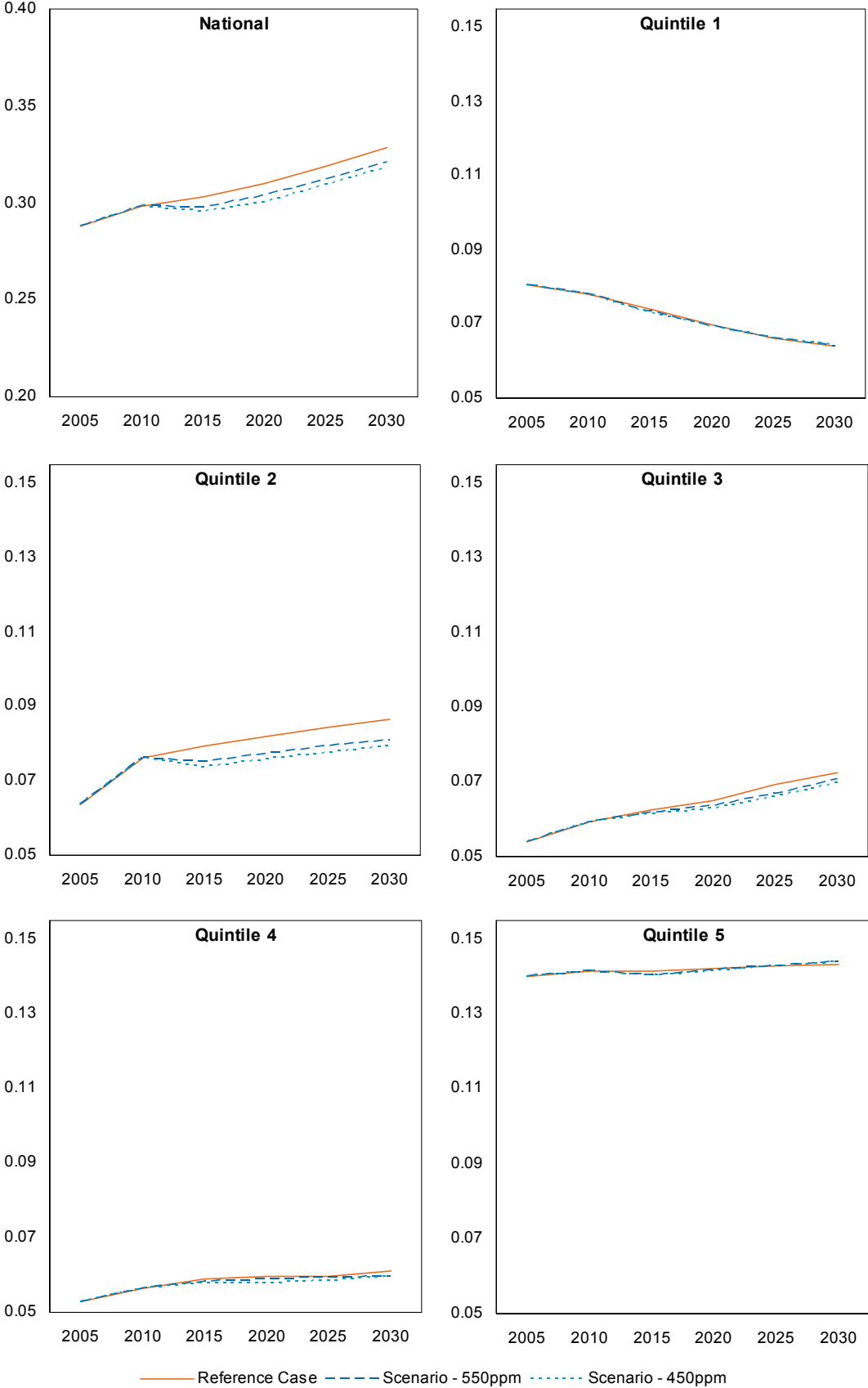
Figure 5.4 shows that the changes in incomes over time are accompanied by an increase in income inequality as measured by the Gini coefficient. This is due to the much higher income increases for the higher income quintiles compared to the lower income quintiles. This is mainly due to the assumption made in MMRF-Green regarding the indexation of benefit payments to the CPI rather than the wage index. The increase in CPI is usually much lower than the increase in the wage index over the same time. Currently, all pension payments are indexed with average male weekly earnings.

Comparing the reference case with the two scenarios, the increase in the Australian-wide inequality is smaller under the 450ppm and 550ppm scenarios than under the reference case, and between 2010 and 2015, it is actually slightly decreasing. The mitigation policies appear to reduce the Gini coefficient both overall and within each income quintile, although the reduction is minimal and mainly restricted to quintiles 2 and 3.

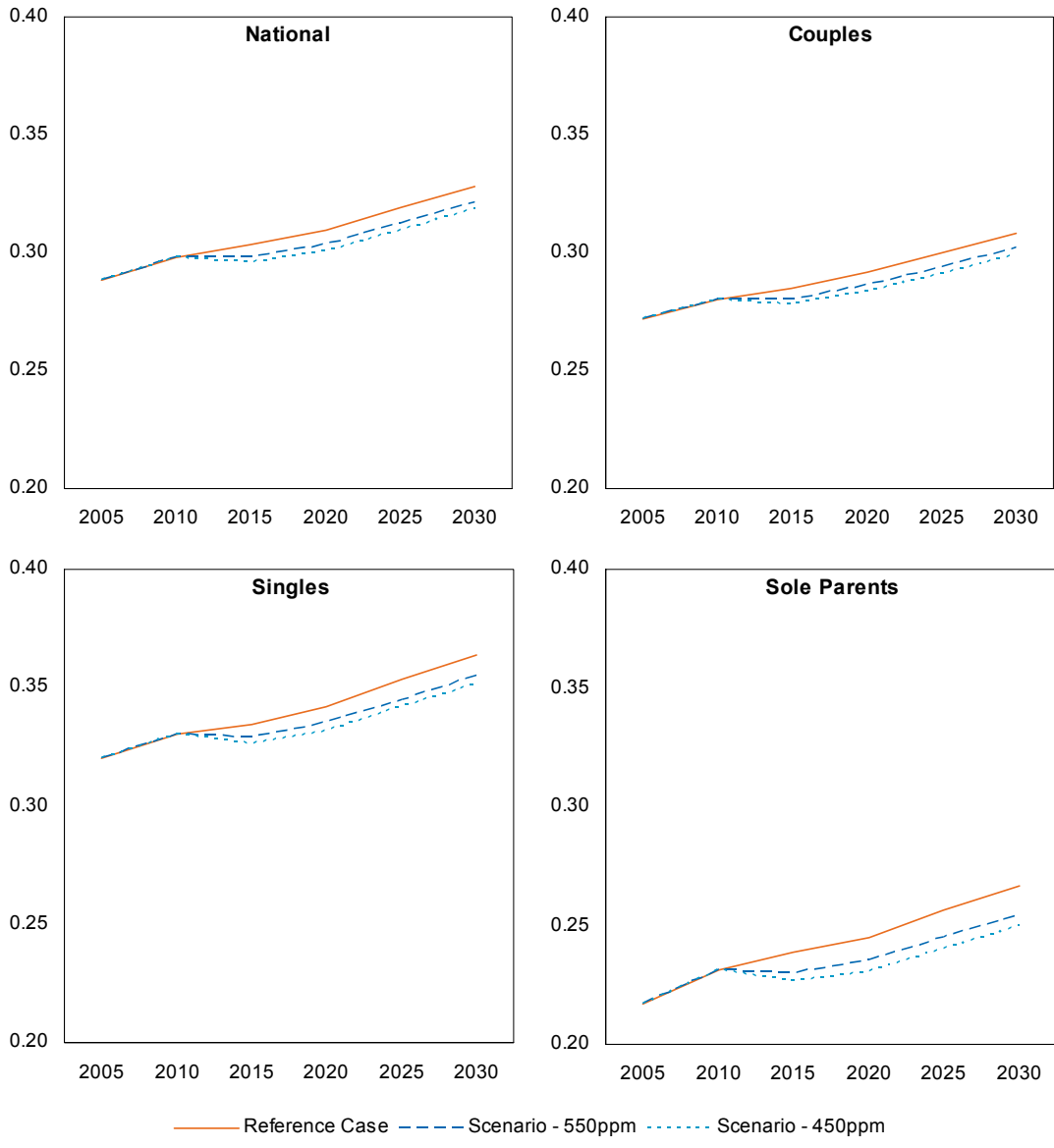
Figure 5.4 shows that there is a reduction in inequality at the national level when comparing the two mitigation scenarios with the reference case. The lump sum transfers taking place under the mitigation scenarios have a dampening impact on the Gini coefficients since they are equally distributed on a per capita basis. In addition, income growth is lower under the two mitigation scenarios so that the divergence between factor income and benefit payments is reduced (should the permit revenues be returned to households, targeting low-income households, then inequality might be further reduced).

The graphs in Figure 5.1 show that the reduction in income growth under the two mitigation scenarios is higher for the higher income quintiles, for which factor income is much more important than benefit payments. This is an interesting result since there is a concern that lower income groups are affected more severely by climate change and by the subsequent policy changes aimed at mitigating the climate change effects, resulting in higher income inequality. However, it seems that other changes over time rather than the mitigation policies are causing an increased inequality and a worse relative income position for the lower income quintiles. Compared to the change in the national Gini over time, the difference between the scenarios and the reference case at each point in time is small. So the effect of climate change mitigation policies (that is the 450 and 550ppm scenarios) on the Gini is limited, compared to other changes predicted to occur over time.

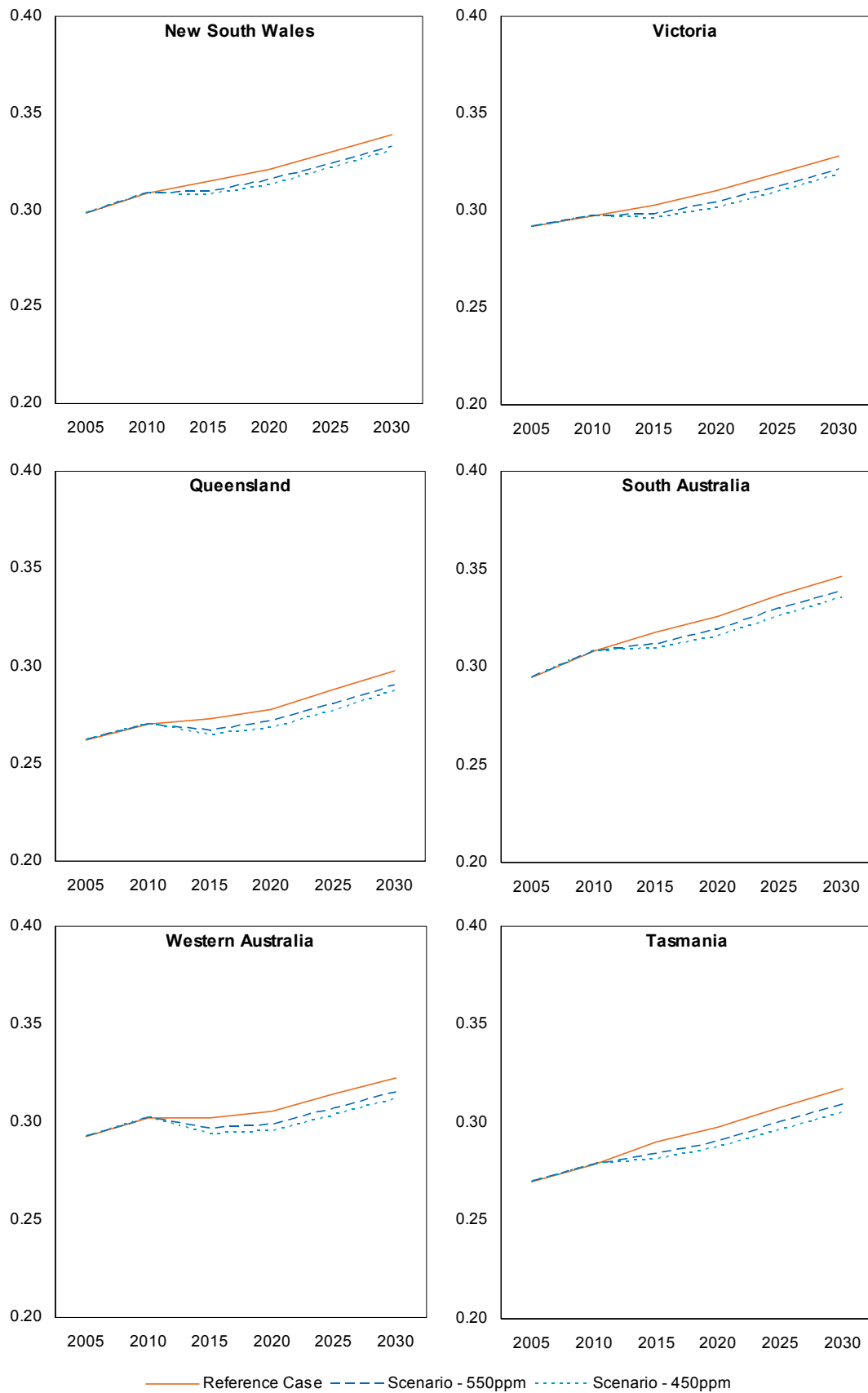
**Figure 5.4 Gini coefficient within income quintiles**



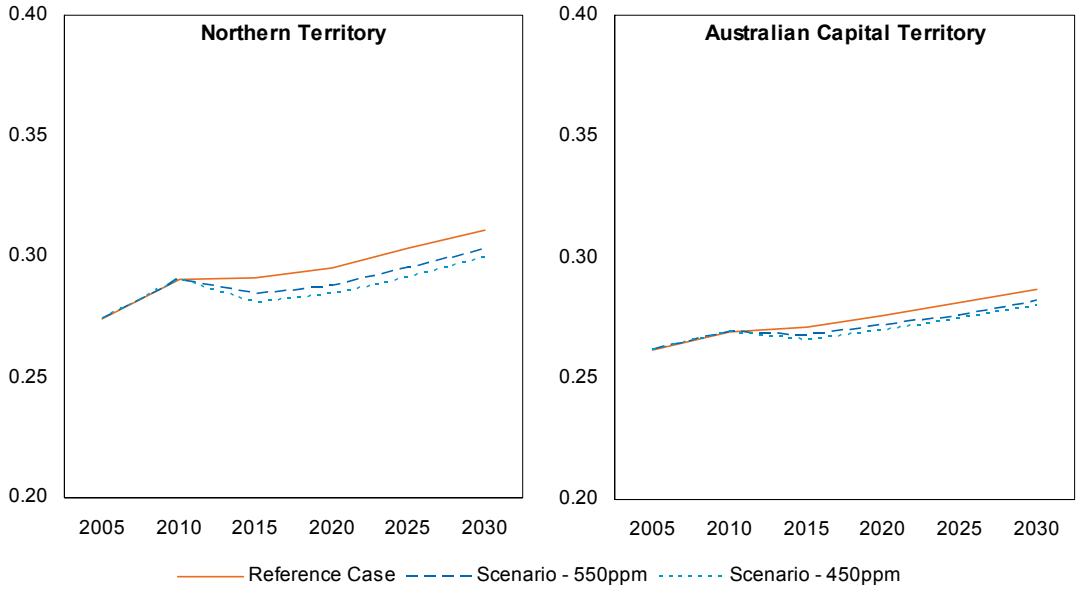
**Figure 5.5 Gini coefficient by household type**



**Figure 5.6 Gini coefficient by State**



**Figure 5.6 Continued**



Comparing the Gini coefficients by quintile shows that the highest inequality within a quintile is observed in the top income quintile, which is not surprising due to the wide range of incomes in this quintile.<sup>21</sup> However, over time the increase in inequality is not as large in this quintile as in some of the lower quintiles, in particular in quintiles 2 and 3. The Gini coefficient in quintile 1 decreases whereas the Gini increases over time in all the other quintiles. The decrease over time in inequality in the first quintile is due to the increase in the proportion of households in this quintile who are on benefit payments. These payments are fixed amounts depending on household composition and the reason for eligibility only. Over time, the households most dependent on benefit payments tend to fall into the first quintile because benefit payments are not increasing over time in real terms. As the share of households dependent on benefit payments increases among quintile 1, inequality falls because benefit payments are more evenly spread across households than other sources of income would be. The substantial lump sum transfers taking place under both mitigation scenarios reinforce this trend and reduce the increase in the Gini coefficient for the other quintiles.

Comparing the Gini by household type shows that single parents have the lowest inequality, which indicates that they form a more homogenous group than singles or couples in terms of RNI. A likely explanation is that a large proportion of their income depends on benefit payments. Possibly for the same reason, single parents display the highest increase in inequality over time. By design, benefit payments increase to a lower extent than labour income, so that working single parents move away from the rest of the distribution over time causing inequality to increase. Again, the lump sum transfers associated with the introduction of the ETS substantially reduce the increase in inequality in these three demographic groups.

<sup>21</sup> The highest income quintile covers a wider range of incomes than the four lower income quintiles.

Intra-State inequality (as measured by the Gini coefficient) varies between 0.26 and 0.30 in 2005, with the ACT at the lowest level close to 0.26 and New South Wales at the highest level around 0.30. All States experience a substantial increase in inequality over time (except between 2010 and 2015 for some States) under all scenarios. However, the increase is reduced under both mitigating policy scenarios.

### **5.3 Household expenditure: budget shares**

There are two groups of commodities that are of particular interest in the analysis. The budget share of basic necessities provides an indication of the pressure on low-income households who usually spend a larger proportion of their income on basic necessities than high-income households.<sup>22</sup> Given the focus of this report on the effects of mitigation policies to deal with expected climate change, the budget share of a household's energy bundle is also important. The commodities included in the basic necessities and in the energy bundle are reported in Table C.2 in Appendix C. Figures 5.7, 5.8 and 5.9 present the average budget share of basic necessities at the national level and by income quintile, household type and State respectively. The average budget share of energy-related expenditure is presented in Figures 5.10, 5.11 and 5.12.

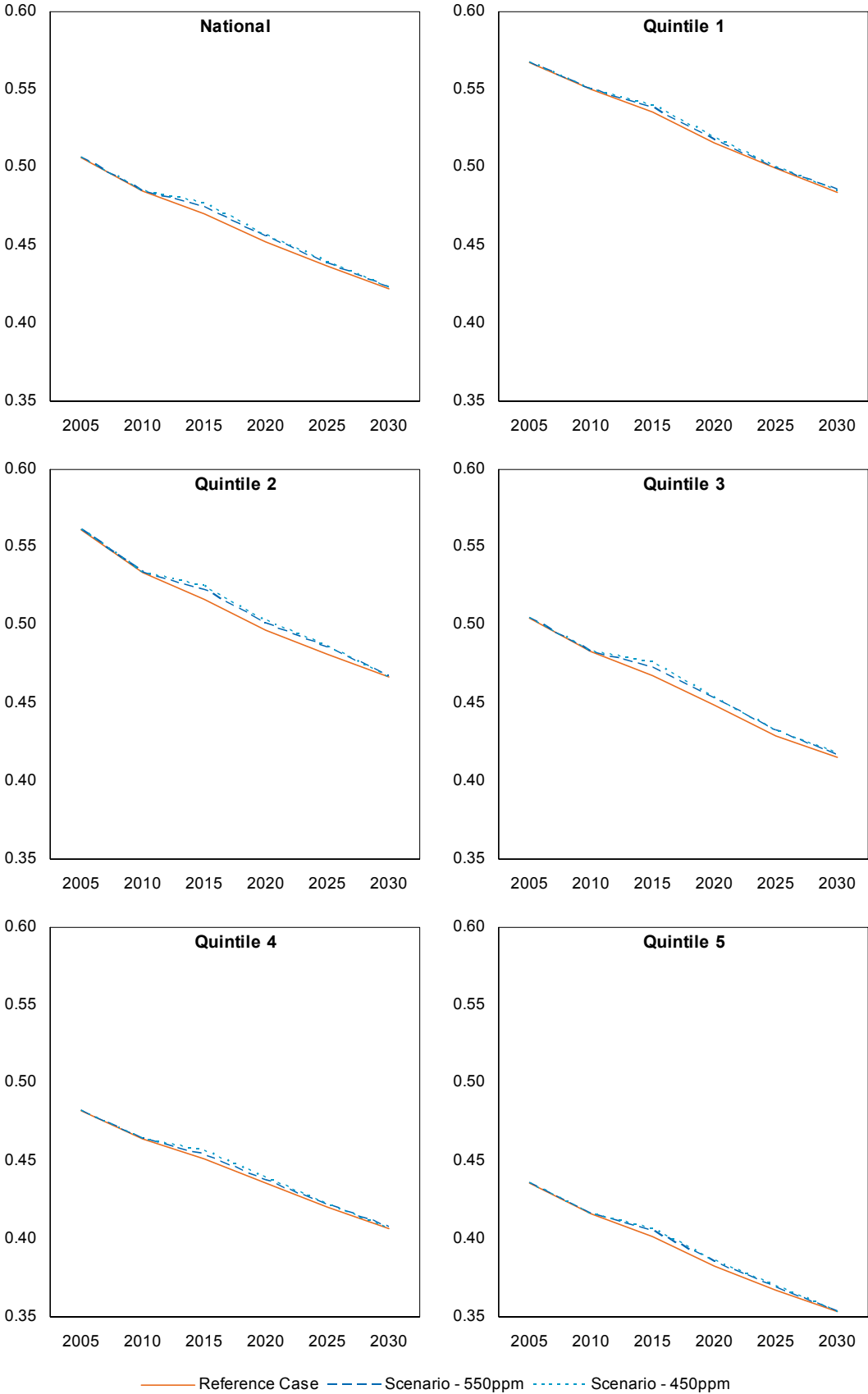
Average budget shares of basic expenditure and energy bundles are in general very similar for the reference case and the two scenarios. The overall pattern derived from the MMRF-Green modelling is one of declining shares over time. Prices may increase, but households' incomes are increasing as well, counteracting the price effect on the shares by increasing total expenditure. In addition, substitution effects cause household consumption to shift away from the commodities showing the highest price increases over time.

The mitigation policies are not introduced until 2013, which is why the reference case and the two scenarios coincide in 2005 and 2010. The shares of basic necessities in the different scenarios (at the national level but also by quintile or household type) diverge in 2015 (after the mitigation policy is introduced), but then converge again and the three scenarios display very similar shares in 2030.

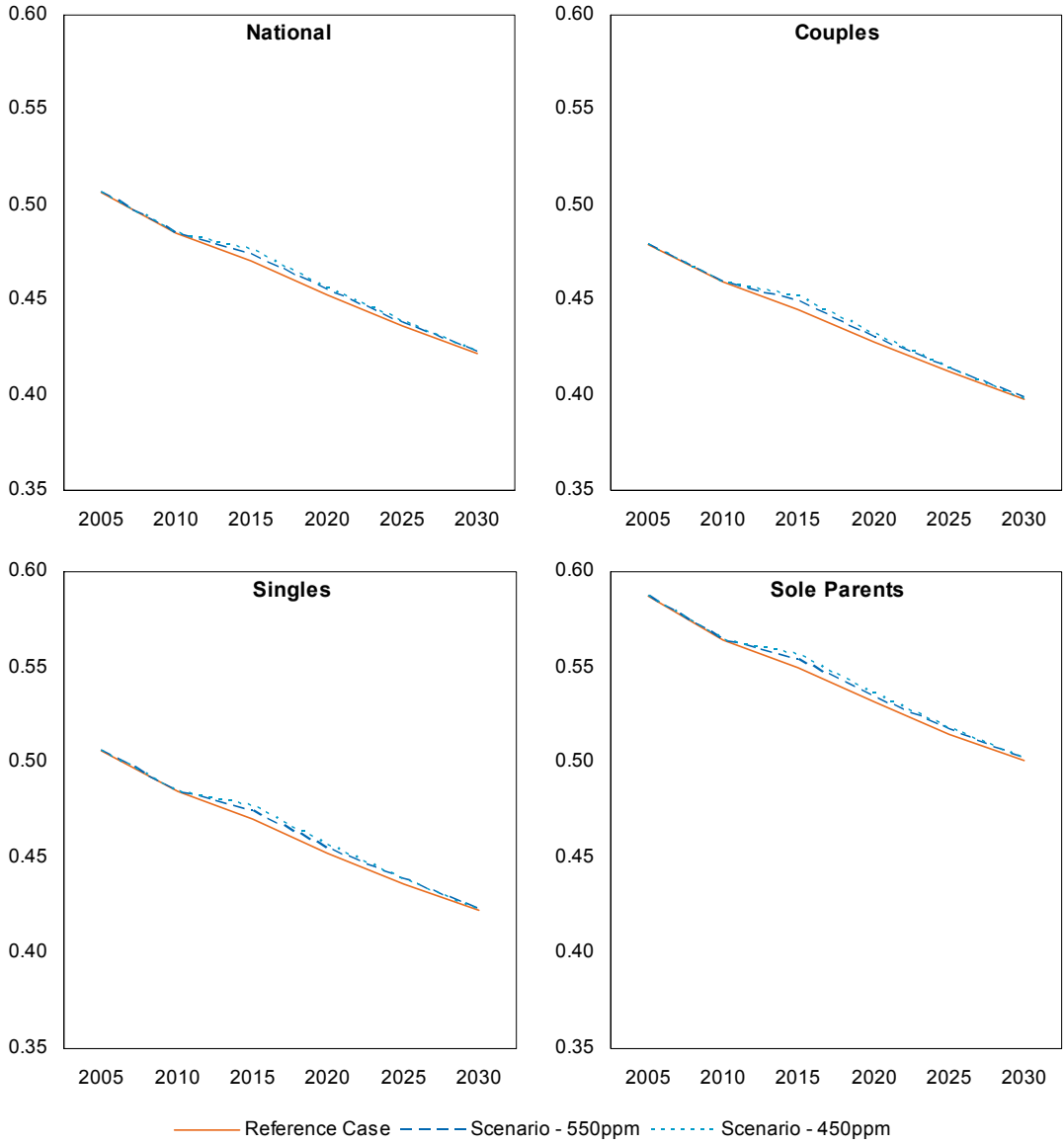
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<sup>22</sup> See Figure 16.2 in Garnaut (2008: p. 388).

**Figure 5.7 Average budget shares of basic necessities by income quintile**



**Figure 5.8 Average budget shares of basic necessities by household type**



**Figure 5.9 Average budget shares of basic necessities by State**

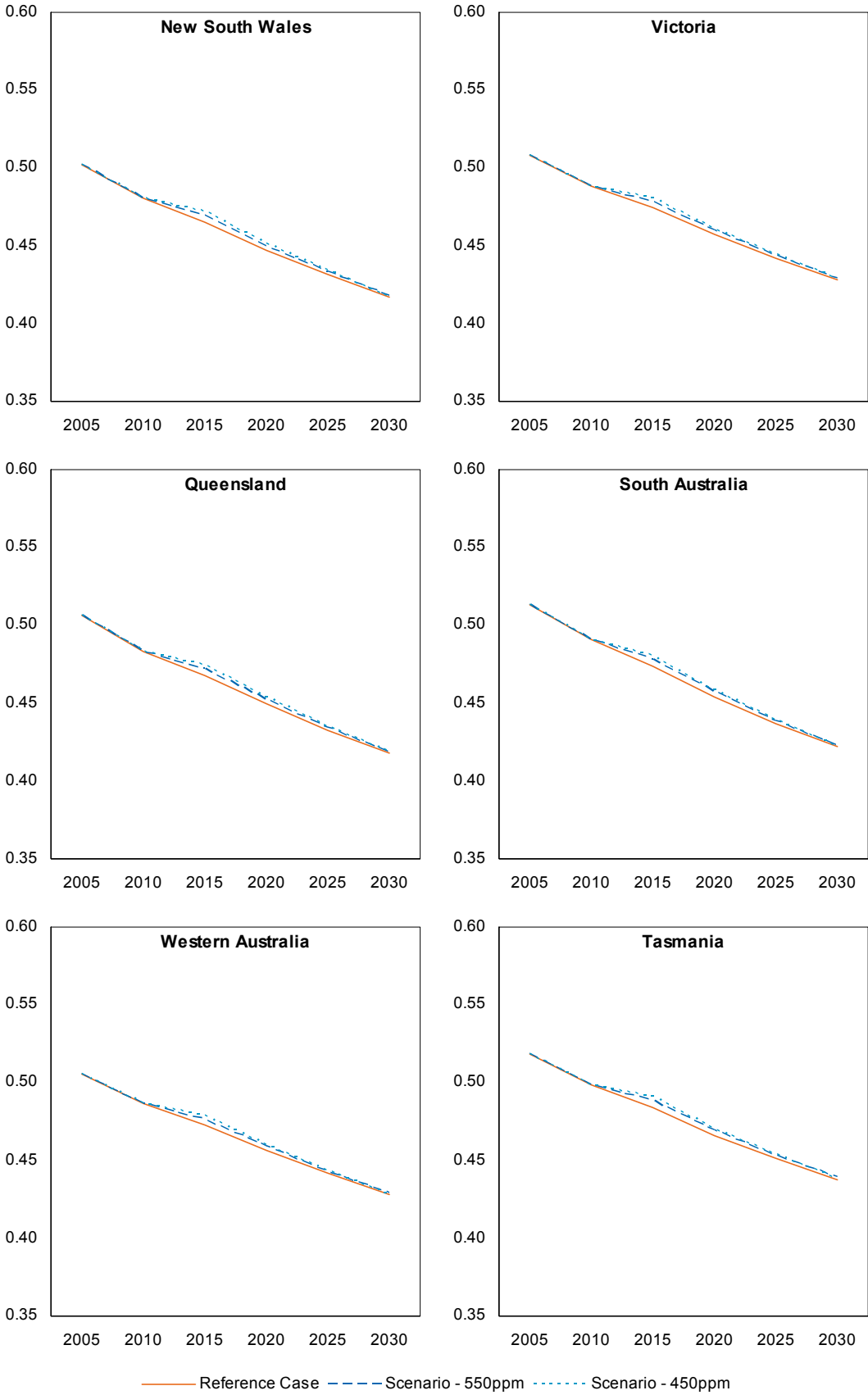
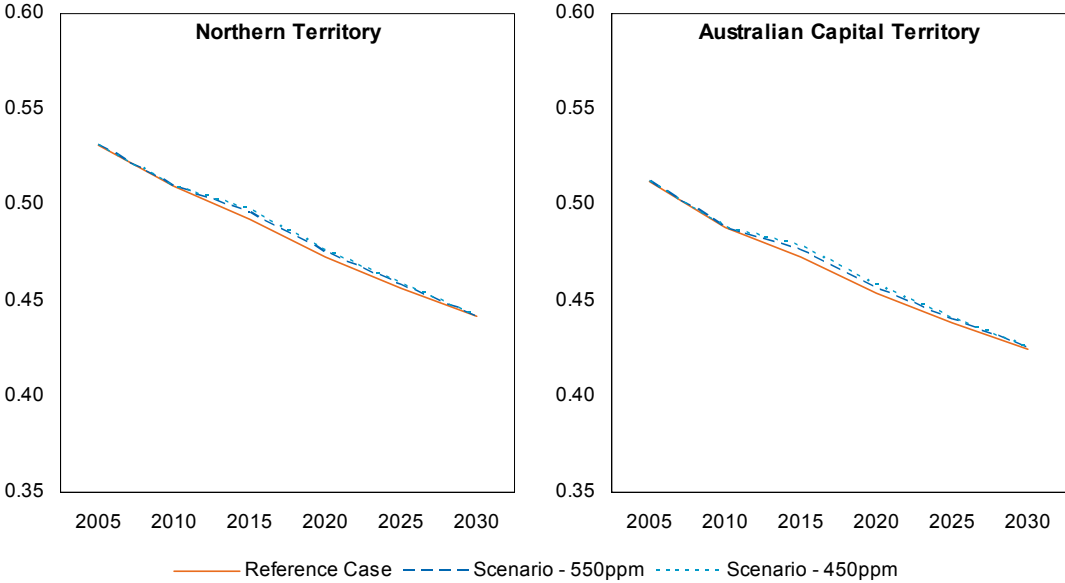
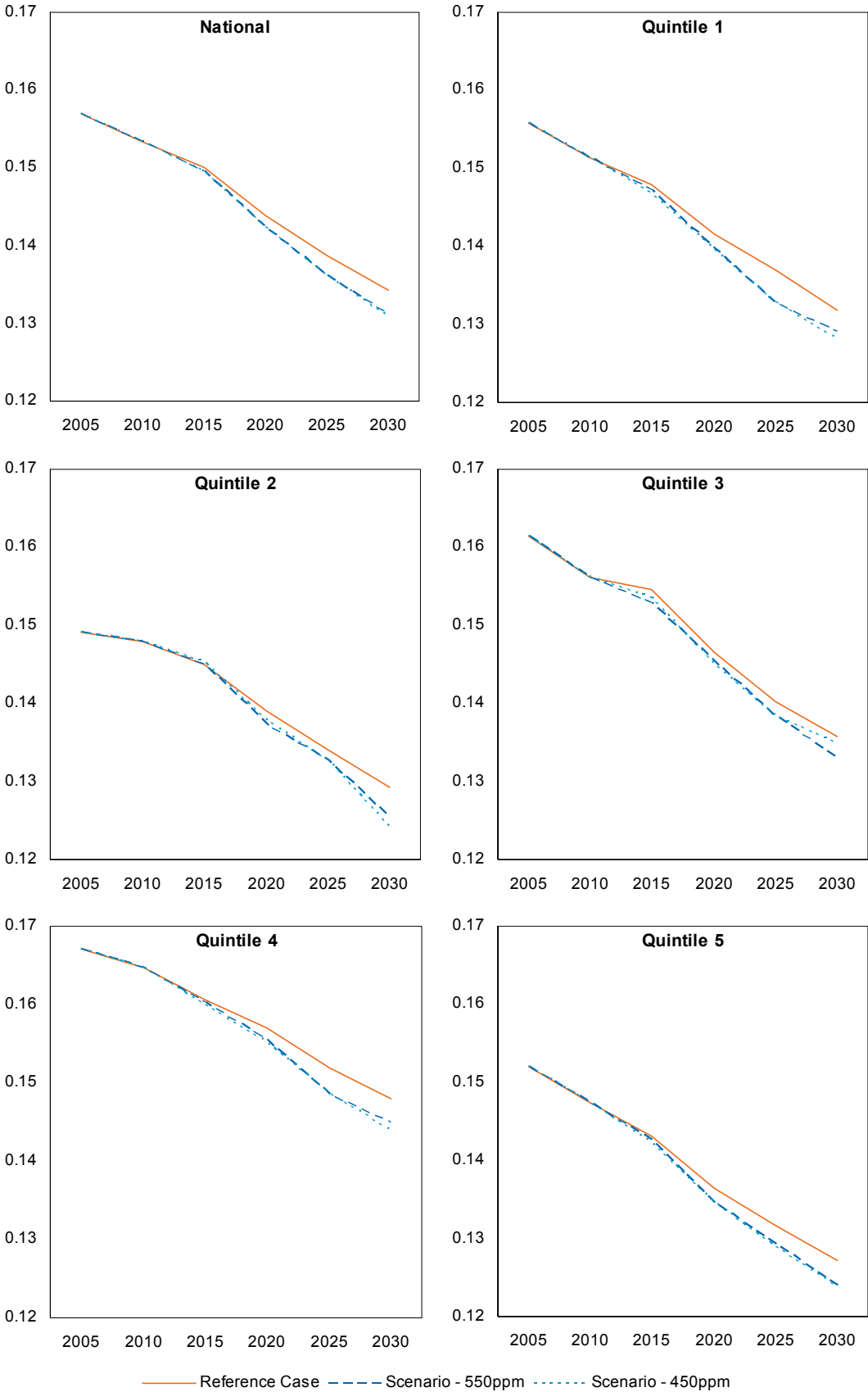


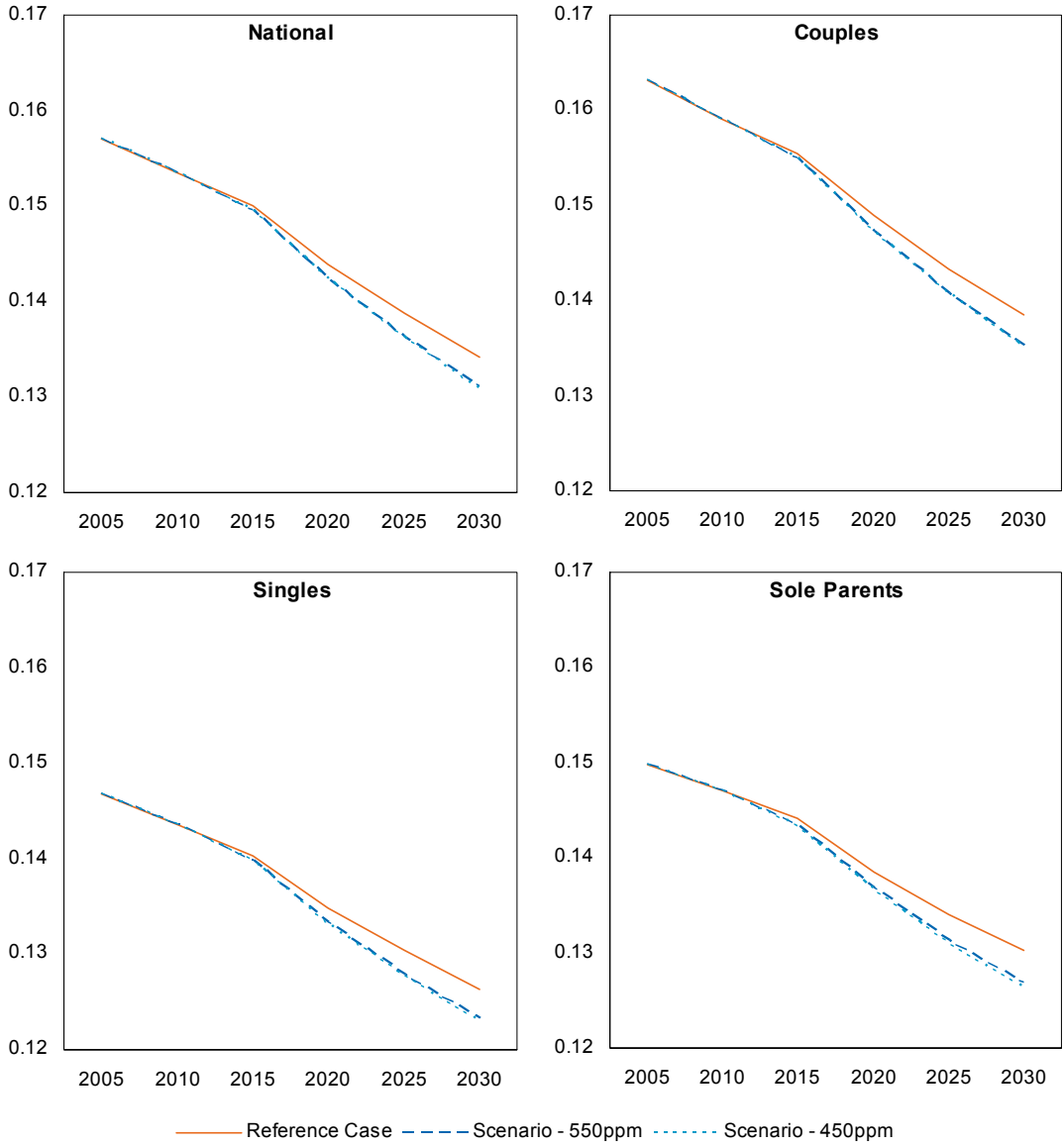
Figure 5.9 Continued



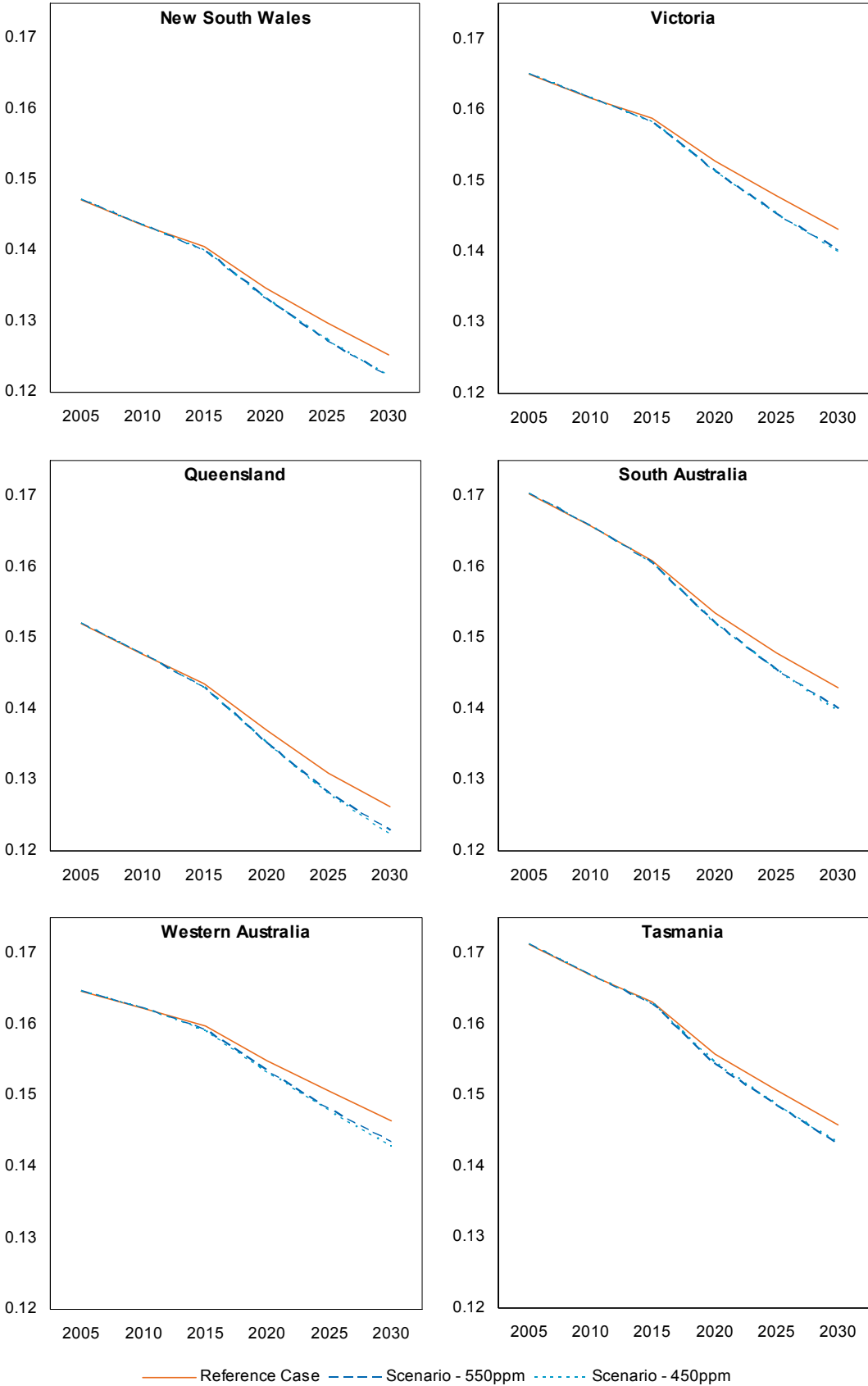
**Figure 5.10 Average budget shares of energy-related expenditures by income quintile**



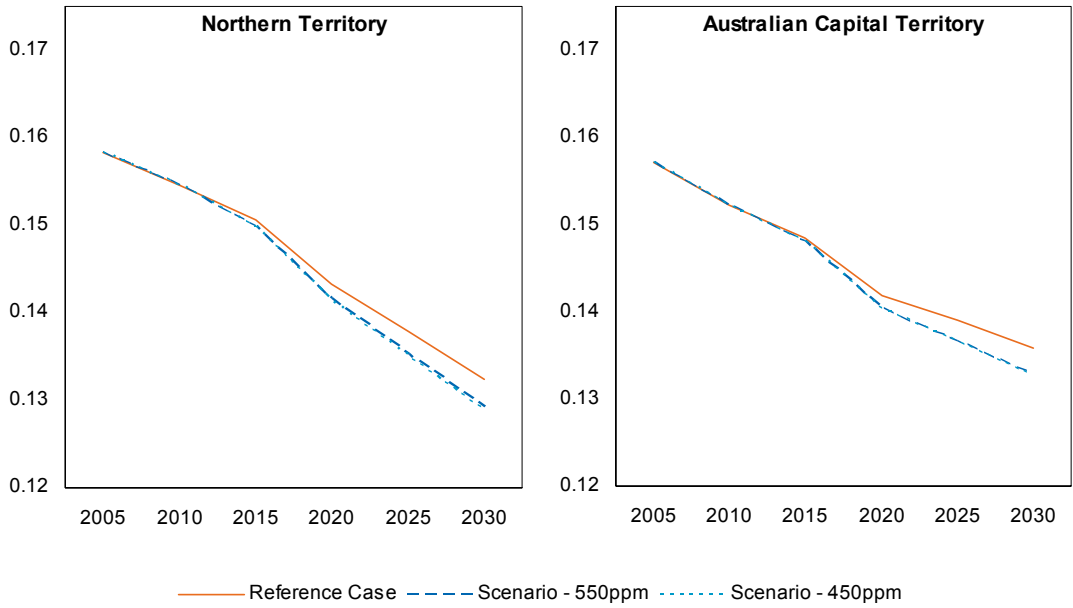
**Figure 5.11 Average budget shares of energy-related expenditures by household type**



**Figure 5.12 Average budget shares of energy-related expenditures by State**



**Figure 5.12 Continued**



In contrast to the observation on basic necessity shares, the energy shares are diverging over time between the reference case on the one hand, and the 450ppm and 550ppm scenarios on the other. The reference case and two scenarios are slightly less similar for the energy bundle shares than for basic necessities, but the divergence remains quite small. However, the divergence seems to continue for a longer period of time after introduction of the policies than for basic necessities. Two possible explanations for this phenomenon predicted by MMRF-Green come to mind. Once a new technology using less energy is obtained then this keeps the demand for energy at a continued lower level. Likewise, as long as prices reflect carbon content, substitution effects remain in place, and are likely to strengthen over time.

Comparing the budget shares of basic necessities by income quintile, by household type and by State, they seem to involve parallel shifts of the curves only. As expected, higher income quintiles have lower budget shares; single parents and singles (who are on average on lower incomes than couple families) have higher budget shares; and New South Wales has the lowest budget share (this is at least partly explained by the high RNI, but the ACT had the highest RNI and appears to be middle of the range with regard to the budget share of basic necessities).

The pattern for the energy bundle is less regular: it is lowest for income quintiles 2 and 5 (for singles and in New South Wales), and highest for quintiles 3 and 4 (for couple families and in Tasmania). The differences in the budget shares used on energy between quintiles are relatively small: around 2 percentage points only at any point in time. Keeping this in mind, we examine the composition of income quintiles 2 and 5. These two quintiles contain more one- and two-person households, whereas quintiles 3 and 4 contain more households of three persons or more. Households in income quintiles 1 and 2 are more likely to live in dwellings

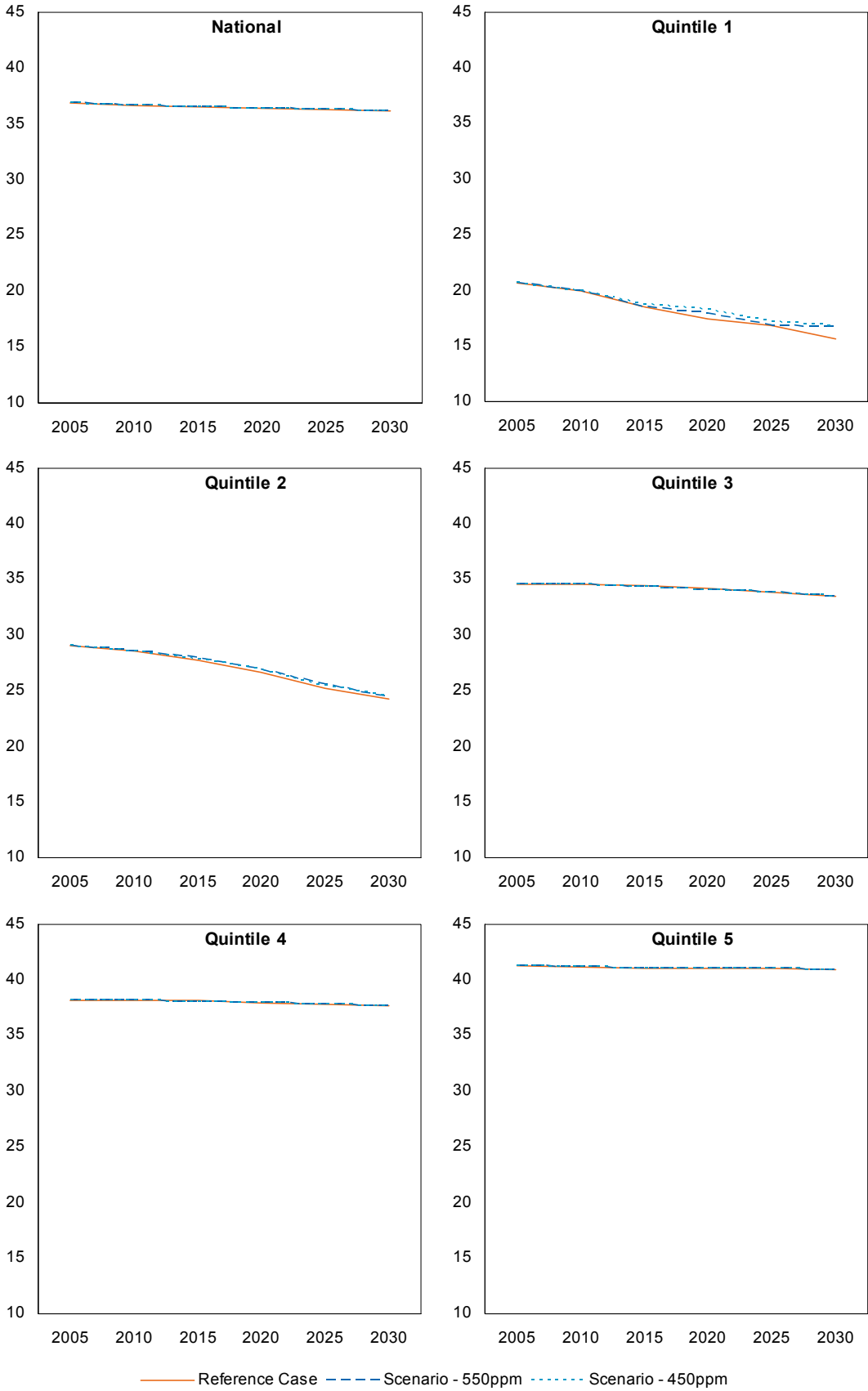
with fewer bedrooms than households in the higher quintiles. Both household size and dwelling size are likely to affect the amount of energy use.

Compared to the reference case, the two scenarios display slightly higher budget shares for the basic necessities and slightly lower budget shares for the energy bundle (note that the scale of the two sets of graphs is different). The two scenarios display very similar budget shares for the energy bundle. Sometimes the 450ppm shows the lowest share and sometimes it is the 550ppm scenario. However, the differences between these two scenarios in terms of budget shares are so small that they can hardly be considered relevant. MRRF-Green predicts that despite the increase in energy prices, the share of the energy bundle decreases, indicating a reduced consumption of energy by households. The 450ppm scenario has a slightly higher budget share for basic necessities than the 550ppm scenario, and both are fractionally higher compared to the reference case at the national level. Given this increased overall budget share of basic necessities and the slightly reduced energy share in the two mitigation scenarios compared to the reference case, the consumption value of other commodities in the basic necessities group must have increased under the two mitigation policies relative to the reference case. Indeed, MMRF-Green predicts that the mitigation policies will lead to an increase in the price of dwelling ownership relative to the reference case. Since dwelling ownership represents a large share of basic necessities, this relative price increase explains the increase in the budget shares of basic necessities to a large extent. However, by 2030 the changes in the three scenarios have mostly converged according to the MMRF-Green predictions.

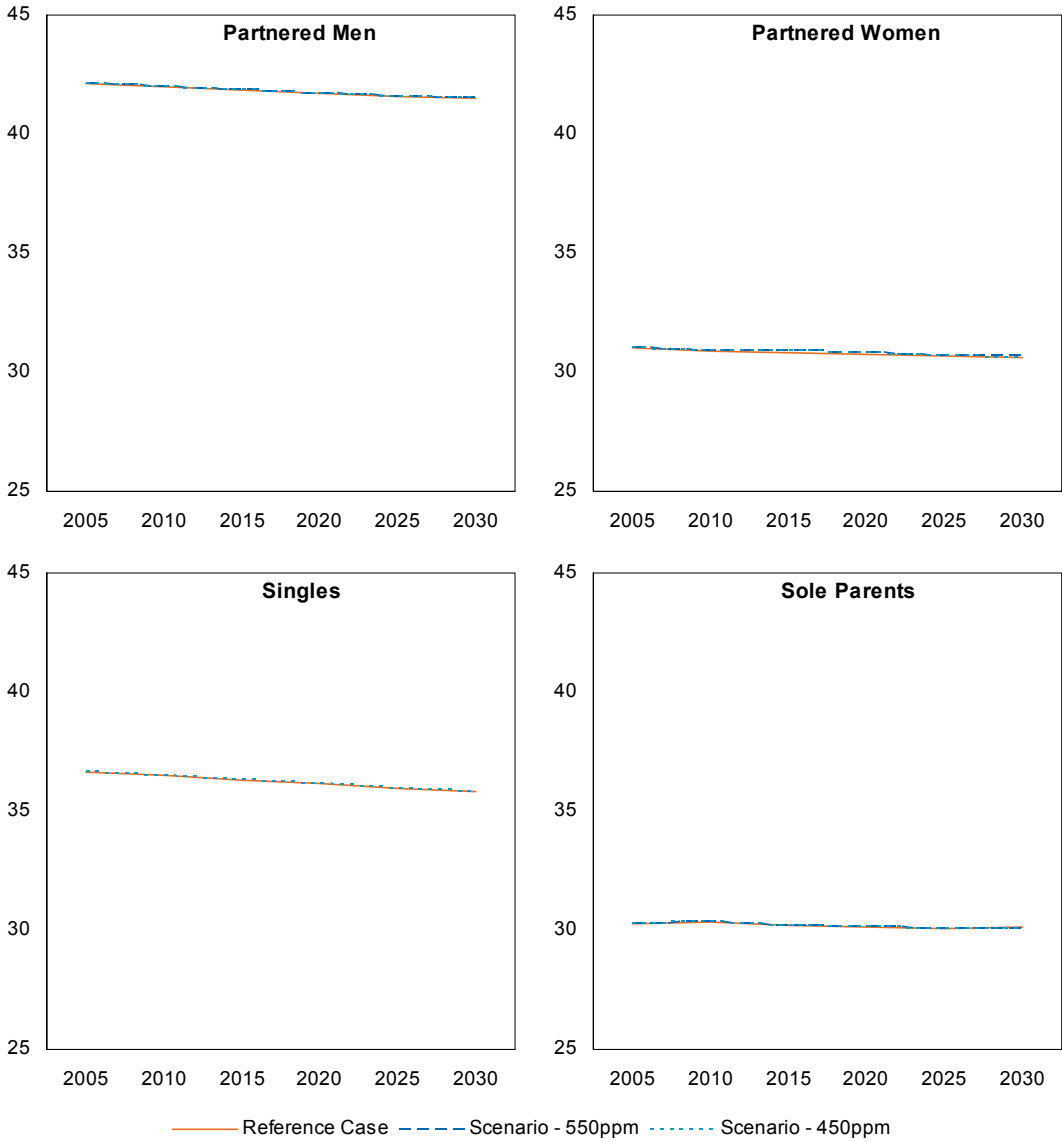
#### **5.4 Weekly hours of work**

Average weekly hours of work by income quintile, household type and State are presented in Figures 5.13 to 5.15. As expected, since labour supply is a major contributor to a household's income, the average hours of work increase with income quintile. Single parents and partnered women have the lowest average hours of work (and this is not predicted to change much over time), and partnered men have the highest labour supply. There are some differences by State, with residents in the two Territories working on average the longest hours and residents in Tasmania working the shortest hours. The ACT is the only region where average hours of work are predicted to increase; in the other regions it remains about the same or decreases slightly. These results are essentially generated by changes in the employment structures since in MMRF-Green no particular assumption is made regarding labour supply at the individual level. As a result, the predicted increase in average hours of work in the ACT is caused by an increase in the number of workers in the industry sectors where working hours are relatively long.

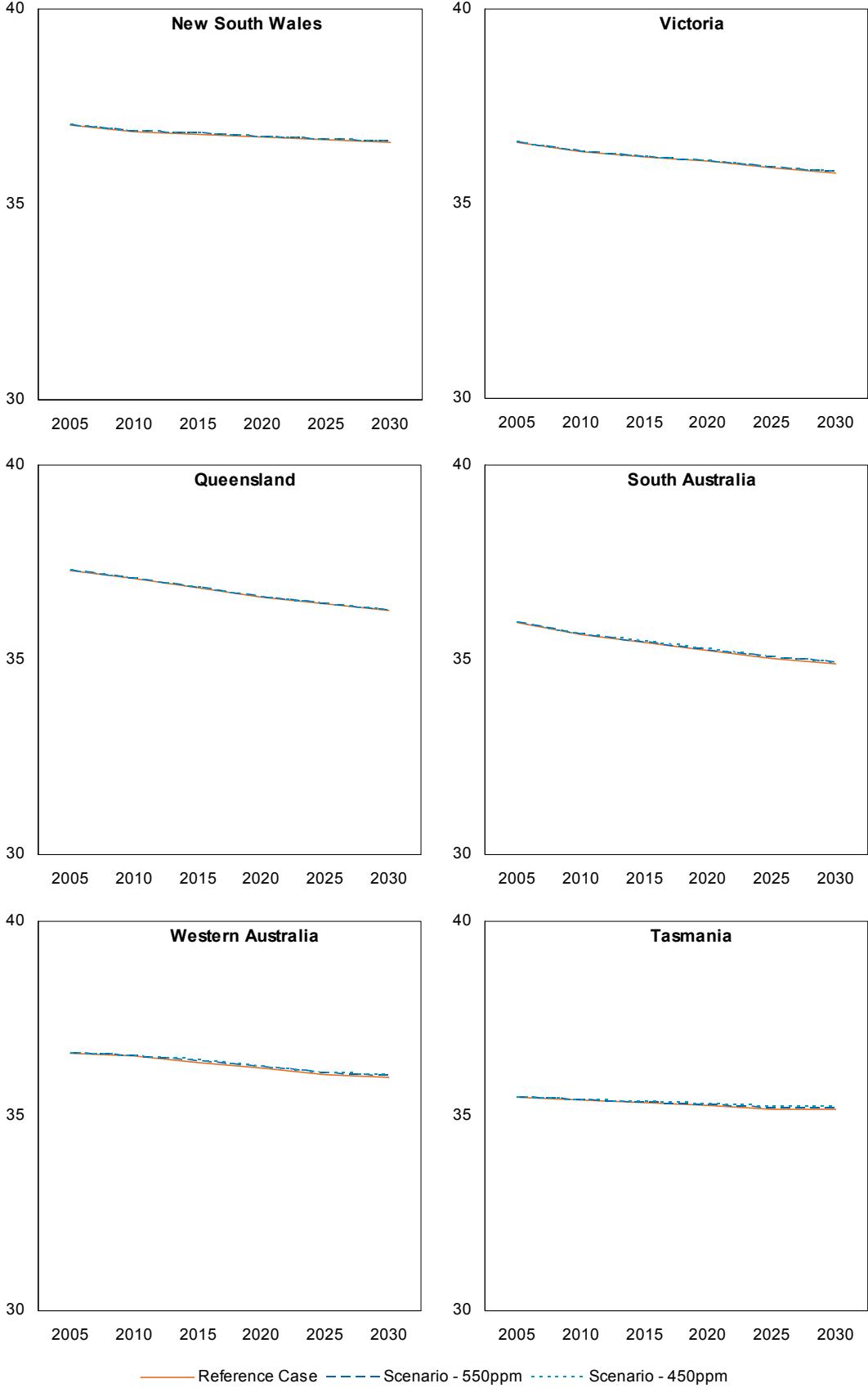
**Figure 5.13 Average weekly hours of work by income quintile**



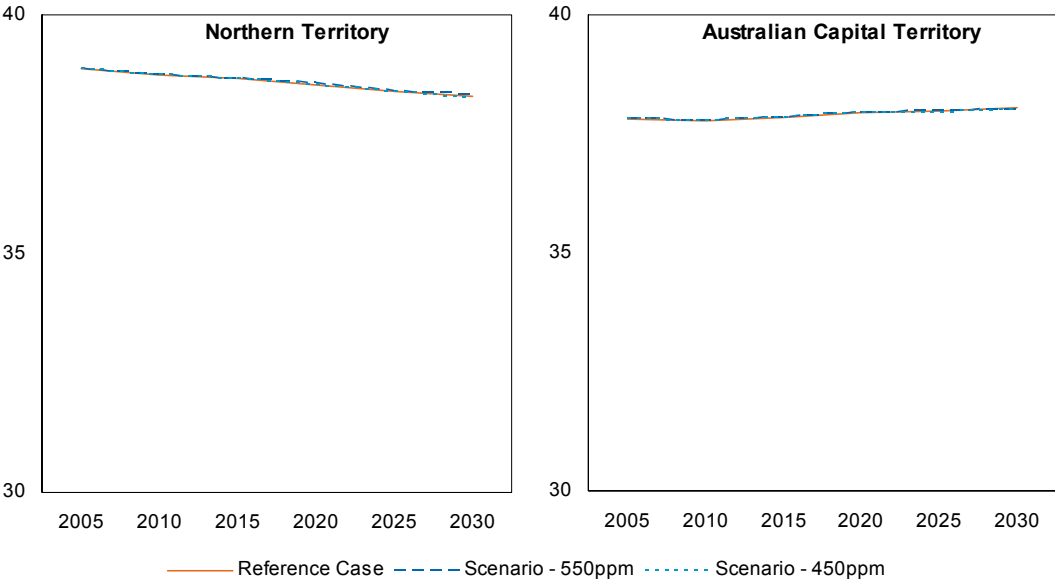
**Figure 5.14 Average weekly hours of work by household type**



**Figure 5.15 Average weekly hours of work by State**



**Figure 5.15 Continued**



Over time there is little change in the average hours of work overall. However, in the lowest two quintiles, there is a small reduction in the average hours of work, representing a larger proportion of individuals being dependent on benefits in these two groups where those on benefits may be more likely not to participate in the labour force. In the majority of subgroups and at the population level, there is little difference in outcomes under the reference case and under either of the two mitigation policy scenarios. There is a slight increase in average hours of work for the lowest two quintiles under the two mitigation scenarios.

**6. Conclusion**

This report considers a specific approach of disaggregating output from a Computable General Equilibrium (CGE) model, MMRF-Green (see Commonwealth of Australia, 2008), into impacts at the household and individual level for the period from 2005 to 2030. This report considers an approach to compute the potential distributional effects of two climate-change mitigation policies compared to a reference case without mitigation. CGE predictions of aggregate economic effects arising from climate change policies are disaggregated to the household and individual level. These CGE results, used as inputs in this report, were computed as part of the Garnaut Review. Our approach is based on a large number of assumptions (both in our own modelling and in the modelling that precedes it) and therefore the results that we present should be interpreted with caution. Appendix F gives an overview of important assumptions and limitations. The specific results obtained are a useful addition to the debate. Ideally the sensitivity of results to a range of assumptions should be checked before drawing any strong conclusions. A number of assumptions used in this report were imposed by the specific CGE results we use (and in theory, these could be changed to be

made more suitable for the distributional analysis). The microsimulation modelling would also benefit from access to aggregate results which would provide more detail on a number of key outcomes, such as for example, wage and employment changes by occupation or skill level, or consumption changes by broad income categories to allow for differences in price responses for low-income households from higher income households. Despite these caveats, the results from this analysis are of interest and an important first step in setting up this type of analysis. From this analysis it appears further work would be viable and is likely to be productive. Future work could be based on alternative CGE analyses designed to capture the effects of greenhouse mitigation policy changes (and associated compensation arrangements) on the income and welfare of individual households in an improved way.

The two climate change mitigation policies considered are the 450ppm scenario –which involves reducing emissions for Australia to a stabilisation level of 90 per cent below 2000 levels by 2050– and the 550ppm scenario –which involves a reduction to 80 per cent (Garnaut, 2008). The economy-wide impacts estimated by a CGE model (MMRF-Green) are transferred to a microsimulation model (MITTS) and disaggregated to the household level. This approach is used to predict the economic effects of climate-change mitigation policies at the household and individual level. The first part of the report describes the approach implemented to use MMRF results as input in MITTS. The main difficulty arises from the fact that information regarding households is highly aggregated in CGE models like MMRF-Green, while microsimulation models like MITTS use and provide very detailed information at the household and individual level.

The distributional analysis focuses on the variations of five outcome variables for the period from 2005 to 2030. Specifically, the six points in time considered within this period are 2005 (base year), 2010, 2015, 2020, 2025 and 2030. For each point in time and each outcome variable, the results obtained under the two mitigation scenarios are compared to the results obtained under the reference case. Moreover, the impact on each outcome variable is considered by income quintile, household type and region. In the CGE modelling on which this report is based, it is assumed that climate change itself will not have a direct economic impact before 2030. Therefore, the only difference between the mitigation scenarios and the reference case is the introduction of an Emissions Trading Scheme (ETS) on 1 July 2013, which results in all scenarios being identical prior to this date. It is assumed that the revenue generated by the introduction of an ETS is returned to households as equal lump sum transfers on a per capita basis.

The five outcome variables considered in this report are real net income, income inequality, the budget shares of basic necessities, the budget shares of an energy bundle and average hours of work. The main findings are the following:

- Although the reference case scenario and the two mitigation policy scenarios are all predicted to experience a substantial increase in aggregate gross income, the introduction of both mitigation policies is expected to result in slower income growth. Under the 450ppm scenario, total gross income increases by about 90 per cent by 2030 compared to 98 per cent in the reference case.
- Under all scenarios, the highest income quintiles experience the largest increases in average real net incomes (RNI) while the bottom quintile experiences almost no growth. However, low-income households are better off under the mitigation scenarios due to the returned permit revenue, which is a relatively large amount for this group and appears to overcompensate them for the introduction of the mitigation policies.
- Both RNI levels and growth are highest for couples (with or without children) and lowest for single parents. Although mitigation policies have a small negative impact on RNI for couples and singles, their effect is positive for sole parents up to around 2015 possibly due to the over-representation of low-income households within this group. After 2020, mitigation policies have a small negative impact on RNI for sole parents as well.
- The mitigation policies appear to have a relatively small negative effect on RNI in all States, although the higher income States have a larger reduction in average RNI compared to the lower income States.
- The changes in incomes over time are accompanied by an increase in income inequality as measured by the Gini coefficient. To a large extent, this is due to the assumption made in MMRF-Green regarding the indexation of benefit payments to the CPI instead of the wage index.
- Both mitigation policies appear to reduce inequality overall, within each income quintile, each household type and each State. The lump sum transfers distributed under the mitigation scenarios have a dampening impact on the Gini coefficients since they are distributed on a per capita basis. In addition, income growth is slightly lower under the two mitigation scenarios so that the divergence over time between factor income and benefit payments is reduced. However, the reduction in inequality is much lower than the increase in inequality over time. The latter appears to a large extent due to the assumption of constant real benefit levels over time (that is benefits are indexed to the CPI only, which is lower than the real wage growth).
- Average budget shares of basic expenditure and energy bundles are in general very similar for the reference case and the two scenarios. The overall pattern derived from the MMRF-Green modelling is one of declining shares over time.

- The shares of basic necessities in the different scenarios (at the national level but also by income quintile or household type) slightly diverge in 2015 (after the mitigation policy is introduced), but then converge again and the three scenarios display very similar shares in 2030.
- By contrast, the energy shares are diverging over time between the reference case on the one hand, and the 450ppm and 550ppm scenarios on the other. Compared to the reference case, the two scenarios display slightly lower budget shares for the energy bundle.
- Over time there is very little change in the average hours of work. Moreover, in the majority of subgroups and at the population level, there is little difference in outcomes under the reference case and under either of the two mitigation policy scenarios.

## Appendix A: MMRF-Green output

Appendix Table A.1 MMRF-Green output to be used in MITTS

	Changes over time	Changes across scenarios	Changes broken down by	Additional information	MMRF assumptions	Information used by MITTS
<b>Population</b>						
Population (projections from Treasury and ABS 2005, series B)	Yes Exogenous	No	State	In MITTS we also use age and gender, as provided by Treasury	Adopts Treasury projections but only total population by State is used in MMRF	Population projections by age, gender and State from Treasury
Interstate migrations	Yes Combination of exogenous (Treasury) and endogenous changes	No	No breakdown	Changes determined by Treasury + MMRF	Interstate migrations only affect population size (but not population composition)	State populations for all scenarios from MMRF
<b>Labour Market</b>						
Employment levels	Yes in short run No in long run	Yes	State & industry			Changes in employment levels by State and industry + base values
Unemployment levels	Yes	Yes	State			Changes in unemployment levels by State + base values
Wages	Yes Endogenous	Yes	State		Flexible wages	Percentage changes in average real wages by State
Wage differentials by State & industry	No	No	-		Wage differentials are fixed	
<b>Prices</b>						
Price changes	Yes Endogenous	Yes Endogenous	63 commodities State		CPI = numéraire	63 price changes from the 8 regions

## Appendix Table A.1 Continued

	Changes over time	Changes across scenarios	Changes broken down by	Additional information	MMRF assumptions	Information used by MITTS
<b>Tax and social security system</b>						Initial tax rates and benefit levels (for comparison purposes)
Income tax rates	No	No	No breakdown, just 1 national average			-
Unemployment benefits	Yes Endogenous	Yes Endogenous	State	Indexed to CPI	Fixed in real terms (aggregate amount follows number of unemployed)	CPI index
Pensions	Yes Endogenous	Yes Endogenous	State	Indexed to CPI	Fixed in real terms (aggregate amount follows population size)	CPI index
Disability grant and other government benefits	Yes Endogenous	Yes Endogenous	State	Indexed to CPI	Fixed in real terms (aggregate amount follows population size)	CPI index
<b>Non-labour factor income</b>						
Non-labour factor income	Yes Endogenous	Yes Endogenous	State	Includes profit, dividends, income from own business, income from agricultural land (latter is small), rents and imputed rents. See National accounts.		Average changes in household real capital returns by State
<b>Household expenditures</b>						Initial budget shares of 63 commodities by State and concordance tables
Consumption patterns	Yes Endogenous	Yes Endogenous	State and 63 commodities	ABS ANZSIC classification	63 commodities include 3 energy-related commodities CPI = numéraire	Changes in 63 budget shares by State

Note: Endogenous means that changes in the corresponding variables are determined by MMRF-Green. Exogenous means that changes (if any) are exogenous to MMRF-Green.

## Appendix B: Industry concordance table

**Table B.1 Mapping of the 55 MMRF-Green industries into the 13 MITTS industries**

<b>Agriculture, Forestry and Fishing</b>	
1	Sheep and cattle
2	Dairy
3	Other animals
4	Grains
5	Other agriculture
6	Agricultural services and fishing
7	Forestry and logging
<b>Mining</b>	
8	Coal mining
9	Oil mining
10	Gas mining
11	Iron ore mining
12	Non-ferrous metal ores
13	Other mining
<b>Manufacturing</b>	
14	Meat products
15	Other food and drink products
16	Textiles, clothing and footwear
17	Wood products
18	Paper products
19	Printing and publishing
20	Petroleum refinery
21	Other chemicals
22	Rubber and plastic products
23	Non-metallic construction materials (not cement)
24	Cement
25	Iron and steel
26	Alumina
27	Aluminium
28	Other non-ferrous metals
29	Other metal products
30	Motor vehicle and parts
31	Other manufacturing products
<b>Electricity, Gas and Water Supply</b>	
32	Electricity - coal
33	Electricity - gas
34	Electricity - oil products
35	Electricity - nuclear
36	Electricity - hydro

**Table B.1 Continued**

<b>Electricity, Gas and Water Supply (continued)</b>
37 Electricity - non-hydro renewable
38 Electricity supply
39 Gas supply
40 Water supply
<b>Construction</b>
41 Construction services
<b>Wholesale Trade &amp; Retail Trade</b>
42 Trade services
<b>Accommodation, Cafes and Restaurants</b>
43 Accommodation and hotels
<b>Transport and Storage</b>
44 Road transport - passenger
45 Road transport - freight
46 Rail transport - passenger
47 Rail transport - freight
48 Other transport (includes water transport)
49 Air transport
<b>Communication Services</b>
50 Communication services
<b>Finance and Insurance</b>
51 Financial services
<b>Property and Business Services</b>
52 Business services
53 Dwelling ownership
<b>Government Administration and Defence &amp; Education &amp; Health and Community Services</b>
54 Public services
<b>Cultural and Recreational Services &amp; Personal and Other Services</b>
55 Other services

## Appendix C: HES to MMRF-Green Commodities<sup>23</sup>

**Table C.1 Mapping of 600+ HES expenditure items to 63 MMRF-Green commodities**

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6 Other agriculture

- Trees, shrubs and plants
- Other gardening products
- Animal purchases

7 Agricultural services and fishing

- Fishing equipment

15 Meat products

- Meat (excluding fish and seafood) not further defined (nfd)
- Ham (including canned)
- Bacon (including canned)
- Sausages (not continental)
- Canned meat (other than bacon and ham)
- Frozen processed meat
- Mince
- Smallgoods
- Processed meat not elsewhere classified (nec)
- Prepared beef and veal
- Beef and veal nec
- Prepared mutton and lamb
- Mutton and lamb nec
- Prepared pork (excluding bacon and ham)
- Pork (excluding bacon and ham) nec
- Prepared poultry
- Poultry nec
- Game
- Offal
- Meat (excluding fish and seafood) nec
- Fresh meat for animal food (including mince and bones)

16 Other food and drink products

- Food and non-alcoholic beverages nfd
  - Bread
  - Flour
  - Cakes, tarts and puddings (fresh or frozen)
  - Biscuits
  - Cake, biscuit, pudding and bread mixes
  - Breakfast cereals
  - Pasta
  - Rice
  - Cereals and pasta nec
- 

<sup>23</sup> For missing commodities, no expenditure was observed in the HES.

**Table C.1 Continued**

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## 16 Other food and drink products (continued)

Fish and seafood nfd  
Fresh fish and seafood  
Frozen fish and seafood  
Canned and bottled fish and seafood  
Fish and seafood nec  
Fresh eggs  
Eggs and egg products nec  
Fresh milk  
Fresh cream  
Cheese  
Butter  
Powdered milk  
Yoghurt  
Dairy products nec  
Margarine  
Edible oils and fats nec  
Fruit and nuts nfd  
Fresh fruit nfd  
Fresh citrus fruit  
Fresh stone fruit  
Fresh apples and pears  
Fresh berries  
Fresh grapes  
Fresh melons  
Fresh tropical fruit (excluding bananas)  
Fresh bananas  
Fresh fruit nec  
Canned, frozen and bottled fruit  
Dried fruit nfd  
Dried grapes  
Dried fruit nec  
Nuts  
Vegetables nfd  
Fresh vegetables nfd  
Fresh potatoes  
Fresh onions  
Other fresh root vegetables  
Fresh tomatoes  
Fresh flower vegetables  
Fresh leaf vegetables  
Fresh peas and beans  
Fresh pumpkin  
Fresh vegetables nec  
Frozen vegetables  
Other vegetables

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**Table C.1 Continued**

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## 16 Other food and drink products (continued)

Sugar  
Marmalades, jams and preserves  
Honey  
Syrups  
Jellies and desserts  
Potato crisps and other savoury confectionery  
Chocolate confectionery  
Ice confectionery (including ice cream)  
Confectionery nec  
Spices and herbs  
Sauces and salad dressings  
Spreads and dips  
Other food additives  
Canned spaghetti and baked beans  
Canned and bottled baby foods  
Frozen prepared meals  
Packaged prepared meals nec  
Non-alcoholic beverages nfd  
Soft drinks  
Packaged waters  
Fruit and vegetable juice nfd  
Fruit juice  
Vegetable juice  
Mixed fruit and vegetable juice  
Tea  
Coffee  
Canned and packeted soup  
Soy and non-dairy milks  
Food drinks nec  
Cordials  
Unpackaged milk-based beverages  
Food nec  
Non-alcoholic beverages nec  
Alcoholic beverages nfd  
Alcoholic beverages nfd for consumption off licensed premises  
Alcoholic beverages nfd for consumption on licensed premises  
Beer nfd  
Beer for consumption off licensed premises  
Beer for consumption on licensed premises  
Wine nfd  
Wine for consumption off licensed premises  
Wine for consumption on licensed premises  
Spirits nfd  
Spirits for consumption off licensed premises  
Spirits for consumption on licensed premises

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**Table C.1 Continued**

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## 16 Other food and drink products (continued)

Other alcoholic beverages nfd  
Other alcoholic beverages for consumption off licensed premises  
Other alcoholic beverages for consumption on licensed premises  
Cigarettes  
Other tobacco  
Tobacco products nec  
Animal food nfd  
Prepared dog and cat food  
Bird seed and other seeds  
Animal food nec  
Ice

## 17 Textiles, clothing and footwear

Clothing nfd  
Men's clothing nfd  
Men's suits  
Men's coats  
Men's trousers (excluding jeans)  
Men's jeans  
Men's cardigans and pullovers  
Men's shirts  
Men's underwear  
Men's sleepwear  
Men's T-shirts  
Men's clothing nec  
Women's clothing nfd  
Women's trousers and skirts (excluding jeans)  
Women's dresses and suits  
Women's jeans  
Women's coats  
Women's cardigans and pullovers  
Women's foundation garments  
Women's underwear (excluding foundation garments)  
Women's sleepwear  
Women's shirts and blouses  
Women's T-shirts  
Women's clothing nec  
Boys' clothing nfd  
Boys' underwear  
Boys' sleepwear  
Boys' trousers (excluding jeans)  
Boys' shirts  
Boys' jeans  
Boys' suits  
Boys' coats

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**Table C.1 Continued**

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17 Textiles, clothing and footwear (continued)
Boys' cardigans and pullovers
Boys' T-shirts
Boys' clothing nec
Girls' clothing nfd
Girls' underwear (excluding foundation garments)
Girls' sleepwear
Girls' dresses and suits
Girls' skirts and trousers (excluding jeans)
Girls' shirts and blouses
Girls' jeans
Girls' coats
Girls' cardigans and pullovers
Girls' foundation garments
Girls' T-shirts
Girls' clothing nec
Nappies
Infants' clothing nec
Men's hosiery
Women's hosiery
Children's and infants' hosiery
Hats and other headwear
Clothing accessories (e.g. ties, gloves, handkerchiefs)
Clothing materials
Haberdashery
Other clothing nec
Footwear nfd
Sports and leisure footwear nfd
Footwear nec
Men's footwear nfd
Men's sports and leisure footwear
Men's footwear nec
Women's footwear nfd
Women's sports and leisure footwear
Women's footwear nec
Children's and infants' footwear nfd
Children's and infants' sports and leisure footwear
Children's and infants' footwear nec
Carpets
Floor rugs, mats and matting
Bed linen
Blankets and travelling rugs
Bedspreads and continental quilts
Pillows and cushions
Towels and face washers
Table and kitchen linen

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**Table C.1 Continued**

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## 17 Textiles, clothing and footwear (continued)

- Curtains
- Other household textiles
- Household linen and furnishings (excluding ornamental) nec
- Surgical dressings
- Specialist sports shoes

## 18 Wood products

- Wood for fuel (selected dwelling)
- Wood for fuel (other property)
- Other floor coverings

## 19 Paper products

- Household paper products (excluding stationery)
- Paper and writing pads
- Cards, envelopes and forms

## 20 Printing and publishing

- Books
- Newspapers
- Magazines and comics
- Books, newspapers, magazines and other printed material nec

## 25 Other fuels

- Heating oil (selected dwelling)
- Heating oil (other property)
- Kerosene and paraffin
- Domestic fuel and power nec
- Motor vehicle fuel, lubricants and additives nfd
- Oils, lubricants and additives
- Bottled gas for BBQ

## 26 Other chemicals

- Household soaps and detergents
  - Household polishes
  - Other household cleaning agents
  - Swimming pool chemicals
  - Medicines and pharmaceutical products nfd
  - Prescriptions
  - Non-prescribed pain relievers
  - Sunscreens
  - Non-prescribed ointments and lotions nec
  - Medicines and pharmaceutical products nec
  - Animal health products
  - Oral hygiene products
  - Toilet soap
-

**Table C.1 Continued**

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## 26 Other chemicals (continued)

- Talcum powders and deodorants
- Haircare products
- Fragrances
- Toiletries and cosmetics nec

## 27 Rubber and plastic products

- Repairs and maintenance - paint
- Vinyl and other sheet floor coverings
- Foodwraps (excluding paper)
- Tyres and tubes

## 28 Non-metallic construction materials (not cement)

- Floor tiles
- Tableware
- Glassware

## 34 Other metal products

- Cutlery
- Nails, screws and other fasteners

36 Other manufacturing products<sup>a</sup>

- Repairs and maintenance (materials only) nec
- Bedroom furniture
- Lounge/dining room furniture
- Outdoor/garden furniture
- Other furniture
- Blinds
- Paintings, carvings and sculptures
- Ornamental furnishings nec
- Cooking utensils
- Cleaning utensils
- Glassware, tableware, cutlery and household utensils nec
- Gardening tools
- Household non-durables nfd
- Household non-durables nec
- Medicines, pharmaceutical products and therapeutic appliances nfd
- First aid supplies, therapeutic appliances and equipment nec
- Purchase of caravan (other than selected dwelling)
- Purchase of bicycle
- Television aerials nec
- Blank video cassettes and video discs
- Audio cassettes and tapes
- Blank computer media
- Blank and pre-recorded media nec
- Sunglasses (excluding prescription)

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**Table C.1 Continued**

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36 Other manufacturing products (continued) <sup>a</sup>
Other optical goods
Studio and other professional photography
Musical instruments and accessories
Purchase of boat
Boat purchase, parts and operation nec
Purchase of aircraft
Aircraft purchase, parts and operation nec
Toys
Camping equipment
Sports equipment nfd
Golf equipment (excluding specialist sports shoes)
Water sport, snow sport and skating equipment
Bats, sticks, racquets and balls for field and court games
Sports equipment nec
Above ground pool
Art and craft materials
Recreational and educational equipment nec
Feminine hygiene products
Stationery equipment nfd
Pens
Stationery equipment nec
Watches
Clocks (including timers)
Jewellery
Travel goods, handbags, umbrellas, wallets and related
Lay-by (unspecified content)
Baby goods (excluding clothing)
Christmas decorations
Miscellaneous goods nec
45 Water supply
Water and sewerage rates and charges (selected dwelling)
Water and sewerage rates (other property)
47 Trade services
Repairs and maintenance (contractors) - repainting
Repairs and maintenance (contractors) - electrical work
Repairs and maintenance (contractors) - plumbing
Repairs and maintenance (contractors) - reroofing
Repairs and maintenance (contractors) - nec
Landscape contractor
Additions and extensions
Internal renovations
Insulation

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**Table C.1 Continued**

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## 48 Accommodation and hotels

Meals in restaurants, hotels, clubs and related  
Fast food and takeaway (not frozen)  
School lunch money  
Holiday hotel/motel charges - Australia (less than 4 nights)  
Holiday hotel/motel charges - Australia (4 nights or more)  
Holiday flat/house charges - Australia (less than 4 nights)  
Holiday flat/house charges - Australia (4 nights or more)  
Caravan park fees/hire of caravans - Australia (less than 4 nights)  
Caravan park fees/hire of caravan - Australia (4 nights or more)  
Other accommodation charges - Australia (less than 4 nights)  
Other accommodation charges - Australia (4 nights or more)  
Holiday motel/hotel charges - overseas (less than 4 nights)  
Holiday motel/hotel charges - overseas (4 nights or more)  
Other holiday accommodation charges - overseas (less than 4 nights)  
Other accommodation charges - overseas (4 nights or more)  
Non-holiday accommodation  
Airfare inclusive package tours - Australia (less than 4 nights)  
Airfare inclusive package tours - Australia (4 nights or more)  
Other package tours - Australia (less than 4 nights)  
Other package tours - Australia (4 nights or more)  
Airfare inclusive package tours - overseas (less than 4 nights)  
Airfare inclusive package tours - overseas (4 nights or more)  
Other package tours - overseas (less than 4 nights)  
Other package tours - overseas (4 nights or more)

## 49 Road transport - passenger

Bus and tram fares  
Taxi fares  
Holiday bus fares - Australia (less than 4 nights)  
Holiday bus fares - Australia (4 nights or more)

## 51 Rail transport - passenger

Rail fares  
Holiday rail fares - Australia (less than 4 nights)  
Holiday rail fares - Australia (4 nights or more)

## 53 Other transport (includes water transport)

Postal charges  
Public transport fares nfd  
Water transport fares  
Combined bus/tram/rail/water transport fares  
Public transport fares nec  
Removalists charges  
Fare and freight charges (excluding holidays and public transport) nec  
Other holiday fares - Australia (excluding vehicle hire) (less than 4 nights)

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**Table C.1 Continued**

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## 53 Other transport (includes water transport) (continued)

- Other holiday fares - Australia (excluding vehicle hire) (4 nights or more)
- Other holiday fares - overseas (less than 4 nights)
- Other holiday fares - overseas (4 nights or more)
- Delivery charges not associated with a specific good

## 54 Air transport

- Air fares (excluding holiday)
- Holiday air fares - Australia (less than 4 nights)
- Holiday air fares - Australia (4 nights or more)
- Holiday airfares - overseas (less than 4 nights)
- Holiday airfares - overseas (4 nights or more)

## 55 Communication services

- Fixed telephone account
- Mobile telephone account
- Public telephone call (not account)
- Mobile phone charges (not account)
- Telephone and facsimile charges nec
- TV games and computer software nfd
- Computer software - games
- Computer software (excluding games)
- TV games and computer software nec
- Pre-recorded video cassettes and video discs
- Pre-recorded compact discs and records (audio)
- Pay TV fees
- Internet charges (account)
- Internet charges (not account)

## 56 Financial services

- House insurance - separable (selected dwelling)
  - Contents insurance - separable (selected dwelling)
  - House and contents insurance - inseparable (selected dwelling)
  - Audiovisual equipment and personal computer repairs insurance
  - Household appliance repairs insurance nec
  - Sickness and personal accident insurance
  - Compulsory insurance of motor vehicle (other than motor cycle)
  - Other insurance of motor vehicle (other than motor cycle)
  - Compulsory insurance of motor cycle, caravan and trailer
  - Other insurance of motor cycle, caravan and trailer
  - Insurance (other property)
  - Financial institution charges and fees on financial institution accounts
  - Duties, taxes and charges on financial institution accounts nec
  - Fees nec - private
  - Personal belongings insurance
  - Travel insurance - selected payments
-

**Table C.1 Continued**

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## 56 Financial services (continued)

- Superannuation and annuities
- Life insurance
- Loans for alterations and additions - interest component
- Loans for vehicle - interest component
- Loans for holiday - interest component
- Loans - interest component (excluding housing loans) nec
- Interest payments on credit card purchases
- Interest payments on credit card cash advances

## 57 Business services

- Hire of clothing and footwear
- Pest control services
- Gardening services
- Private rubbish removals
- Housekeeping and cleaning services (including ironing) nfd
- Home help services
- Housekeeping and cleaning services (including ironing) nec
- Security services
- Household services nec
- Carpet cleaning
- Hire of tools
- Hire of household durables nec
- Hire of therapeutic appliances
- Vehicle hire and leasing expenses (non-holiday)
- Vehicle charges (including hire of accessories) nec
- Hire of television
- Hire of video cassette recorder
- Hire of video cassette tapes and TV/computer games
- Hire of sports equipment
- Hire of recreational and educational equipment nec
- Holiday vehicle hire - Australia (less than 4 nights)
- Holiday vehicle hire - Australia (4 nights or more)
- Veterinary charges
- Animal minding charges
- Animal care and grooming
- Legal fees
- Accountant and tax agent fees
- Lease payments (excluding vehicle leases)
- Personal advertising and related

## 58 Dwelling ownership

- Rent payments
- Rate payments (selected dwelling) nfd
- Local government rates (selected dwelling)
- Body Corporate Payments (selected dwelling)

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**Table C.1 Continued**

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## 58 Dwelling ownership (continued)

Rate payments (other property) nfd  
Local government rates (other property)  
Rent payments (other property)  
Body corporate payments (other property)  
Payments for other property nec  
Fees nfd

## 59 Public services

Child care services nfd  
Preschool  
Formal child care services nec  
Informal child care services  
General practitioner doctor's fees  
Specialist doctor's fees  
Dental fees  
Optician's fees (including spectacles)  
Physiotherapy and chiropractic fees  
Health practitioner's fees nec  
Hospital and nursing home charges  
Other medical care and health expenses nec  
Compulsory registration of motor vehicle (other than motor cycle)  
Compulsory registration of motor cycle, caravan and trailer  
Driver's licence  
Animal fees (including registration)  
Education fees for primary and secondary school nfd  
Primary school fees (excluding school sports fees) (government) - including pre year 1  
Primary school sports fees (government) - including pre-year 1  
Primary school fees (excluding school sports fees) (independent) - including pre year 1 - Catholic  
Primary school sports fees (independent) - including pre-year 1- Catholic  
Primary school fees (excluding school sports fees) (independent) - including pre-year 1 - excluding Catholic  
Primary school sports fees (independent) - including pre-year-1 - excluding Catholic  
Secondary school fees (excluding school sports fees) (government)  
Secondary school sports fees (government)  
Secondary school fees (excluding school sports fees) (independent) - Catholic  
Secondary school sports fees (independent) - Catholic  
Secondary school fees (excluding school sports fees) (independent) - excluding Catholic  
Secondary school sports fees (independent) - excluding Catholic  
HECS  
Higher education institution fees nec  
TAFE course fees  
Fees paid to other educational institutions nec  
Private education tuition fees  
Counselling services

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**Table C.1 Continued**

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## 59 Public services (continued)

Registration and insurance of boat  
Registration and insurance of aircraft  
Government duties, taxes and charges on financial institution accounts  
Fees nec - government  
Hospital, medical and dental insurance<sup>b</sup>  
Ambulance insurance (separate insurance)<sup>b</sup>

## 60 Other services

Dry cleaning and laundering of clothes  
Clothing repairs and alterations  
Footwear repairs and alterations  
Repair and maintenance of soft furnishings  
Repair and maintenance of audiovisual equipment and personal computers  
Repair and maintenance of household appliances nec  
Repair and maintenance of tools  
Repair and maintenance of household durables nec  
Combined compulsory registration and insurance of motor vehicle (other than motor cycle)  
Combined compulsory registration and insurance of motor cycle, caravan and trailer  
Crash repairs  
Vehicle servicing (including parts and labour)  
Parking fees  
Subscription to motor organisations  
Gambling nfd  
Lottery tickets  
Lotto type games and instant lottery (scratch cards)  
TAB, on course betting and related  
Poker machines and ticket machines  
Blackjack, roulette and other casino-type games  
TAB - betting (excluding animal racing)  
Club and casino broadcast gaming  
Gambling nec  
Repair of optical and photographic equipment  
Repair of sports equipment  
Repair of recreational and educational equipment (excluding audiovisual equipment) nec  
Health and fitness studio charges  
Sporting club subscriptions  
Squash court hire charges  
Ten pin bowling charges  
Green fees  
Sports lessons  
Spectator admission fees to sport  
Sports fees and charges nec  
Cinema fees and charges  
Live theatre fees and charges nfd  
Music concert fees and charges

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**Table C.1 Continued**

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## 60 Other services (continued)

Live theatre fees and charges nec  
Dance and nightclub fees and charges  
National park fees and charges  
Zoo fees and charges  
Art gallery and museum fees and charges  
Clubs and association subscriptions (excluding sports clubs)  
Cultural fees and charges nec  
Day trips and other excursions  
Amusement arcade machines  
Culture course  
Recreation course  
Life education program  
Culture and recreation lessons (excluding sports lessons) nec  
Charges for physical recreation nec  
Recreational and educational services nec  
Hair services nfd  
Hair services (male)  
Hair services (female)  
Personal care services nec  
Union dues, professional association subscriptions  
Repair of miscellaneous goods  
Miscellaneous services nec  
In-ground swimming pool  
Outside building  
Other outside improvements  
Capital housing costs nec  
Driving lessons  
Photographic film and chemicals (including developing)

## 61 Private transport services

Petrol  
Holiday petrol - Australia (less than 4 nights)  
Holiday petrol - Australia (4 nights or more)  
Diesel fuel  
LPG and other gas fuels  
Purchase of motor vehicle (other than motor cycle)  
Purchase of motor cycle  
Purchase of trailer  
Motor vehicle batteries  
Motor vehicle electrical accessories (purchased separately)  
Vehicle parts purchased separately nec  
Vehicle accessories purchased separately nec  
Road tolls

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**Table C.1 Continued**

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62 Private electrical equipment services<sup>b</sup>

63 Private heating equipment services<sup>b</sup>

Mains gas (selected dwelling)

Bottled gas - excluding gas for BBQs (selected dwelling)

Mains gas (other property)

Bottled gas (other property)

80 MIAESR defined – Appliances<sup>b</sup>

Cooking stoves, ovens, microwaves, hot plates and ranges

Refrigerators and freezers

Washing machines

Air-conditioners

Dishwashers

Clothes dryers

Whitegoods and other electrical appliances nec

Non-electrical household appliances

Lawnmowers (including electric)

Other hand and power tools

Mobile phones

Telephone handset (purchase)

Answering machines

Tools and other household durables nec

Therapeutic appliances and equipment (excluding hire)

Televisions

Satellite dishes

Video cassette recorders

Video cameras

Digital video disc players/laser disc players

Set top boxes

Video equipment nec

Radios

CD player

Integrated sound system

Amplifiers and tuner-amplifiers

Speakers

Audio equipment nec

Home entertainment systems

Audiovisual equipment and parts nec

Home computer equipment (including pre-packaged software)

Photographic equipment (excluding film and chemicals)

Shavers, hairdryers and related

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**Table C.1 Continued**

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81 MIAESR defined – Electricity<sup>b</sup>

Electricity (selected dwelling)

Electricity (other property)

96 MIAESR defined - Income tax<sup>c</sup>

Income tax

97 MIAESR defined - CPI adjustable residual<sup>c</sup>

Animal expenses nfd

Animal expenses nec

Alimony or maintenance payments

Cash gifts, donations to charity nfd

Cash gifts, donations to family or friends

Cash gifts, donations to churches, synagogues and related

Cash gifts, donations to charity nec

Pocket money or allowance

Fines

Mortgage repayments - principal component (selected dwelling)

Mortgage repayments - principal component (other property)

Purchase of selected dwelling or other property (excluding mortgage repayments but including outright purchase, deposit, net of sales)

98 MIAESR defined - Local and State taxes of various sorts<sup>c</sup>

Land tax (selected dwelling)

Land tax (other property)

100 MIAESR defined – Mortgage interest payments<sup>c</sup>

Mortgage repayments - interest component (selected dwelling)

Mortgage repayments - interest component (other property)

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Notes: a) Medical, hospital, dental and ambulance insurance should be included with all other insurance under MMRF commodity 56, financial services. However, as these specific insurance costs are more likely to rise with the CPI associated with health expenditures they have been re-assigned to commodity 59, public services.

b) MIAESR defined group 80 (appliances) and 81 (electricity) are fully redistributed over commodities 36, 62 and 63 as per below:

62 - PrivElec: 50 per cent of electricity purchased by households (“81”) plus 30 per cent of household appliances purchased by households (“80”)

63 - PrivHeat: Whatever is already assigned to commodity 63 plus 50 per cent of electricity (“81”) and about 60 per cent of household appliances purchased by households (“80”)

36 - Other manufacturing products: whatever was already assigned to commodity 36 plus the remaining 10 per cent of appliances (“80”) not assigned to commodity 62 or 63.

c) MIAESR defined groups 96, 97, 98 and 100 are not redistributed and are not considered to be part of the expenditures on MMRF commodities 1 through 63.

**Table C.2 Basic Necessities and the Energy Bundle**

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**Basic Necessities**

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- 15 Meat products
- 16 Other food and drink products
- 17 Textiles, clothing and footwear
- 45 Water supply
- 49 Road transport - passenger
- 51 Rail transport - passenger
- 53 Other transport (includes water transport)
- 58 Dwelling ownership
  
- 61 Private transport services
- 62 Private electrical equipment services
- 63 Private heating equipment services

**Energy Bundle:**

- 61 Private transport services
- 62 Private electrical equipment services
- 63 Private heating equipment services

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Note: Although in principle the definition of basic necessities and the energy bundle are flexible, they need to be a grouping of the existing MMRF-Green commodities for consistency. The reason for this is that price changes and consumption level changes in MMRF-Green are available only by commodities as defined in MMRF-Green, and not by individual household expenditure item available in the HES.

## Appendix D: The Reweighting Procedure

The calibration approach used in this report produces new weights which achieve specified population totals for selected variables, subject to the constraint that there are minimal adjustments to the original weights.

A formal statement of the problem of obtaining ‘minimum distance’ weights and a general approach to the solution are described in D.1. The constrained minimisation problem must be solved using iterative methods, and an approach using Newton’s method is described. The distance measure and the corresponding solution are discussed in D.2. Section D.3 presents tables with the required population totals for the base year and the five simulation years in each scenario and the reference case. In addition, the effect on the weights is briefly discussed. The first two sections in this Appendix are quite technical due to the subject matter.

### D.1 Statement of the Minimisation Problem

This section provides a general statement of the problem of minimising the overall distance between two sets of weights, subject to a set of calibration conditions. For each of  $K$  individuals in a sample survey, information is available about  $J$  variables; these are placed in the vector:

$$x_k = \begin{bmatrix} x_{k,1} \\ \cdot \\ \cdot \\ \cdot \\ x_{k,J} \end{bmatrix} \quad (\text{D.1})$$

For present purposes these vectors contain only the variables of interest for the calibration exercise. Many of the elements of  $x_k$  are likely to be 0/1 variables. For example  $x_{k,j} = 1$  if the  $k^{\text{th}}$  individual is in a particular age group, and zero otherwise. The sum  $\sum_{k=1}^K x_{k,j}$  therefore gives the number of individuals in the sample, who are in the age group.

Let the sample design weights, provided by the statistical agency responsible for data collection, be denoted  $s_k$  for  $k = 1, \dots, K$ . These weights are used to produce estimated population totals,  $\hat{t}_{x|s}$ , based on the sample, given by the  $J$ -element vector:

$$\hat{t}_{x|s} = \sum_{k=1}^K s_k x_k \quad (\text{D.2})$$

The problem examined in this appendix can be stated as follows. Suppose that other data sources, for example census or MMRF-Green, provide information about ‘true’ population

totals,  $t_x$ . The problem is to compute new weights,  $w_k$ , for  $k = 1, \dots, K$  which are as close as possible to the design weights,  $s_k$ , while satisfying the set of  $J$  calibration equations:

$$t_x = \sum_{k=1}^K w_k x_k \quad (\text{D.3})$$

It is thus necessary to specify a criterion by which to judge the closeness of the two sets of weights.

In general, denote the distance between  $w_k$  and  $s_k$  as  $G(w_k, s_k)$ . The aggregate distance between the design and calibrated weights is thus:

$$D = \sum_{k=1}^K G(w_k, s_k) \quad (\text{D.4})$$

The problem is therefore to minimise (D.4) subject to (D.3). The Lagrangean for this problem is:

$$L = \sum_{k=1}^K G(w_k, s_k) + \sum_{j=1}^J \lambda_j \left( t_{x,j} - \sum_{k=1}^K w_k x_{k,j} \right) \quad (\text{D.5})$$

where  $\lambda_j$  for  $j = 1, \dots, J$  are the Lagrange multipliers.

### D.1.1 A Class of Distance Functions

Suppose that  $G(w_k, s_k)$  has the property that the differential with respect to  $w_k$  can be expressed as a function of the ratio  $w_k/s_k$ , so that:

$$\frac{\partial G(w_k, s_k)}{\partial w_k} = g\left(\frac{w_k}{s_k}\right) \quad (\text{D.6})$$

The  $K$  first-order conditions for minimisation can therefore be written as:

$$g\left(\frac{w_k}{s_k}\right) = x'_k \lambda \quad (\text{D.7})$$

Write the inverse function of  $g$  as  $g^{-1}$ , so that if  $g(w_k/s_k) = u$ , say, then  $w_k/s_k = g^{-1}(u)$ . In the case of the chi-square distance function used above,  $g(w_k/s_k) = w_k/s_k - 1$ , and the inverse takes a simple linear form. In general, from (D.7) the  $k$  values of  $w_k$  are expressed as:

$$w_k = s_k g^{-1}(x'_k \lambda) \quad (\text{D.8})$$

If the inverse function,  $g^{-1}$ , can be obtained explicitly, equation (D.8) can be used to compute the calibrated weights, given a solution for the vector,  $\lambda$ .

The Lagrange multipliers can be obtained by post-multiplying (D.8) by the vector  $x_k$ , summing over all  $k = 1, \dots, K$  and using the calibration equations, so that:

$$t_x = \sum_{k=1}^K w_k x_k = \sum_{k=1}^K s_k g^{-1}(x'_k \lambda) x_k \quad (\text{D.9})$$

Finally, subtracting  $\hat{t}_{x|s} = \sum_{k=1}^K s_k x_k$  from both sides of (D.9) gives:

$$t_x - \hat{t}_{x|s} = \sum_{k=1}^K s_k \left\{ g^{-1}(x'_k \lambda) - 1 \right\} x_k \quad (\text{D.10})$$

The term  $s_k \left\{ g^{-1}(x'_k \lambda) - 1 \right\}$  is a scalar and the left hand side is a known vector. In general, (D.10) is nonlinear in the vector  $\lambda$  and so must be solved using an iterative procedure, as described in the following subsection.

### D.1.2 An Iterative Procedure

Writing  $t_x - \hat{t}_{x|s} = a$ , the equations in (D.10) can be written as:

$$f_i(\lambda) = a_i - \sum_{k=1}^K s_k x_{k,i} \left\{ g^{-1}(x'_k \lambda) - 1 \right\} = 0 \quad (\text{D.11})$$

for  $i = 1, \dots, J$ . The roots can be obtained using Newton's method. This involves the following iterative sequence, where  $\lambda^{[I]}$  denotes the value of  $\lambda$  in the  $I^{\text{th}}$  iteration:<sup>24</sup>

$$\lambda^{[I+1]} = \lambda^{[I]} - \left[ \frac{\partial f_i(\lambda)}{\partial \lambda_\ell} \right]_{\lambda^{[I]}}^{-1} [f(\lambda)]_{\lambda^{[I]}} \quad (\text{D.12})$$

The Hessian matrix  $\left[ \partial f_i(\lambda) / \partial \lambda_\ell \right]$  and the vector  $f(\lambda)$  on the right hand side of (D.12) are evaluated using  $\lambda^{[I]}$ . The elements  $\partial f_i(\lambda) / \partial \lambda_\ell$  are given by:

$$\frac{\partial f_i(\lambda)}{\partial \lambda_\ell} = - \sum_{k=1}^K s_k x_{k,i} \frac{\partial g^{-1}(x'_k \lambda)}{\partial \lambda_\ell} \quad (\text{D.13})$$

which can be written as:

$$\frac{\partial f_i(\lambda)}{\partial \lambda_\ell} = - \sum_{k=1}^K s_k x_{k,i} x_{k,\ell} \frac{dg^{-1}(x'_k \lambda)}{d(x'_k \lambda)} \quad (\text{D.14})$$

Starting from arbitrary initial values, the matrix equation in (D.12) is used repeatedly to adjust the values until convergence is reached, where possible.

As mentioned earlier, the application of the approach requires that it is limited to distance functions for which the form of the inverse function,  $g^{-1}(u)$ , can be obtained explicitly,

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<sup>24</sup> The approach described here differs somewhat from other routines described in the literature, for example in Singh and Mohl (1996) and Vanderhoeft (2001). However, it provides extremely rapid convergence.

given the specification for  $G(w, s)$ . Hence, the Hessian can easily be evaluated at each step using an explicit expression for  $dg^{-1}(x'_k \lambda)/d(x'_k \lambda)$ . As these expressions avoid the need for the numerical evaluation of  $g^{-1}(x'_k \lambda)$  and  $dg^{-1}(x'_k \lambda)/d(x'_k \lambda)$  for each individual at each step, the calculation of the new weights can be expected to be relatively quick, even for large samples.<sup>25</sup> However, a solution does not necessarily exist, depending on the distance function used and the adjustment required to the vector  $t_x - \hat{t}_{x|s}$ .

## **D.2 The Adjusted Chi-Squared Function as the Distance Function**

This section considers the chi-squared function as the distance function, which satisfies the properties discussed in D.1. It examines the chi-squared distance function and its modification to restrict the range of deviation in the revised weights from the original weights. The chi-squared type of distance measure gives the aggregate distance by:

$$D = \frac{1}{2} \sum_{k=1}^K \frac{(w_k - s_k)^2}{s_k} \quad (\text{D.15})$$

It can be shown that an explicit solution can be obtained in this case (see for example Cai *et al.*, 2006). However, no constraints are placed on the size of the adjustment to each of the survey weights, and it is possible for some calibrated weights to become negative. Deville and Särndal (1992) suggested the following simple modification. Define  $r_L$  and  $r_U$  such that  $r_L < 1 < r_U$ . The objective is to ensure that, for increases, the proportionate change,  $w/s - 1$ , is less than  $r_U - 1$ , or that  $r_U > w/s$ . For decreases, the aim is to ensure that  $1 - w/s$  (or the negative of the proportional change) is less than  $1 - r_L$ , so that  $r_L < w/s$ .

For the chi-squared distance function,  $g^{-1}(u) = 1 + u$ , where  $u = x'_k \lambda$  and  $g^{-1}(u)$  solves for  $w/s$ . Hence if  $g^{-1}(u) = w/s$  is outside the specified range, it is necessary to set it to the relevant limit, either  $r_U$  or  $r_L$ , rather than allow it to take the value generated. Since  $g^{-1}(u) - 1 = w/s - 1 = u$ , it is clear that the limits are exceeded if  $u < r_L - 1$  and if  $u > r_U - 1$ . In each case where the value of  $g^{-1}(u)$  has to be set to the relevant limit, the corresponding value of  $dg^{-1}(u)/du$  is zero. This approach ensures that weights are kept within the range,  $r_L s_k < w_k < r_U s_k$ .

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<sup>25</sup> Using numerical methods to solve for each  $g^{-1}(u)$  and  $dg^{-1}(u)/du$ , for  $u = x'_k \lambda$ , for every individual in each iteration, would increase the computational burden substantially.

### ***D.3 Reweighting Benchmarks and Effects on Weights***

This section presents the actual benchmarks used in the reweighting procedures in a number of tables. The population projections underlying MMRF-Green are presented in Table D.1. These projections describe the structure of the total population as well as total regional populations by age and gender. All scenarios share the same population projections. Note that Table D.1 presents the information used in the second step of the reweighting procedure. In the first step, State populations are broken down by age and gender. The SIHC combines the two Territories in one category, so we artificially reproduce the distinction between ACT and NT in MITTS by predicting the probability for each household of living in the ACT or NT. Using this probability, each household is assigned to the ACT or the NT. However, note that this is a probabilistic assignment and not an exact one (see Appendix E).

Employment benchmarks by region and by industry, as well as unemployment benchmarks by region are presented in Table D.2 for the reference case, in Table D.3 for the 550ppm scenario and in Table D.4 for the 450ppm scenario. Note that these tables only present aggregate information to limit the size of the tables. In the actual reweighting, regional and industry dimensions are combined instead of being considered separately (resulting in  $8 \times 13 = 104$  categories to benchmark employment against, instead of  $8 + 13 = 21$  categories). Similarly, age and gender are combined with region in the first reweighting step (resulting in  $8 \times 29 = 232$  categories).

In addition, this section summarises by how much each sample weight changes due to the reweighting procedure through reporting the size of the factor of change at each decile point of these changes. Table D.5 indicates how the sample weights are affected by the reweighting procedure in the reference case. Results for the other scenarios are not reported given that they are very similar. The main reason for this similarity is that population projections are the same across scenarios and that differences in employment projections across scenarios are limited.

**Table D.1 MMRF underlying population projections**

		2005 (base)	2010	2015	2020	2025	2030
<b>Gender</b>	<b>Age group</b>						
ALL	0–4	1,286,669	1,377,998	1,444,285	1,528,885	1,589,781	1,621,914
ALL	5–9	1,336,038	1,356,656	1,431,796	1,496,481	1,581,222	1,642,426
ALL	10–14	1,400,665	1,401,404	1,413,368	1,486,606	1,551,391	1,636,384
Males	15–19	716,664	756,837	752,150	758,974	795,712	829,617
Males	20–24	730,248	794,929	823,899	817,987	825,056	862,019
Males	25–29	691,290	801,136	858,031	885,072	879,432	886,790
Males	30–34	753,999	749,334	852,202	907,592	934,744	929,433
Males	35–39	738,304	798,190	790,367	891,727	947,146	974,554
Males	40–44	766,977	770,511	827,452	819,255	920,536	976,212
Males	45–49	727,940	781,319	783,621	840,416	832,995	934,366
Males	50–54	666,673	727,475	780,453	783,960	841,253	834,904
Males	55–59	622,413	658,787	718,857	773,002	778,121	836,101
Males	60–64	473,857	606,317	645,442	706,817	762,149	769,389
Males	65–69	375,879	452,037	582,663	624,087	686,710	743,353
Males	70–74	299,377	344,251	420,555	546,580	590,178	653,698
Males	>74	506,446	582,353	676,386	817,624	1,044,509	1,264,854
Females	15–19	682,940	714,005	710,730	714,168	750,805	781,973
Females	20–24	703,939	744,879	762,670	757,311	760,841	797,613
Females	25–29	682,870	779,438	806,783	821,417	816,169	819,873
Females	30–34	764,498	742,153	832,382	856,754	871,498	866,466
Females	35–39	746,409	802,272	776,220	864,566	889,075	904,054
Females	40–44	777,301	771,785	824,287	797,402	885,776	910,565
Females	45–49	738,691	789,338	781,272	833,375	807,038	895,545
Females	50–54	672,751	739,467	788,875	781,552	833,934	808,377
Females	55–59	616,038	669,138	735,877	785,789	779,477	832,243
Females	60–64	469,219	609,393	664,206	731,184	781,662	776,722
Females	65–69	384,669	460,518	598,928	654,135	721,500	772,724
Females	70–74	324,589	366,925	443,171	578,133	633,969	701,741
Females	>74	742,483	809,386	898,001	1,041,504	1,292,203	1,559,827
<b>Region</b>							
New South Wales		6,759,079	7,118,118	7,452,971	7,822,920	8,218,094	8,598,145
Victoria		5,051,123	5,436,097	5,795,915	6,136,110	6,461,449	6,772,877
Queensland		3,997,041	4,428,900	4,858,426	5,302,638	5,762,930	6,221,323
South Australia		1,552,708	1,633,871	1,700,665	1,757,034	1,804,930	1,844,924
Western Australia		2,016,636	2,240,838	2,468,146	2,680,791	2,882,840	3,080,089
Tasmania		486,438	519,300	525,509	538,922	550,910	563,005
Northern Territory		206,518	226,117	244,156	263,987	285,517	308,075
Australian Capital Territory		330,292	354,990	379,140	399,952	418,213	435,299
Total population		20,399,835	21,958,232	23,424,927	24,902,355	26,384,882	27,823,737

**Table D.2 MMRF unemployment and employment projections: Reference case**

	2005 (base)	2010	2015	2020	2025	2030
<b>Employment by region</b>						
New South Wales	3,318,803	3,653,124	3,826,477	3,965,949	4,098,241	4,226,716
Victoria	2,507,891	2,816,770	3,001,690	3,136,671	3,248,310	3,355,935
Queensland	1,970,452	2,276,867	2,502,656	2,699,115	2,886,048	3,070,492
South Australia	773,492	850,949	886,118	902,879	911,266	917,648
Western Australia	992,902	1,154,781	1,271,846	1,362,000	1,440,573	1,517,358
Tasmania	236,951	264,692	268,126	271,303	272,829	275,012
Northern Territory	95,117	108,452	116,931	124,811	132,568	140,805
Australian Capital Territory	162,792	182,879	194,790	202,600	208,425	213,826
<b>Total employment</b>	<b>10,058,401</b>	<b>11,308,514</b>	<b>12,068,634</b>	<b>12,665,327</b>	<b>13,198,259</b>	<b>13,717,791</b>
<b>Employment by industry</b>						
Agriculture, Forestry and Fishing	356,896	354,103	432,741	474,481	492,996	510,219
Mining	127,222	179,589	158,797	124,892	111,608	106,097
Manufacturing	1,062,504	1,009,447	1,018,979	977,547	913,326	845,680
Electricity, Gas and Water Supply	87,305	83,119	81,143	88,412	75,286	68,689
Construction	876,482	1,012,818	988,687	988,353	1,016,615	1,029,952
Wholesale Trade & Retail Trade	1,941,600	2,169,045	2,202,751	2,236,712	2,251,258	2,239,915
Accommodation, Cafes and Restaurants	482,166	531,270	604,953	673,590	729,728	785,793
Transport and Storage	462,701	473,334	497,445	489,300	471,891	454,815
Communication Services	184,218	174,106	156,508	140,094	126,273	116,882
Finance and Insurance	376,725	413,737	442,639	457,922	467,992	477,971
Property and Business Services	1,198,269	1,545,998	1,824,553	2,096,209	2,369,929	2,639,003
Government Administration and Defence & Education & Health and Community Services	1,949,224	2,240,271	2,421,375	2,569,780	2,712,492	2,859,717
Cultural and Recreational Services & Personal and Other Services	953,091	1,121,678	1,238,063	1,348,035	1,458,864	1,583,058
<b>Unemployment by region</b>						
New South Wales	173,708	191,206	200,280	207,580	214,504	221,228
Victoria	131,264	147,431	157,110	164,175	170,018	175,651
Queensland	103,135	119,173	130,991	141,274	151,058	160,712
South Australia	40,628	44,696	46,543	47,424	47,864	48,199
Western Australia	56,926	66,207	72,919	78,088	82,593	86,995
Tasmania	13,043	14,570	14,759	14,934	15,018	15,138
Northern Territory	5,527	6,302	6,795	7,252	7,703	8,182
Australian Capital Territory	8,673	9,743	10,377	10,793	11,104	11,391
<b>Total unemployment</b>	<b>532,903</b>	<b>599,328</b>	<b>639,773</b>	<b>671,519</b>	<b>699,861</b>	<b>727,496</b>

**Table D.3 MMRF unemployment and employment projections: 550ppm scenario**

	2005 (base)	2010	2015	2020	2025	2030
<b>Employment by region</b>						
New South Wales	3,318,803	3,653,124	3,787,030	3,938,489	4,066,992	4,193,389
Victoria	2,507,891	2,816,770	2,979,151	3,123,832	3,241,142	3,352,432
Queensland	1,970,452	2,276,867	2,486,071	2,679,054	2,857,991	3,035,141
South Australia	773,492	850,949	880,721	904,185	915,025	924,610
Western Australia	992,902	1,154,781	1,275,444	1,370,838	1,452,841	1,529,641
Tasmania	236,951	264,692	265,516	269,415	271,589	274,914
Northern Territory	95,117	108,452	117,342	125,609	133,612	141,882
Australian Capital Territory	162,792	182,879	192,285	200,554	206,138	211,321
<b>Total employment</b>	<b>10,058,401</b>	<b>11,308,514</b>	<b>11,983,560</b>	<b>12,611,978</b>	<b>13,145,330</b>	<b>13,663,331</b>
<b>Employment by industry</b>						
Agriculture, Forestry and Fishing	356,896	354,103	436,255	481,005	503,579	526,272
Mining	127,222	179,589	160,810	126,328	112,459	106,435
Manufacturing	1,062,504	1,009,447	1,018,671	981,549	919,031	854,344
Electricity, Gas and Water Supply	87,305	83,119	71,434	78,542	66,212	61,507
Construction	876,482	1,012,818	961,376	966,543	992,596	1,002,400
Wholesale Trade & Retail Trade	1,941,600	2,169,045	2,184,911	2,228,275	2,244,408	2,234,275
Accommodation, Cafes and Restaurants	482,166	531,270	597,062	663,277	715,995	768,207
Transport and Storage	462,701	473,334	496,027	487,499	469,681	452,915
Communication Services	184,218	174,106	155,678	140,181	126,530	117,113
Finance and Insurance	376,725	413,737	441,091	457,667	468,135	478,340
Property and Business Services	1,198,269	1,545,998	1,813,615	2,091,934	2,366,287	2,635,974
Government Administration and Defence & Education & Health and Community Services	1,949,224	2,240,271	2,420,378	2,575,949	2,720,477	2,866,884
Cultural and Recreational Services & Personal and Other Services	953,091	1,121,678	1,226,252	1,333,230	1,439,941	1,558,664
<b>Unemployment by region</b>						
New South Wales	173,708	191,206	196,665	203,771	210,133	216,867
Victoria	131,264	147,431	155,740	164,104	170,341	176,786
Queensland	103,135	119,173	128,948	139,082	147,745	156,423
South Australia	40,628	44,696	46,431	47,834	48,666	49,522
Western Australia	56,926	66,207	72,690	78,089	82,801	87,267
Tasmania	13,043	14,570	14,679	14,930	15,089	15,429
Northern Territory	5,527	6,302	6,727	7,184	7,637	8,119
Australian Capital Territory	8,673	9,743	9,969	10,421	10,708	10,981
<b>Total unemployment</b>	<b>532,903</b>	<b>599,328</b>	<b>631,849</b>	<b>665,413</b>	<b>693,119</b>	<b>721,393</b>

**Table D.4 MMRF unemployment and employment projections: 450ppm scenario**

	2005 (base)	2010	2015	2020	2025	2030
<b>Employment by region</b>						
New South Wales	3,318,803	3,653,124	3,771,680	3,938,701	4,067,563	4,200,216
Victoria	2,507,891	2,816,770	2,968,586	3,119,067	3,236,402	3,354,295
Queensland	1,970,452	2,276,867	2,474,516	2,674,702	2,848,123	3,011,471
South Australia	773,492	850,949	880,736	910,110	924,501	938,370
Western Australia	992,902	1,154,781	1,278,800	1,372,751	1,454,793	1,534,365
Tasmania	236,951	264,692	265,905	271,172	274,596	280,053
Northern Territory	95,117	108,452	117,496	125,382	132,856	140,796
Australian Capital Territory	162,792	182,879	191,063	199,808	205,173	210,467
<b>Total employment</b>	<b>10,058,401</b>	<b>11,308,514</b>	<b>11,948,783</b>	<b>12,611,693</b>	<b>13,144,008</b>	<b>13,670,032</b>
<b>Employment by industry</b>						
Agriculture, Forestry and Fishing	356,896	354,103	442,235	495,842	531,945	571,410
Mining	127,222	179,589	159,810	122,853	107,569	100,175
Manufacturing	1,062,504	1,009,447	1,022,729	988,818	925,681	859,010
Electricity, Gas and Water Supply	87,305	83,119	71,235	83,083	69,857	65,567
Construction	876,482	1,012,818	946,682	956,916	980,825	990,580
Wholesale Trade & Retail Trade	1,941,600	2,169,045	2,178,720	2,232,699	2,252,012	2,244,512
Accommodation, Cafes and Restaurants	482,166	531,270	591,645	656,444	705,747	755,394
Transport and Storage	462,701	473,334	495,369	484,560	465,272	446,025
Communication Services	184,218	174,106	155,002	140,149	126,518	117,213
Finance and Insurance	376,725	413,737	440,111	457,250	467,337	477,784
Property and Business Services	1,198,269	1,545,998	1,809,900	2,090,410	2,361,412	2,628,227
Government Administration and Defence & Education & Health and Community Services	1,949,224	2,240,271	2,416,775	2,574,109	2,715,122	2,859,565
Cultural and Recreational Services & Personal and Other Services	953,091	1,121,678	1,218,570	1,328,560	1,434,710	1,554,570
<b>Unemployment by region</b>						
New South Wales	173,708	191,206	195,895	205,081	213,457	223,259
Victoria	131,264	147,431	155,503	164,927	172,114	178,927
Queensland	103,135	119,173	127,808	138,143	146,732	155,036
South Australia	40,628	44,696	46,556	48,459	49,989	51,555
Western Australia	56,926	66,207	73,042	78,944	84,541	90,219
Tasmania	13,043	14,570	14,708	15,150	15,615	16,308
Northern Territory	5,527	6,302	6,707	7,141	7,593	8,098
Australian Capital Territory	8,673	9,743	9,804	10,345	10,645	10,959
<b>Total unemployment</b>	<b>532,903</b>	<b>599,328</b>	<b>630,023</b>	<b>668,190</b>	<b>700,685</b>	<b>734,362</b>

**Table D.5 Ratio of new weights to original sample weights: Reference case**

	2005	2010	2015	2020	2025	2030
Decile 1	0.64	0.63	0.63	0.59	0.53	0.47
Decile 2	0.77	0.79	0.82	0.80	0.77	0.71
Decile 3	0.87	0.90	0.94	0.95	0.93	0.91
Decile 4	0.94	0.99	1.05	1.09	1.08	1.07
Decile 5	1.02	1.08	1.16	1.22	1.26	1.28
Decile 6	1.10	1.18	1.27	1.38	1.42	1.50
Decile 7	1.18	1.30	1.44	1.55	1.69	1.77
Decile 8	1.30	1.45	1.61	1.77	1.95	2.15
Decile 9	1.51	1.76	1.94	2.15	2.40	2.71

Note: This table should be read as follows: for 10 per cent of the records, the ratio of the new weight for 2005 (after reweighting) to the original sample weight is smaller than 0.64. For another 10 per cent of the records it is higher than 1.51.

## Appendix E: Distinguishing the Territories in the SIHC

The SIHC observes State of residency together with whether the household lives in a capital city (except when the respondent lives in one of the territories). The Australian Capital Territory and the Northern Territory cannot be distinguished in these ABS data. However, access to this information is available through the ABS' Remote Access Data Laboratory (RADL). Although these households cannot be identified at an individual level, the use of RADL informs us that there are 377 households from the Northern Territory and 269 households from the Australian Capital Territory in the SIHC.

Using RADL, a Probit model is estimated to predict the probabilities of being in the Australian Capital Territory based on a range of household characteristics. The coefficient estimates are reported in Table E.1. Following this approach, the distinction between ACT and NT is artificially reproduced in MITTS by predicting the probability for each household of living in the ACT or NT. Using this probability, which depends on the household's characteristics, each household is assigned to the ACT or the NT. Note that this is not an exact assignment. Someone assigned to the ACT may actually live in the NT, but the distribution of individuals with particular characteristics should be approximately right.

**Table E.1 Probit estimates**

Dependent variable is ACT	Coef.	Std. Err.	z	P> z
Household size	0.055	0.117	0.47	0.638
Number employed in household	-0.428	0.174	-2.46	0.014
Number unemployed in household	-1.630	0.963	-1.69	0.091
Current weekly income per employee	-0.210	0.209	-1.01	0.314
Weekly housing costs	0.707	0.943	0.75	0.453
Number of full-time and part-time students in household	0.180	0.255	0.71	0.480
Age of the reference person	-0.018	0.027	-0.68	0.499
Number of pension/benefit recipients in household	-0.022	0.218	-0.10	0.919
Own dwelling (no mortgage)	0.529	0.319	1.66	0.097
Renter	-0.560	0.270	-2.07	0.038
Number of workers in Government Administration and Defence in household	0.263	0.206	1.27	0.203
Number of high-skilled workers in household	0.614	0.183	3.36	0.001
Number of workers in Electricity, Gas and Water Supply, Construction or Wholesale Trade by household	-1.051	0.287	-3.67	0.000
ABS weight	0.034	0.003	11.75	0.000
Constant	-6.134	0.767	-8.00	0.000

## **Appendix F: Assumptions and Limitations**

This appendix draws together the assumptions outlined throughout the report, providing a concise dot point overview of all these assumptions in one place.

Since we use the MMRF-Green output as the basis for the analysis in this report, we inherit all the assumptions underlying MMRF-Green. We therefore first repeat the assumptions most relevant to our work of disaggregating MMRF-Green output to the individual level. In a second subsection, we list the assumptions underlying the microsimulation analysis. Finally, we also want to describe some of the main limitations of our modelling as we perceive it.

### ***F.1 MMRF-Green Assumptions***

- Treasury's projections form the basis of the population projections underlying MMRF-Green.
- Treasury projections are altered by interstate migration as predicted by MMRF-Green.
- Employment levels by industry and region are determined by the model.
- The long-run rate of unemployment is assumed to be fixed.
- Changes in average wages differ by region but not by industry (nor occupation).
- Base values of wages differ by region and industry (not by occupation).
- 63 different commodities are distinguished whose relative prices are endogenous and change over time.
- Relative price changes differ by region and policy run.
- Each of the eight regions has one single representative household with its own consumption function.
- Adjustments in the 63 budget shares following price changes are determined at the regional level.
- The same exogenous single income tax rate is applied to all representative households.
- It is assumed that climate change itself will not have a direct economic impact before 2030.
- Benefits from the mitigation policies resulting from a reduced adverse effect on climate will only become evident after 2030.

## **F.2 MITTS Assumptions/Approximations**

### **F.2.1 The population in MITTS**

- The 2003/2004 Survey of Income and Housing Cost (SIHC) collected by the Australian Bureau of Statistics (2007) and updated to 2005/2006 is the base year file used in MITTS.
- Treasury population projections are altered by MMRF-Green, but MMRF-Green does not provide information about the new age and gender structure of regional populations. A two-step reweighting approach ensures that MITTS is consistent with MMRF-Green and that the deviations between MITTS and Treasury projections are minimal.
- MITTS is reweighted separately for every year for which a simulation is run (including base year), benchmarking the MITTS input data against MMRF-Green output to reproduce the required employment and population changes over time.

### **F.2.2 Income and wages**

- All results are expressed in 2005/2006 or base year prices.
- Financial information in 2003/2004 is increased to reflect January 2010, 2015, 2020, 2025 and 2030 values. Non-labour income in MITTS is updated using MMRF-Green changes for non-labour income.
- Wage rates are updated using the average male and female wage indices until 2005, while MMRF-Green regional wage indices are used in subsequent years.
- MMRF-Green generates average changes in wages and non-labour factor income only by region. In MITTS, the average change corresponding to the relevant region of residence is applied to each household.

### **F.2.3 Income tax and social security**

- Since MMRF-Green is based on the 2005/2006 financial year, the tax and social security system of January 2006 is used in MITTS.
- All major social security payments and income taxes are included in MITTS.
- The information in the SIHC is used to calculate eligibility for the different social security payments, not accounting for asset tests or residency requirements
- Only income changes in real terms are used so that other eligibility criteria for benefits do not have to be updated to account for inflation.
- A 100 per cent take-up of benefits is assumed.

- Income tax thresholds are indexed to real wages in order to hold the national average tax rate constant, in accordance with MMRF-Green assumptions.
- Following MMRF assumptions, all personal-benefit payments are indexed to the Consumer Price Index (CPI) in order to be held constant in real terms.

#### **F.2.4 Income quintiles**

- Income quintiles are determined at the income unit level and are based on the ranking of income units according to real disposable income per adult equivalent.
- Equivalising of incomes is achieved using the Whiteford equivalence scale.
- New income quintiles are computed for each year of the analysis since it cannot be assumed that income units belonging to a particular quintile will still belong to the same quintile five years later.
- Income quintiles differ across scenarios because changes in incomes and employment are different across scenarios.

#### **F.2.5 Consumption behaviour**

- Cumulative price changes by commodity from MMRF-Green are combined with the previous period's budget shares to compute real incomes adjusted for household-specific consumption patterns. Using the current budget shares is not appropriate because it would imply a 'double counting' of the price effects (via their effects on consumption patterns, on top of the price effects).
- MITTS does not include a model explaining consumption. Changes in consumption patterns as predicted by MMRF-Green are required as input, and this represents all behavioural responses.
- In MMRF-Green, changes in consumption patterns are only available at the regional level and therefore the same budget share changes (in percentage points) are applied to all households' budget shares within the same region. If these adjustments result in negative budget shares these are replaced by zero. All budget shares are evenly scaled to add up to 100 per cent following adjustment.
- The 600+ expenditure items in the Household Expenditure Survey (HES) are mapped to the 63 commodities used in MMRF-Green.
- The definitions of basic necessities and the energy bundle are restricted to groupings of MMRF-Green commodities since price changes and consumption level changes are only available by MMRF-Green commodity.
- Basic necessities consist of the energy bundle plus the MMRF-Green commodities 'Meat products', 'Other food and drink products', 'Textiles, clothing and footwear',

'Water supply', 'Road transport - passenger', 'Rail transport - passenger', 'Other transport (includes water transport)', and 'Dwelling ownership'.

- The energy bundle consists of the MMRF-Green commodities 'Private transport services', 'Private electrical equipment services', and 'Private heating equipment services'.
- Private transport services include: petrol, diesel, LPG and other gas fuels; purchases of motor vehicle (including motor cycles and trailers); motor vehicle parts, batteries, and electrical accessories; road tolls.
- Private electrical equipment services include: 50 per cent of electricity purchased by households plus 30 per cent of household appliances purchased by households
- Private heating equipment services include: mains and bottled gas; 50 per cent of electricity purchased by households plus 60 per cent of household appliances purchased by households.
- The aggregate HES expenditure is based on updates of the weights provided in the HES. That is, the actual weights provided in the HES are updated in accordance with the population reweighting.
- The industry classification is more aggregated in MITTS (13 industry groups) than in MMRF-Green (55 industry groups) thus MMRF-Green industries are mapped into MITTS industries.

### ***F.3 Limitations***

- Changes in wages are available only at a highly aggregated level in MMRF-Green (changes in wages only differ by region).
- The MMRF-Green model does not distinguish between skilled and unskilled workers, which is a limitation with regard to wage and employment developments.
- Similarly there is no distinction in consumption responses to price changes between low and high income households. This is in particular relevant for the energy price changes which are expected to be very high.
- The real world from 2009 is basically unknown and becomes more in future years the further these years are away. Only in future can we determine how realistic some of the assumptions were that are made now.

## Appendix G: Tables corresponding to Figures 5.1 to 5.15

**Table G.1 Average real net income per adult equivalent by income quintile**

		2005	2010	2015	2020	2025	2030
Quintile 1	Reference Case	12,452	13,122	13,400	13,872	14,267	14,623
	Scenario - 550ppm	12,452	13,122	13,646	14,028	14,405	14,698
	Scenario - 450ppm	12,452	13,122	13,711	14,159	14,530	14,806
Quintile 2	Reference Case	17,434	18,940	19,392	20,038	20,551	21,008
	Scenario - 550ppm	17,434	18,940	19,428	19,946	20,423	20,766
	Scenario - 450ppm	17,434	18,940	19,420	20,033	20,483	20,839
Quintile 3	Reference Case	25,051	28,178	29,327	30,982	32,870	34,532
	Scenario - 550ppm	25,051	28,178	28,957	30,266	31,847	33,270
	Scenario - 450ppm	25,051	28,178	28,805	30,180	31,708	33,110
Quintile 4	Reference Case	34,397	38,949	40,772	43,617	47,055	50,343
	Scenario - 550ppm	34,397	38,949	40,192	42,379	45,222	48,055
	Scenario - 450ppm	34,397	38,949	39,901	42,098	44,865	47,602
Quintile 5	Reference Case	55,734	62,855	65,991	70,817	76,879	82,986
	Scenario - 550ppm	55,734	62,855	64,893	68,747	73,893	79,129
	Scenario - 450ppm	55,734	62,855	64,313	68,174	73,191	78,307
Total	Reference Case	30,091	33,725	35,223	37,526	40,290	43,010
	Scenario - 550ppm	30,091	33,725	34,908	36,739	39,082	41,390
	Scenario - 450ppm	30,091	33,725	34,716	36,601	38,885	41,123

**Table G.2 Average real net income per adult equivalent by household type**

		2005	2010	2015	2020	2025	2030
Couples	Reference Case	32,556	36,597	38,186	40,675	43,710	46,746
	Scenario - 550ppm	32,556	36,597	37,818	39,786	42,355	44,930
	Scenario - 450ppm	32,556	36,597	37,595	39,625	42,130	44,633
Singles	Reference Case	25,236	27,904	29,056	30,767	32,765	34,696
	Scenario - 550ppm	25,236	27,904	28,785	30,122	31,797	33,429
	Scenario - 450ppm	25,236	27,904	28,629	29,985	31,610	33,187
Sole Parents	Reference Case	22,429	24,439	25,436	26,986	28,759	30,404
	Scenario - 550ppm	22,429	24,439	25,612	26,885	28,420	29,835
	Scenario - 450ppm	22,429	24,439	25,653	26,989	28,489	29,838
Total	Reference Case	30,091	33,725	35,223	37,526	40,290	43,010
	Scenario - 550ppm	30,091	33,725	34,908	36,739	39,082	41,390
	Scenario - 450ppm	30,091	33,725	34,716	36,601	38,885	41,123

**Table G.3 Average real net income per adult equivalent by State**

		2005	2010	2015	2020	2025	2030
New South Wales	Reference Case	31,231	35,621	37,823	40,658	43,844	47,112
	Scenario - 550ppm	31,231	35,621	37,395	39,724	42,394	45,182
	Scenario - 450ppm	31,231	35,621	37,178	39,596	42,216	44,924
Victoria	Reference Case	30,026	33,276	35,010	37,581	40,383	42,970
	Scenario - 550ppm	30,026	33,276	34,671	36,737	39,141	41,323
	Scenario - 450ppm	30,026	33,276	34,466	36,550	38,877	41,029
Queensland	Reference Case	28,760	31,837	32,356	33,978	36,205	38,381
	Scenario - 550ppm	28,760	31,837	32,115	33,275	35,118	36,930
	Scenario - 450ppm	28,760	31,837	31,930	33,169	34,946	36,627
South Australia	Reference Case	29,181	31,832	34,167	36,889	40,013	43,150
	Scenario - 550ppm	29,181	31,832	33,828	36,180	38,926	41,690
	Scenario - 450ppm	29,181	31,832	33,648	36,109	38,862	41,619
Western Australia	Reference Case	29,905	33,889	34,106	35,471	37,888	40,323
	Scenario - 550ppm	29,905	33,889	34,046	35,038	37,146	39,218
	Scenario - 450ppm	29,905	33,889	33,921	34,863	36,902	38,930
Tasmania	Reference Case	26,949	29,767	31,876	34,167	36,835	39,436
	Scenario - 550ppm	26,949	29,767	31,652	33,451	35,780	38,072
	Scenario - 450ppm	26,949	29,767	31,591	33,488	35,798	38,141
Northern Territory	Reference Case	29,954	34,989	35,425	36,982	39,477	41,989
	Scenario - 550ppm	29,954	34,989	35,345	36,496	38,650	40,728
	Scenario - 450ppm	29,954	34,989	35,169	36,257	38,263	40,180
Australian Capital Territory	Reference Case	34,020	38,818	40,587	43,919	48,181	52,513
	Scenario - 550ppm	34,020	38,818	40,107	42,775	46,399	50,169
	Scenario - 450ppm	34,020	38,818	39,841	42,530	46,052	49,728
Total	Reference Case	30,091	33,725	35,223	37,526	40,290	43,010
	Scenario - 550ppm	30,091	33,725	34,908	36,739	39,082	41,390
	Scenario - 450ppm	30,091	33,725	34,716	36,601	38,885	41,123

**Table G.4 Gini coefficient within income quintiles**

		<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>
Quintile 1	Reference Case	0.081	0.078	0.074	0.070	0.066	0.064
	Scenario - 550ppm	0.081	0.078	0.073	0.069	0.066	0.064
	Scenario - 450ppm	0.081	0.078	0.073	0.069	0.066	0.064
Quintile 2	Reference Case	0.064	0.076	0.080	0.082	0.084	0.087
	Scenario - 550ppm	0.064	0.076	0.075	0.077	0.079	0.081
	Scenario - 450ppm	0.064	0.076	0.074	0.076	0.078	0.079
Quintile 3	Reference Case	0.054	0.059	0.062	0.065	0.069	0.073
	Scenario - 550ppm	0.054	0.059	0.062	0.063	0.067	0.071
	Scenario - 450ppm	0.054	0.059	0.061	0.063	0.066	0.070
Quintile 4	Reference Case	0.053	0.057	0.059	0.060	0.060	0.061
	Scenario - 550ppm	0.053	0.057	0.058	0.059	0.059	0.060
	Scenario - 450ppm	0.053	0.057	0.058	0.058	0.059	0.059
Quintile 5	Reference Case	0.140	0.141	0.141	0.142	0.143	0.143
	Scenario - 550ppm	0.140	0.141	0.141	0.142	0.143	0.144
	Scenario - 450ppm	0.140	0.141	0.140	0.141	0.143	0.144
Total	Reference Case	0.288	0.298	0.303	0.310	0.319	0.328
	Scenario - 550ppm	0.288	0.298	0.298	0.304	0.312	0.321
	Scenario - 450ppm	0.288	0.298	0.296	0.301	0.309	0.318

**Table G.5 Gini coefficient by household type**

		<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>
Couples	Reference Case	0.272	0.280	0.285	0.291	0.300	0.308
	Scenario - 550ppm	0.272	0.280	0.280	0.286	0.294	0.302
	Scenario - 450ppm	0.272	0.280	0.278	0.283	0.291	0.300
Singles	Reference Case	0.320	0.330	0.335	0.342	0.353	0.364
	Scenario - 550ppm	0.320	0.330	0.329	0.335	0.345	0.355
	Scenario - 450ppm	0.320	0.330	0.326	0.332	0.342	0.352
Sole Parents	Reference Case	0.217	0.231	0.238	0.245	0.257	0.267
	Scenario - 550ppm	0.217	0.231	0.230	0.235	0.245	0.254
	Scenario - 450ppm	0.217	0.231	0.226	0.231	0.240	0.250
Total	Reference Case	0.288	0.298	0.303	0.310	0.319	0.328
	Scenario - 550ppm	0.288	0.298	0.298	0.304	0.312	0.321
	Scenario - 450ppm	0.288	0.298	0.296	0.301	0.309	0.318

**Table G.6 Gini coefficient by State**

		<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>
New South Wales	Reference Case	0.298	0.309	0.315	0.321	0.330	0.339
	Scenario - 550ppm	0.298	0.309	0.310	0.316	0.324	0.333
	Scenario - 450ppm	0.298	0.309	0.308	0.313	0.321	0.330
Victoria	Reference Case	0.291	0.297	0.303	0.310	0.319	0.328
	Scenario - 550ppm	0.291	0.297	0.298	0.304	0.313	0.321
	Scenario - 450ppm	0.291	0.297	0.296	0.302	0.310	0.318
Queensland	Reference Case	0.262	0.271	0.273	0.278	0.288	0.298
	Scenario - 550ppm	0.262	0.271	0.267	0.271	0.281	0.290
	Scenario - 450ppm	0.262	0.271	0.265	0.268	0.277	0.287
South Australia	Reference Case	0.294	0.308	0.317	0.326	0.337	0.346
	Scenario - 550ppm	0.294	0.308	0.312	0.319	0.330	0.339
	Scenario - 450ppm	0.294	0.308	0.309	0.316	0.326	0.335
Western Australia	Reference Case	0.293	0.302	0.302	0.306	0.314	0.323
	Scenario - 550ppm	0.293	0.302	0.296	0.299	0.307	0.315
	Scenario - 450ppm	0.293	0.302	0.294	0.296	0.303	0.312
Tasmania	Reference Case	0.270	0.278	0.290	0.298	0.308	0.317
	Scenario - 550ppm	0.270	0.278	0.284	0.290	0.300	0.309
	Scenario - 450ppm	0.270	0.278	0.282	0.287	0.296	0.305
Northern Territory	Reference Case	0.274	0.291	0.291	0.295	0.303	0.311
	Scenario - 550ppm	0.274	0.291	0.284	0.288	0.295	0.303
	Scenario - 450ppm	0.274	0.291	0.281	0.284	0.291	0.299
Australian Capital Territory	Reference Case	0.262	0.269	0.271	0.276	0.281	0.287
	Scenario - 550ppm	0.262	0.269	0.267	0.272	0.276	0.282
	Scenario - 450ppm	0.262	0.269	0.266	0.270	0.274	0.280
Total	Reference Case	0.288	0.298	0.303	0.310	0.319	0.328
	Scenario - 550ppm	0.288	0.298	0.298	0.304	0.312	0.321
	Scenario - 450ppm	0.288	0.298	0.296	0.301	0.309	0.318

**Table G.7 Average budget shares of basic necessities by income quintile**

		2005	2010	2015	2020	2025	2030
Quintile 1	Reference Case	0.568	0.550	0.535	0.516	0.499	0.484
	Scenario - 550ppm	0.568	0.550	0.538	0.518	0.499	0.486
	Scenario - 450ppm	0.568	0.550	0.540	0.519	0.500	0.485
Quintile 2	Reference Case	0.562	0.533	0.517	0.497	0.482	0.467
	Scenario - 550ppm	0.562	0.533	0.523	0.501	0.486	0.467
	Scenario - 450ppm	0.562	0.533	0.525	0.503	0.487	0.467
Quintile 3	Reference Case	0.505	0.483	0.468	0.449	0.429	0.416
	Scenario - 550ppm	0.505	0.483	0.473	0.453	0.432	0.417
	Scenario - 450ppm	0.505	0.483	0.477	0.453	0.433	0.418
Quintile 4	Reference Case	0.482	0.464	0.452	0.436	0.421	0.406
	Scenario - 550ppm	0.482	0.464	0.454	0.438	0.422	0.408
	Scenario - 450ppm	0.482	0.464	0.457	0.440	0.422	0.407
Quintile 5	Reference Case	0.436	0.417	0.401	0.383	0.367	0.353
	Scenario - 550ppm	0.436	0.417	0.405	0.385	0.369	0.353
	Scenario - 450ppm	0.436	0.417	0.407	0.386	0.369	0.353
Total	Reference Case	0.506	0.485	0.470	0.452	0.437	0.422
	Scenario - 550ppm	0.506	0.485	0.474	0.455	0.438	0.423
	Scenario - 450ppm	0.506	0.485	0.477	0.456	0.439	0.423

**Table G.8 Average budget shares of basic necessities by household type**

		2005	2010	2015	2020	2025	2030
Couples	Reference Case	0.480	0.459	0.445	0.428	0.412	0.398
	Scenario - 550ppm	0.480	0.459	0.449	0.431	0.414	0.399
	Scenario - 450ppm	0.480	0.459	0.452	0.432	0.415	0.398
Singles	Reference Case	0.541	0.521	0.507	0.489	0.473	0.460
	Scenario - 550ppm	0.541	0.521	0.510	0.492	0.475	0.461
	Scenario - 450ppm	0.541	0.521	0.513	0.493	0.476	0.460
Sole Parents	Reference Case	0.587	0.564	0.549	0.531	0.515	0.501
	Scenario - 550ppm	0.587	0.564	0.554	0.535	0.517	0.502
	Scenario - 450ppm	0.587	0.564	0.556	0.536	0.518	0.502
Total	Reference Case	0.506	0.485	0.470	0.452	0.437	0.422
	Scenario - 550ppm	0.506	0.485	0.474	0.455	0.438	0.423
	Scenario - 450ppm	0.506	0.485	0.477	0.456	0.439	0.423

**Table G.9 Average budget shares of basic necessities by State**

		2005	2010	2015	2020	2025	2030
New South Wales	Reference Case	0.502	0.480	0.465	0.447	0.431	0.417
	Scenario - 550ppm	0.502	0.480	0.470	0.450	0.433	0.418
	Scenario - 450ppm	0.502	0.480	0.472	0.451	0.434	0.417
Victoria	Reference Case	0.508	0.488	0.474	0.457	0.442	0.429
	Scenario - 550ppm	0.508	0.488	0.478	0.460	0.444	0.429
	Scenario - 450ppm	0.508	0.488	0.481	0.461	0.445	0.429
Queensland	Reference Case	0.506	0.483	0.468	0.449	0.432	0.418
	Scenario - 550ppm	0.506	0.483	0.472	0.452	0.434	0.419
	Scenario - 450ppm	0.506	0.483	0.475	0.454	0.435	0.418
South Australia	Reference Case	0.513	0.491	0.474	0.454	0.437	0.422
	Scenario - 550ppm	0.513	0.491	0.478	0.457	0.439	0.423
	Scenario - 450ppm	0.513	0.491	0.480	0.458	0.439	0.422
Western Australia	Reference Case	0.506	0.487	0.473	0.456	0.442	0.428
	Scenario - 550ppm	0.506	0.487	0.477	0.459	0.443	0.429
	Scenario - 450ppm	0.506	0.487	0.479	0.460	0.443	0.428
Tasmania	Reference Case	0.518	0.499	0.484	0.466	0.451	0.438
	Scenario - 550ppm	0.518	0.499	0.488	0.470	0.454	0.439
	Scenario - 450ppm	0.518	0.499	0.491	0.470	0.454	0.438
Northern Territory	Reference Case	0.531	0.510	0.492	0.473	0.457	0.442
	Scenario - 550ppm	0.531	0.510	0.496	0.475	0.458	0.442
	Scenario - 450ppm	0.531	0.510	0.498	0.477	0.459	0.442
Australian Capital Territory	Reference Case	0.512	0.488	0.473	0.454	0.439	0.425
	Scenario - 550ppm	0.512	0.488	0.476	0.457	0.440	0.426
	Scenario - 450ppm	0.512	0.488	0.479	0.458	0.441	0.425
Total	Reference Case	0.506	0.485	0.470	0.452	0.437	0.422
	Scenario - 550ppm	0.506	0.485	0.474	0.455	0.438	0.423
	Scenario - 450ppm	0.506	0.485	0.477	0.456	0.439	0.423

**Table G.10 Average budget shares of energy expenditures by income quintile**

		2005	2010	2015	2020	2025	2030
Quintile 1	Reference Case	0.151	0.146	0.143	0.137	0.132	0.127
	Scenario - 550ppm	0.151	0.146	0.142	0.135	0.128	0.124
	Scenario - 450ppm	0.151	0.146	0.142	0.134	0.128	0.123
Quintile 2	Reference Case	0.144	0.143	0.140	0.134	0.129	0.124
	Scenario - 550ppm	0.144	0.143	0.140	0.132	0.128	0.120
	Scenario - 450ppm	0.144	0.143	0.140	0.133	0.128	0.119
Quintile 3	Reference Case	0.156	0.151	0.150	0.141	0.135	0.131
	Scenario - 550ppm	0.156	0.151	0.148	0.140	0.133	0.128
	Scenario - 450ppm	0.156	0.151	0.149	0.140	0.133	0.130
Quintile 4	Reference Case	0.162	0.160	0.156	0.152	0.147	0.143
	Scenario - 550ppm	0.162	0.160	0.155	0.150	0.144	0.140
	Scenario - 450ppm	0.162	0.160	0.155	0.150	0.144	0.139
Quintile 5	Reference Case	0.147	0.142	0.138	0.131	0.127	0.122
	Scenario - 550ppm	0.147	0.142	0.138	0.130	0.124	0.119
	Scenario - 450ppm	0.147	0.142	0.137	0.130	0.124	0.119
Total	Reference Case	0.152	0.148	0.145	0.139	0.134	0.129
	Scenario - 550ppm	0.152	0.148	0.145	0.137	0.131	0.126
	Scenario - 450ppm	0.152	0.148	0.144	0.137	0.131	0.126

**Table G.11 Average budget shares of energy expenditures by household type**

		2005	2010	2015	2020	2025	2030
Couples	Reference Case	0.158	0.154	0.150	0.144	0.138	0.133
	Scenario - 550ppm	0.158	0.154	0.150	0.142	0.136	0.130
	Scenario - 450ppm	0.158	0.154	0.150	0.142	0.136	0.130
Singles	Reference Case	0.142	0.138	0.135	0.130	0.125	0.121
	Scenario - 550ppm	0.142	0.138	0.135	0.128	0.123	0.118
	Scenario - 450ppm	0.142	0.138	0.135	0.128	0.123	0.118
Sole Parents	Reference Case	0.145	0.142	0.139	0.134	0.129	0.125
	Scenario - 550ppm	0.145	0.142	0.138	0.132	0.126	0.122
	Scenario - 450ppm	0.145	0.142	0.138	0.132	0.126	0.121
Total	Reference Case	0.152	0.148	0.145	0.139	0.134	0.129
	Scenario - 550ppm	0.152	0.148	0.145	0.137	0.131	0.126
	Scenario - 450ppm	0.152	0.148	0.144	0.137	0.131	0.126

**Table G.12 Average budget shares of energy expenditures by State**

		2005	2010	2015	2020	2025	2030
New South Wales	Reference Case	0.142	0.139	0.136	0.130	0.125	0.120
	Scenario - 550ppm	0.142	0.139	0.135	0.128	0.122	0.117
	Scenario - 450ppm	0.142	0.139	0.135	0.128	0.122	0.117
Victoria	Reference Case	0.160	0.157	0.154	0.148	0.143	0.138
	Scenario - 550ppm	0.160	0.157	0.153	0.146	0.140	0.135
	Scenario - 450ppm	0.160	0.157	0.153	0.146	0.140	0.135
Queensland	Reference Case	0.147	0.143	0.139	0.132	0.126	0.121
	Scenario - 550ppm	0.147	0.143	0.138	0.130	0.123	0.118
	Scenario - 450ppm	0.147	0.143	0.138	0.130	0.123	0.117
South Australia	Reference Case	0.165	0.161	0.156	0.149	0.143	0.138
	Scenario - 550ppm	0.165	0.161	0.155	0.147	0.140	0.135
	Scenario - 450ppm	0.165	0.161	0.155	0.147	0.140	0.135
Western Australia	Reference Case	0.160	0.157	0.155	0.150	0.146	0.142
	Scenario - 550ppm	0.160	0.157	0.154	0.148	0.143	0.138
	Scenario - 450ppm	0.160	0.157	0.154	0.148	0.143	0.138
Tasmania	Reference Case	0.166	0.162	0.158	0.151	0.146	0.141
	Scenario - 550ppm	0.166	0.162	0.158	0.149	0.143	0.138
	Scenario - 450ppm	0.166	0.162	0.158	0.149	0.144	0.138
Northern Territory	Reference Case	0.153	0.150	0.146	0.138	0.133	0.127
	Scenario - 550ppm	0.153	0.150	0.145	0.137	0.130	0.124
	Scenario - 450ppm	0.153	0.150	0.145	0.136	0.130	0.124
Australian Capital Territory	Reference Case	0.152	0.147	0.144	0.137	0.134	0.131
	Scenario - 550ppm	0.152	0.147	0.143	0.135	0.132	0.128
	Scenario - 450ppm	0.152	0.147	0.143	0.135	0.132	0.128
Total	Reference Case	0.152	0.148	0.145	0.139	0.134	0.129
	Scenario - 550ppm	0.152	0.148	0.145	0.137	0.131	0.126
	Scenario - 450ppm	0.152	0.148	0.144	0.137	0.131	0.126

**Table G.13 Average weekly hours of work by income quintile**

		<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>
Quintile 1	Reference Case	20.6	19.9	18.6	17.4	16.8	15.7
	Scenario - 550ppm	20.6	19.9	18.5	17.9	16.9	16.7
	Scenario - 450ppm	20.6	19.9	18.8	18.2	17.2	16.8
Quintile 2	Reference Case	29.1	28.6	27.8	26.7	25.2	24.3
	Scenario - 550ppm	29.1	28.6	27.9	26.9	25.5	24.4
	Scenario - 450ppm	29.1	28.6	27.9	26.9	25.5	24.5
Quintile 3	Reference Case	34.6	34.6	34.4	34.2	33.9	33.5
	Scenario - 550ppm	34.6	34.6	34.3	34.1	33.8	33.5
	Scenario - 450ppm	34.6	34.6	34.3	34.1	33.8	33.5
Quintile 4	Reference Case	38.2	38.2	38.1	37.9	37.8	37.7
	Scenario - 550ppm	38.2	38.2	38.1	38.0	37.8	37.7
	Scenario - 450ppm	38.2	38.2	38.1	37.9	37.8	37.7
Quintile 5	Reference Case	41.3	41.2	41.1	41.1	41.1	41.0
	Scenario - 550ppm	41.3	41.2	41.1	41.0	41.0	40.9
	Scenario - 450ppm	41.3	41.2	41.1	41.0	41.0	40.9
Total	Reference Case	36.8	36.7	36.5	36.4	36.3	36.2
	Scenario - 550ppm	36.8	36.7	36.5	36.4	36.3	36.2
	Scenario - 450ppm	36.8	36.7	36.5	36.4	36.3	36.2

**Table G.14 Average weekly hours of work by household type**

		<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>
Partnered Men	Reference Case	42.1	42.0	41.8	41.7	41.6	41.5
	Scenario - 550ppm	42.1	42.0	41.8	41.7	41.6	41.5
	Scenario - 450ppm	42.1	42.0	41.8	41.7	41.6	41.5
Partnered Women	Reference Case	31.0	30.9	30.8	30.8	30.7	30.6
	Scenario - 550ppm	31.0	30.9	30.9	30.8	30.7	30.7
	Scenario - 450ppm	31.0	30.9	30.9	30.8	30.7	30.6
Singles	Reference Case	36.7	36.5	36.3	36.2	36.0	35.8
	Scenario - 550ppm	36.7	36.5	36.3	36.2	36.0	35.8
	Scenario - 450ppm	36.7	36.5	36.3	36.2	36.0	35.8
Sole Parents	Reference Case	30.2	30.4	30.2	30.1	30.1	30.1
	Scenario - 550ppm	30.2	30.4	30.2	30.1	30.1	30.1
	Scenario - 450ppm	30.2	30.4	30.2	30.1	30.1	30.1
Total	Reference Case	36.8	36.7	36.5	36.4	36.3	36.2
	Scenario - 550ppm	36.8	36.7	36.5	36.4	36.3	36.2
	Scenario - 450ppm	36.8	36.7	36.5	36.4	36.3	36.2

**Table G.15 Average weekly hours of work by State**

		<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>
New South Wales	Reference Case	37.0	36.9	36.8	36.7	36.6	36.6
	Scenario - 550ppm	37.0	36.9	36.8	36.7	36.7	36.6
	Scenario - 450ppm	37.0	36.9	36.8	36.7	36.7	36.6
Victoria	Reference Case	36.6	36.3	36.2	36.1	35.9	35.8
	Scenario - 550ppm	36.6	36.3	36.2	36.1	35.9	35.8
	Scenario - 450ppm	36.6	36.3	36.2	36.1	35.9	35.8
Queensland	Reference Case	37.3	37.1	36.8	36.6	36.4	36.3
	Scenario - 550ppm	37.3	37.1	36.8	36.6	36.5	36.3
	Scenario - 450ppm	37.3	37.1	36.8	36.6	36.5	36.3
South Australia	Reference Case	36.0	35.7	35.4	35.2	35.0	34.9
	Scenario - 550ppm	36.0	35.7	35.5	35.3	35.1	34.9
	Scenario - 450ppm	36.0	35.7	35.5	35.3	35.1	34.9
Western Australia	Reference Case	36.6	36.5	36.4	36.2	36.1	36.0
	Scenario - 550ppm	36.6	36.5	36.4	36.3	36.1	36.0
	Scenario - 450ppm	36.6	36.5	36.4	36.3	36.1	36.0
Tasmania	Reference Case	35.5	35.4	35.3	35.3	35.2	35.2
	Scenario - 550ppm	35.5	35.4	35.3	35.3	35.2	35.2
	Scenario - 450ppm	35.5	35.4	35.4	35.3	35.2	35.3
Northern Territory	Reference Case	38.9	38.7	38.7	38.5	38.4	38.3
	Scenario - 550ppm	38.9	38.7	38.7	38.6	38.4	38.3
	Scenario - 450ppm	38.9	38.7	38.7	38.5	38.4	38.3
Australian Capital Territory	Reference Case	37.8	37.8	37.8	38.0	38.0	38.0
	Scenario - 550ppm	37.8	37.8	37.8	38.0	38.0	38.0
	Scenario - 450ppm	37.8	37.8	37.8	37.9	38.0	38.0
Total	Reference Case	36.8	36.7	36.5	36.4	36.3	36.2
	Scenario - 550ppm	36.8	36.7	36.5	36.4	36.3	36.2
	Scenario - 450ppm	36.8	36.7	36.5	36.4	36.3	36.2

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