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# Climate Change Mitigation, Economic Growth and The Distribution of Income

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# CLIMATE CHANGE MITIGATION, ECONOMIC GROWTH AND THE DISTRIBUTION OF INCOME

by

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## 1. Introduction

In October 2008, the Australian Government released a report on *Australia's Low Pollution Future: The Economics of Climate Change Mitigation* (Australian Treasury, 2008). In preparing that report, it engaged the Centre of Policy Studies, Monash University to assist in the modelling of a number of scenarios using the MONASH Multi-Regional Forecasting (MMRF) model of the Australian economy. Two of those scenarios are considered here. The first is a Basecase scenario, or 'business as usual' projection, in which a sequence of annual forecasts is constructed using external forecasts for macro variables, extrapolations of recent trends in industry technologies and household tastes, and estimates of the effects of existing energy policies. In effect, the Basecase scenario shows what might be expected to happen if there were no change to existing greenhouse policies. The second, referred to as the CPRS-5 scenario, includes the effect of a carbon pollution reduction scheme designed to reduce emissions to 5 per cent below 2000 levels by 2020. It is consistent with stabilisation at around 550 parts per million of carbon dioxide equivalent (ppm $C0_2$-e) in the atmosphere by 2100.

The specification of the scenarios, the methodology for their implementation in MMRF, and an explanation of the model's results have all been provided in detail elsewhere[1]. The purpose of the present report is to extend the range of the MMRF results to include the distribution of employment and income. To this end, the projections of employment by industry at the national

[1] A general description of the MMRF model, including enhancements made to facilitate greenhouse gas analyses, is contained in Adams et al. (2003). Its particular application to the Treasury climate change simulations is described in a report by Centre of Policy Studies (2008). Details of the simulation design, results and explanations are provided in the main report by the Treasury (2008).

level[2] are fed into a model describing the operation of occupational labour markets. Results from both models are then used to drive a microsimulation model which generates income results.

The remainder of the paper is organised as follows. Sections 2, 3 and 4 respectively discuss the MMRF model, the labour market model and the microsimultion model, together with selected results derived from the related simulations. Section 5 provides concluding remarks.

## 2. The MMRF Simulations

MMRF is a detailed, dynamic, multi-sectoral, multi-regional, computable general equilibrium (CGE) model of the Australian economy. The version used here distinguishes 58 industries, 63 commodities, 8 states/territories and 56 sub-state regions. Of the 58 industries, three (*Coal*, *Oil* and *Gas*) produce primary fuels, one (*Petroleum Products*) produces refined fuel, six generate electricity and one supplies electricity to final customers. The six generation industries are defined according to primary source of fuel: *Electricity-coal* includes all coal-fired generation technologies; *Electricity–gas* includes all plants using gas turbines, Cogen and combined cycle technologies driven by burning gas; *Electricity-oil* covers all liquid-fuel generators; *Electricity-hydro* covers hydro generation; *Electricity-other* covers the remaining forms of renewable generation from biomass, biogas, wind etc. *Electricity–nuclear* is included for the sake of completeness. It can be triggered, if desired, at a specified CO2 price.

Apart from *Grains* and *Petroleum Products*, each industry produces a single commodity. The *Grains* industry produces grains for animal and human consumption and a small amount of biofuel. The *Petroleum Products* industry produces 5 commodities – *Gasoline*, *Diesel*, *LPG*, *Aviation Fuel*, and *Other Refinery Products*. Thus, 63 commodities in total are produced by the 58 industries.

There are five types of agents in the model: producers, investors, households, governments, and foreigners. For each industry in each region there is an associated investor who assembles units of capital that are specific to the industry. Each region in contains a single household and a regional government. There is also a federal government. Finally, there are foreigners whose behaviour is

[2] The extended results do not contain a regional dimension.

summarised by export demand curves for the commodities of each region and by supply curves for international imports to each region.

MMRF determines regional supplies and demands of commodities through optimising behaviour of agents in competitive markets. Optimising behaviour also determines industry demands for labour and capital. Labour supply at the national level in the long run is determined by demographic factors, while national supply of capital responds to changes in rates of return. Labour and capital can cross regional borders so that each region's endowment of productive resources reflects regional employment opportunities and relative rates of return.

The specifications of supply of, and demand for commodities are co-ordinated through market clearing equations which comprise the general equilibrium core of the model. There are four blocks of equations in addition to the core. The first two describe regional and federal government finances, and the operation of regional labour markets. The third block contains dynamic equations that describe physical capital accumulation and lagged adjustment processes in the national labour market. The final block contains enhancements for the study of greenhouse gas issues.

The national employment projections from MMRF for the two scenarios are set out in Table 1[3]. In most cases, the difference between terminal-period (2024-25) employment in the Basecase and CPRS-5 scenarios for a particular industry is small compared to the growth in employment between the base period (2004-05) and the terminal period. This result is evident in the similarity of the growth rate rankings shown in the table. The industry *7 Forestry* and the forestry-intensive industry *17 Wood Products* improve their rankings the most when CPRS-5 is introduced. The industries *8 Coal* and *32 Electricity Supply*, together with the electricity-intensive industry *27 Aluminium*, suffer the largest falls in their rankings.

MMRF tracks emissions of greenhouse gases at a detailed level. It breaks down emissions according to emitting agent (58 industries and a residential), emitting state or territory (8) and emitting activity (8). Most of the emitting activities are the burning of fuels (*Coal*, *Natural Gas* and

[3] As noted above, the MMRF model contains six different industries for producing and distributing electricity. As no information was available for differentiating between the mix of occupations in these industries, they have been combined into a single industry in this report. The industry as a whole accounts for less than half a per cent of aggregate employment, so the results of the analysis are unlikely to be significantly compromised.

the five types of petroleum products). A residual category, named *Activity*, covers emissions such as fugitives and agricultural emissions not arising from fuel burning.

The resulting 58 × 8 × 8 matrix of emissions is designed to include all emissions except those arising from land clearing. Emissions are measured in terms of carbon dioxide equivalents. MMRF accounts for domestic emissions only, so a change in world emissions as a result of an increase of Australian exports of, say, coal is not accounted for.

Colum 1 of Table 2 shows the emissions intensities (i.e., the emissions per unit output) in 2004-05. Emissions are measured in kilotonnes of $CO_2$ equivalent. The unit of output is the amount that can be bought for $1millon in 2004-05. The emissions intensities change over time in response to the mitigation policy. The average intensity drops from 0.248 in 2004-05 to 0.208 in 2024-25 in the Basecase scenario, and to 0.148 in the CRPS-5 scenario.

According to column 1 of Table 2, the industry *27 Aluminium* is only a moderate emitter of greenhouse gases (rank 12). However, the industry uses large amounts of *32 Electricity* in its production, and *Electricity* has the highest emissions intensity. Hence, a better indicator of the influence of the various industries on atmospheric pollution can be obtained by attributing the emissions associated with the production of intermediate inputs to the using industry. This is done in column 3 of Table 2. According to the adjusted emissions intensities, *Aluminium* rather than *Electricity* is the worst polluter. The intensity for *Electricity* is more than halved, with significant electricity-related emissions now being attributed to *51 Private Electricity* and *52 Private Heating* as well as to *Aluminium*. Similarly, some of the emissions produced by *1 Sheep and Cattle* are attributed to *14 Meat products* and *16 Textiles, Clothing and Footwear*, some produced by *2 Dairy* are attributed *15 Other Food Products*, and some produced by *33 Gas Supply* are attributed to *52 Private Heating*. On the other side of the pollution ledger, some of the reduction in emissions resulting from production in the industry *7 Forestry* are now attributed to the industries which use forestry products as inputs, particularly *17 Wood Products* and *18 Paper Products*. The change to the accounting system reduces the range of the emission intensities by more than half.

**Table 1. Employment by Industry, Thousands of Hours Per Week**

| Code | Industry | (1) 2004-05 | (2) Basecase 2024-25 | (3) | (4) CPRS-5 2024-25 | (5) |
|---|---|---|---|---|---|---|
| | | | Growth (%) | Rank | Growth (%) | Rank |
| 1 | Sheep and Cattle | 4401 | 54.99 | 4 | 51.72 | 4 |
| 2 | Dairy | 933 | 28.78 | 10 | 34.56 | 10 |
| 3 | Other Animal Farming | 530 | -25.05 | 46 | -20.38 | 40 |
| 4 | Grains | 3735 | 67.05 | 3 | 73.63 | 3 |
| 5 | Other Agriculture | 4243 | 44.99 | 7 | 48.93 | 6 |
| 6 | Agricultural Services and Fishing | 1585 | 18.58 | 15 | 21.77 | 14 |
| 7 | Forestry | 495 | 1.32 | 21 | 25.74 | 12 |
| 8 | Coal | 754 | -6.87 | 32 | -20.10 | 39 |
| 9 | Oil | 200 | -23.52 | 44 | -23.02 | 44 |
| 10 | Gas | 48 | 5.41 | 19 | 1.70 | 21 |
| 11 | Iron Ores | 521 | 23.58 | 13 | 29.02 | 11 |
| 12 | Non-ferrous Metal Ores | 1315 | -19.40 | 40 | -19.67 | 37 |
| 13 | Other Mining | 1047 | -22.09 | 42 | -20.81 | 41 |
| 14 | Meat Products | 1829 | 10.21 | 18 | 6.77 | 18 |
| 15 | Other Food Products | 4493 | 1.05 | 22 | 4.24 | 20 |
| 16 | Textile, Clothing and Footwear | 2100 | -23.48 | 43 | -21.84 | 43 |
| 17 | Wood Products | 2416 | -3.67 | 30 | 0.11 | 22 |
| 18 | Paper Products | 704 | -8.85 | 33 | -6.60 | 31 |
| 19 | Printing | 3826 | -1.39 | 27 | -0.60 | 27 |
| 20 | Refinery Products | 224 | 21.27 | 14 | 6.07 | 19 |
| 21 | Chemicals | 1950 | -36.56 | 51 | -35.37 | 51 |
| 22 | Rubber and Plastic Products | 1476 | -15.64 | 37 | -14.35 | 35 |
| 23 | Non-metal Construction Products | 658 | -14.90 | 36 | -13.34 | 34 |
| 24 | Cement | 1031 | -1.98 | 28 | -3.11 | 29 |
| 25 | Iron and Steel | 1048 | -24.94 | 45 | -23.62 | 45 |
| 26 | Alumina | 176 | 43.77 | 8 | 39.51 | 8 |
| 27 | Aluminium | 641 | 26.82 | 11 | -21.10 | 42 |
| 28 | Other Metals Manufacturing | 480 | -71.76 | 52 | -67.20 | 52 |
| 29 | Metal Products | 3438 | -17.96 | 38 | -19.15 | 36 |
| 30 | Motor Vehicles and Parts | 3367 | -27.98 | 48 | -26.32 | 47 |
| 31 | Other Manufacturing | 8085 | -21.06 | 41 | -20.02 | 38 |
| 32 | Electricity Supply | 1845 | -18.22 | 39 | -23.89 | 46 |
| 33 | Gas Supply | 190 | -30.93 | 49 | -32.06 | 50 |
| 34 | Water Supply | 829 | -27.93 | 47 | -27.61 | 48 |
| 35 | Construction | 31073 | 15.33 | 17 | 11.97 | 16 |
| 36 | Trade | 59879 | 16.20 | 16 | 15.58 | 15 |
| 37 | Accommodation and Hotels | 14365 | 51.26 | 6 | 48.92 | 7 |
| 38 | Road Transport, Passengers | 2180 | -4.72 | 31 | -5.98 | 30 |
| 39 | Road Transport, Freight | 7430 | -9.84 | 35 | -10.01 | 33 |
| 40 | Rail Transport, Passengers | 852 | 5.31 | 20 | 11.08 | 17 |
| 41 | Rail Transport, Freight | 568 | -2.26 | 29 | -2.68 | 28 |
| 42 | Water Transport | 473 | -9.50 | 34 | -9.54 | 32 |
| 43 | Air Transport | 5172 | 80.02 | 2 | 79.00 | 2 |
| 44 | Community Services | 6421 | -31.30 | 50 | -31.50 | 49 |
| 45 | Financial Services | 12626 | 24.31 | 12 | 24.37 | 13 |
| 46 | Business Services | 39472 | 97.82 | 1 | 97.30 | 1 |
| 47 | Ownership of Dwelling | 0 | 0.00 | 26 | 0.00 | 26 |
| 48 | Public Services | 67890 | 39.17 | 9 | 39.29 | 9 |
| 49 | Other Services | 19634 | 52.77 | 5 | 51.03 | 5 |
| 50 | Private Transport | 0 | 0.00 | 25 | 0.00 | 25 |
| 51 | Private Electricity | 0 | 0.00 | 24 | 0.00 | 24 |
| 52 | Private Heating | 0 | 0.00 | 23 | 0.00 | 23 |
| 53 | All Industries | 328670 | 31.29 | | 30.73 | |

**Table 2. Emission Intensities, Selected Industries, 2004-05.**

| Code | Industry | (1) Direct Intensities | (2) Direct Intensities | (3) Adjusted Intensities | (4) Adjusted Intensities |
|---|---|---|---|---|---|
| | | Intensity | Rank | Intensity | Rank |
| 1 | Sheep and Cattle | 4.400 | 2 | 1.477 | 7 |
| 2 | Dairy | 1.818 | 4 | 0.379 | 15 |
| 7 | Forestry | -8.263 | 52 | -2.644 | 52 |
| 8 | Coal | 1.034 | 7 | 1.020 | 9 |
| 9 | Oil | 0.119 | 28 | 0.042 | 46 |
| 14 | Meat Products | 0.008 | 46 | 1.984 | 4 |
| 17 | Wood Products | 0.047 | 35 | -0.525 | 51 |
| 18 | Paper Products | 0.211 | 25 | -0.129 | 50 |
| 24 | Cement | 1.738 | 5 | 0.485 | 11 |
| 26 | Alumina | 1.573 | 6 | 1.685 | 5 |
| 27 | Aluminium | 0.826 | 12 | 3.194 | 1 |
| 29 | Metal Products | 0.005 | 48 | 0.283 | 22 |
| 30 | Motor Vehicles and Parts | 0.003 | 49 | 0.107 | 37 |
| 32 | Electricity Supply | 6.553 | 1 | 2.998 | 2 |
| 33 | Gas Supply | 0.780 | 13 | 0.024 | 47 |
| 35 | Construction | 0.011 | 43 | 0.106 | 38 |
| 45 | Financial Services | 0.000 | 51 | 0.004 | 49 |
| 46 | Business Services | 0.006 | 47 | 0.055 | 45 |
| 47 | Ownership of Dwelling | 0.000 | 50 | 0.012 | 48 |
| 51 | Private Electricity | 0.073 | 32 | 1.646 | 6 |
| 52 | Private Heating | 0.722 | 14 | 2.088 | 3 |
| 53 | All Industries | 0.248 | | 0.248 | |

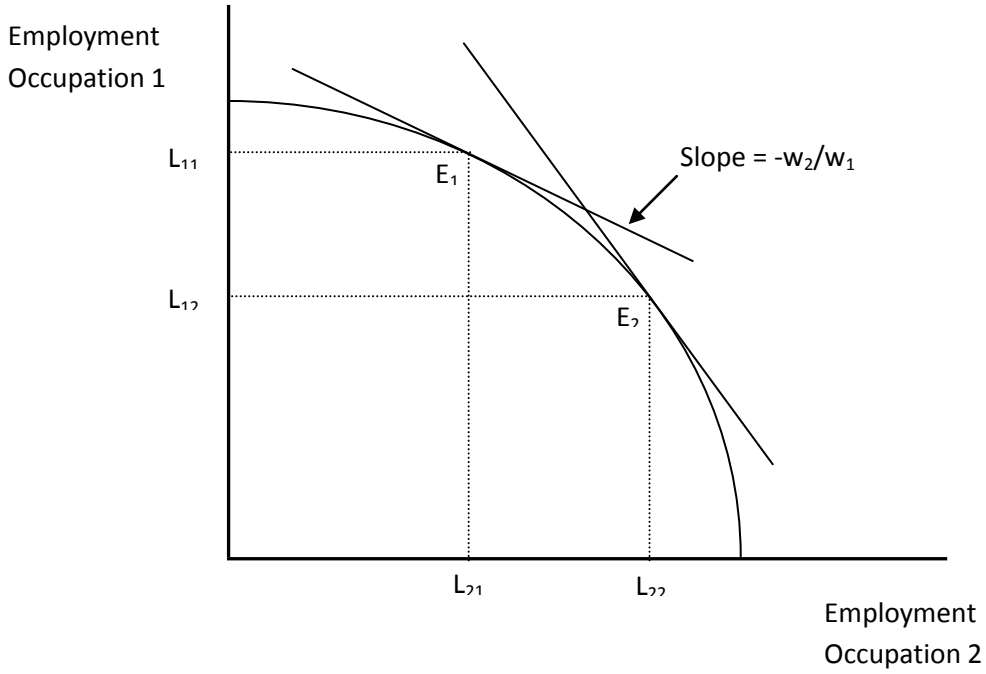
Notes. 1. Intensities are expressed as emissions per unit output. Emissions are measured in kilotonnes of $CO_2$ equivalent. The unit of output is the amount that can be bought for $1millon in 2004-05.
Adjusted intensities are obtained by attributing the emissions associated with the production of intermediate inputs to the using industry.

## 3. The Labour Market Simulations

The labour market effects of the climate change mitigation policy are analysed using the MONASH Labour Market Extension (MLME). This model is designed to be incorporated in the MONASH CGE model (Dixon and Rimmer, 2002), the national model from which the multi-region MMRF model is derived. It describes markets for 81 occupations, the minor groups of the Australian Standard Classification of Occupations. Its purpose is to allow supply constraints on labour by skill to be imposed on demands for labour by industry via the occupational markets.

On the supply side, labour by skill can be converted into labour by occupation according to Constant Elasticity Transformation (CET) functions. Figure 1 presents the idea diagrammatically. The position of the transformation curve is determined by the supply of the skill. If the wage rate of occupation 2 increases relative to that of occupation 1, the isorevenue line becomes steeper, and the owners of the skill can increase their income by transforming some of occupation 1 into

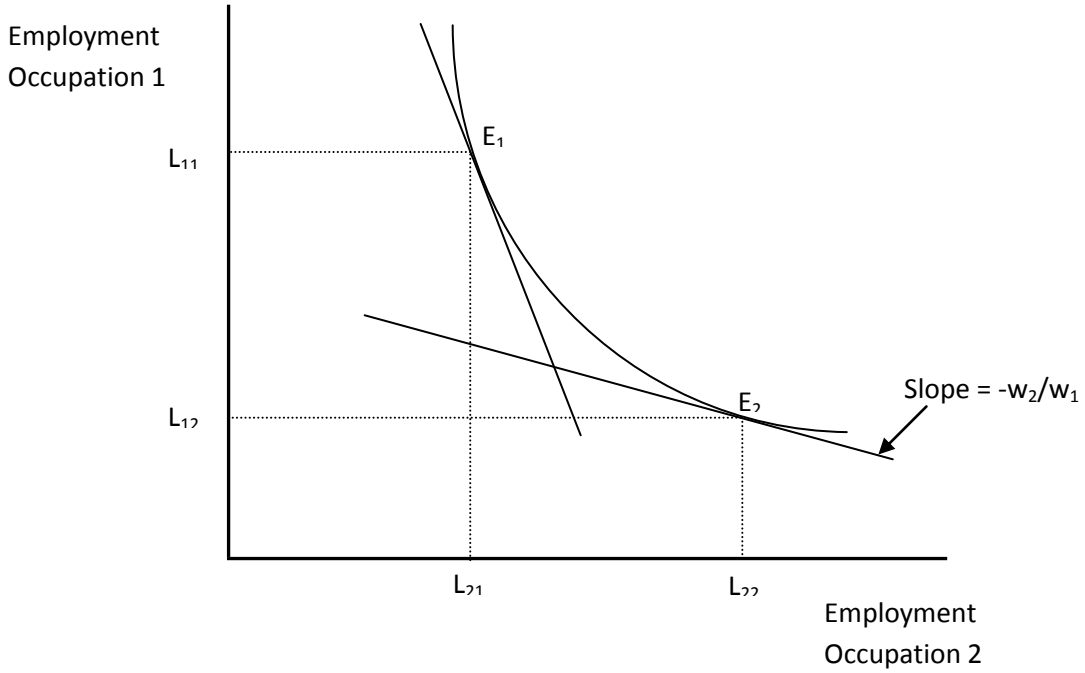
**Figure 1 : Skill Transformations between Occupations**




occupation 2. Hence, they change the occupational mix from $E_1$ to $E_2$. In principle, each of the 64 skills can be transformed into any of the 81 occupations. However, if none of a particular skill is used in a particular occupation in the base period, none of it will be used in that occupation in any of the simulations.

Labour of different occupations can be converted, in turn, into effective units of industry specific labour according to Constant Elasticity Substitution (CES) functions. In Figure 2, the position of the isoquant is determined by the demand for labour in the industry. If the wage rate of occupation 2 decreases relative to that of occupation 1, the isocost line becomes flatter, and the producers in the industry can reduce their costs by substituting some of occupation 2 for occupation 1. Hence they change the occupational mix from $E_1$ to $E_2$. In principle, each of the 52 industries can employ any of 81 occupations but, as before, none of a particular occupation will be used by an industry in a simulation if none of it was used by that industry in the base period.

**Figure 2: Substitution between Occupations in Industries**




As the isoquant is convex to the origin, the number of hours of occupation 2 required to replace an hour of occupation 1 and remain on the isoquant (i.e., and deliver the same amount of industry-specific labour) increases as the amount of occupation 2 already being used increases. More generally, the efficiency of an additional hour of an occupation in an industry decreases as the number of hours of the occupation already being used in that industry increases. In the MONASH and MMRF model, employment by industry is measured in efficiency units. In the MLME model, separate accounting systems are maintained for labour measured in efficiency units and labour measured in hours. However, results are only reported in terms of the latter.

In MMRF, the average real-wage is initially assumed to be sticky so employment can deviate from its Basecase value in response to the CPRS. Over time, though, it is assumed that real wage adjustment steadily eliminates most, if not all, of the short-run consequences for aggregate employment. This means that, in the long run, the costs of reducing emissions are realised almost entirely as a fall in the average real wage rate, rather than as a fall in aggregate employment. This labour market assumption reflect the idea that in the long-run aggregate employment is determined by demographic factors, which are largely unaffected by the adoption of an emissions

reduction policy. Relative wage rates across industries are assumed to remain constant at the levels that prevailed in the base period, 2004-05.

Here, MLME is used in a top-down configuration with MMRF. In other words, MLME accepts the assumption of constant relative wage rates, and accepts the values of aggregate employment, employment by industry and the average wage rate determined by MMRF. That being the case, there is no room for imposing labour supply constraints in MLME and the supply of labour by skill plays no role in the determination of the distributional results. Each industry simply retains the same mix of occupations that it employed in the base period.

Table 3 presents MLME results for the two simulations. According to the table, employment of the occupation *1 General Managers and Administrators* was 2618 thousand hours per week (thpw) in 2004-05. For the Basecase, employment of the occupation is projected to increase to 3499 thpw in the terminal period (i.e., 2024-25). For the CPRS-5 simulation, the increase is only 3486 thpw. Hence, relative to base period employment, the implementation of the mitigation policy results in a reduction in employment of 0.493 per cent. If the 81 ASCO minor groups are reordered according to the increase in employment projected for the terminal period, *1 General Managers and Administrators* is ranked 47$^{th}$.

The occupation with the largest increase is *7 Farmers and Farm Managers*, its employment increasing by 2.161 per cent. The source of the increase can be understood in terms of the contributions of the industries which provide employment to the occupation. Table 4 shows the most important contributors, both positive and negative. Not surprisingly, all are agricultural industries. Australia is a large exporter of agricultural and mining commodities, and of processed food. From Table 2, several of these industries (including *1 Sheep and Cattle*, *8 Coal* and *14 Meat Products*) also have high emission intensities. When the CPRS is introduced, their costs increase and their exports fall, inducing a depreciation of the Australian dollar. All export-oriented and import-competing industries benefit from the change in the exchange rate. For industries *4 Grain*, *5 Other Agriculture*, *2 Dairy* and *3 Other Animal Farming*, the exchange-rate effect is sufficient to deliver an increase in employment in the terminal period, and hence to deliver an increase in employment of *Farmers and Farm Managers*. For industry *1 Sheep and Cattle*, the emissions-intensity effect outweighs the exchange-rate effect and its employment decreases. However, the

**Table 4. Contributions to Deviations in Employment, Expanding Occupations**

| Code | **Occupation** / Contributing Industry | (1) Employ-ment Shares | (2) Contributions to Employment Basecase | (3) CPRS-5 | (4) Deviations |
|---|---|---|---|---|---|
| **7** | **Farmers and Farm Managers** | | | | |
| 4 | Grains | 29.49 | 19.771 | 21.711 | 1.940 |
| 1 | Sheep and Cattle | 34.74 | 19.104 | 17.968 | -1.136 |
| 5 | Other Agriculture | 18.71 | 8.420 | 9.156 | 0.736 |
| 2 | Dairy | 7.48 | 2.152 | 2.585 | 0.433 |
| 3 | Other Animal Farming | 2.69 | -0.674 | -0.548 | 0.126 |
| | Other Industries | 6.89 | 1.336 | 1.398 | 0.062 |
| | All Industries | 100.00 | 50.109 | 52.270 | 2.161 |
| **79** | **Agricultural and Horticultural Labourers** | | | | |
| 5 | Other Agriculture | 31.89 | 14.346 | 15.600 | 1.254 |
| 4 | Grains | 9.08 | 6.087 | 6.684 | 0.597 |
| 1 | Sheep and Cattle | 10.70 | 5.881 | 5.532 | -0.350 |
| 49 | Other Services | 13.82 | 7.295 | 7.054 | -0.241 |
| 7 | Forestry | 0.76 | 0.010 | 0.196 | 0.186 |
| | Other Industries | 33.76 | 6.548 | 6.909 | 0.360 |
| | All Industries | 100.00 | 40.168 | 41.976 | 1.808 |
| **47** | **Wood Tradespersons** | | | | |
| 17 | Wood Products | 35.26 | -1.293 | 0.038 | 1.331 |
| 31 | Other Manufacturing | 50.50 | -10.634 | -10.112 | 0.522 |
| 35 | Construction | 4.49 | 0.689 | 0.537 | -0.151 |
| 36 | Trade | 5.18 | 0.839 | 0.807 | -0.032 |
| 30 | Motor Vehicles and Parts | 1.22 | -0.340 | -0.320 | 0.020 |
| | Other Industries | 3.36 | 0.779 | 0.779 | 0.001 |
| | All Industries | 100.00 | -9.960 | -8.271 | 1.690 |
| **66** | **Intermediate Textile Clothing and Related Machine Operators** | | | | |
| 16 | Textile Clothing and Footwear | 58.67 | -13.773 | -12.815 | 0.958 |
| 27 | Aluminium | 0.40 | 0.108 | -0.085 | -0.193 |
| 31 | Other Manufacturing | 9.22 | -1.941 | -1.846 | 0.095 |
| 15 | Other Food Products | 2.70 | 0.028 | 0.114 | 0.086 |
| 35 | Construction | 2.04 | 0.312 | 0.244 | -0.069 |
| | Other Industries | 26.98 | 4.027 | 4.009 | -0.018 |
| | All Industries | 100.00 | -11.238 | -10.378 | 0.860 |

Notes. Column 1 contains employment shares, measured in per cent, for the base period 2004-05.
Columns 2 and 3 contain the industry contributions, measured in percentage points, to the growth in employment of the nominated occupation between 2004-05 and 2024-25.
Column 4 contains the contributions each industry makes to the deviations in employment of the nominated occupation, measured in percentage points. They are calculated by subtracting column 2 from column 3.

the resulting negative contribution to *Farmers and Farm Managers* is more than offset by the contributions of the expanding agricultural industries.

Table 4 also identifies the main industry contributors for three other occupations with large employment increases in the terminal period. The occupations *79 Agricultural and Horticultural Labourers* and *66 Intermediate Textile Clothing and Related Machine Operators* are heavily influenced by the exchange rate depreciation, the former via the export-oriented agricultural industries previously discussed and the latter via the import-competing industry *16 Textiles Clothing and Footwear*. The occupation *47 Wood Tradespersons*, on the other hand, owes its employment increase to the industry *7 Forestry*; it alone has a negative direct emission intensity and a large negative intensity at that. Hence the introduction of the CPRS actually reduces the costs of production in *Forestry* and its down-stream processing industries *17 Wood Products* and *18 Paper Products*. The resulting employment increase in *Wood Products* is largely responsible for the favourable result for *Wood Tradespersons*.

Table 5 is similar to Table 4, but this time it identifies the industry contributors to the occupations which experience the largest reductions in employment in the terminal period. Prominent among them are the high emission-intensity industries *8 Coal* and *27 Aluminium*. However, the industry *35 Construction* is also an important negative contributor, and its emission intensity is relatively low. In this case, the result derives from the fact that several of the high emission-intensity industries are also very capital intensive. Hence, when the CPRS is introduced, the demand for investment goods falls relative to the demand for consumption goods, both private and public. It follows that industries which mainly service investment loose out to industries which mainly service the other major components of final demand. *Construction* is the prime example.

Policy proposals for climate change mitigation are often based on identifying jobs that can be considered to be "green" in some *a priori* sense. Once identified, the jobs are then recommended for government support of one kind or another as a way of reducing emissions. However, the definitions adopted are often very broad and/or loosely defined. It may reasonably be thought that a classification based on emission intensities would provide a more rigorous *a priori* definition, and hence provide a more reliable guide as to the contributions that various jobs might make to the mitigation process. Table 6 provides some evidence on this conjecture where "jobs" are identified with occupations.

**Table 5. Contributions to Deviations in Employment, Contracting Occupations**

| Code | **Occupation** / Contributing Industry | (1) Employ-ment | (2) Contributions to Demand | (3) | (4) |
|---|---|---|---|---|---|
| | | Shares | Basecase | CPRS-5 | Deviations |
| **69** | **Intermediate Mining and Construction Workers** | | | | |
| 8 | Coal | 11.65 | -0.800 | -2.341 | -1.541 |
| 35 | Construction | 42.04 | 6.446 | 5.031 | -1.415 |
| 27 | Aluminium | 0.41 | 0.110 | -0.086 | -0.196 |
| 11 | Iron Ores | 3.45 | 0.814 | 1.001 | 0.188 |
| 29 | Metal Products | 5.02 | -0.902 | -0.962 | -0.060 |
| 6 | Other Industries | 37.43 | -0.065 | -0.092 | -0.027 |
| 7 | All Industries | 100.00 | 5.602 | 2.551 | -3.051 |
| **42** | **Plumbers** | | | | |
| 35 | Construction | 86.67 | 13.289 | 10.372 | -2.917 |
| 27 | Aluminium | 0.06 | 0.016 | -0.012 | -0.028 |
| 49 | Other Services | 0.85 | 0.447 | 0.432 | -0.015 |
| 36 | Trade | 2.27 | 0.367 | 0.353 | -0.014 |
| 29 | Metal Products | 0.70 | -0.126 | -0.135 | -0.008 |
| 6 | Other Industries | 9.46 | 1.802 | 1.824 | 0.022 |
| 7 | All Industries | 100.00 | 15.795 | 12.835 | -2.960 |
| **65** | **Intermediate Stationary Plant Operators** | | | | |
| 27 | Aluminium | 5.97 | 1.601 | -1.260 | -2.861 |
| 35 | Construction | 12.80 | 1.963 | 1.532 | -0.431 |
| 28 | Other Metals Manufacturing | 4.48 | -3.213 | -3.009 | 0.204 |
| 40 | Rail Transport Passengers | 2.38 | 0.126 | 0.263 | 0.137 |
| 29 | Metal Products | 10.20 | -1.832 | -1.954 | -0.122 |
| 6 | Other Industries | 64.17 | 2.222 | 2.417 | 0.195 |
| 7 | All Industries | 100.00 | 0.866 | -2.011 | -2.877 |
| **41** | **Final Finishers Construction Tradespersons** | | | | |
| 35 | Construction | 80.89 | 12.404 | 9.681 | -2.723 |
| 46 | Business Services | 7.12 | 6.969 | 6.932 | -0.037 |
| 36 | Trade | 3.24 | 0.524 | 0.504 | -0.020 |
| 31 | Other Manufacturing | 1.96 | -0.412 | -0.392 | 0.020 |
| 17 | Wood Products | 0.42 | -0.015 | 0.000 | 0.016 |
| 6 | Other Industries | 6.38 | 0.636 | 0.640 | 0.004 |
| 7 | All Industries | 100.00 | 20.106 | 17.366 | -2.740 |

Notes. Column 1 contains employment shares, measured in per cent, for the base period 2004-05.
Columns 2 and 3 contain the industry contributions, measured in percentage points, to the growth in employment of the nominated occupation between 2004-05 and 2024-25.
Column 4 contains the contributions each industry makes to the deviations in employment of the nominated occupation, measured in percentage points. They are calculated by subtracting column 2 from column 3.

Carbon pollution is emitted by industries. Hence the emission intensity of an hour of labour can be taken to depend only on the industry in which it is employed and not on the occupation or skill of the associated worker. In Table 6, emission intensities per hour computed according to this definition are compared with the corresponding employment deviations from Table 3. If a green job is taken to be one for which employment expands when the CPRS is introduced, emission intensity is not a reliable predictor of "greenness". The occupations *7 Farmers and Farm Managers* and *79 Agricultural and Horticultural Labourers* both have high emission intensities but their employment increases more than that of any other occupation as a result of the mitigation policy. Similarly, the emission intensity of the occupation *42 Plumbers* is only moderate but its employment falls by more than that of any other occupation except *69 Intermediate Mining and Construction Workers*. Evidently, "greenness" also depends on other characteristics of a job such as the capital intensity and the exposure to international trade of the industry providing the job.

## 3. The Income Simulations

The effects of the mitigation policy on the distribution of income are assessed using two related models: the MONASH Income Distribution Extension (MIDE) and the MONASH Microsimulation Extension (MMSE)[4]. Like MLME, MIDE is designed to be incorporated in the MONASH national CGE model and serves two main functions. Firstly, it contains an aggregate social accounting matrix made up of current and capital accounts for the household sector, corporate trading enterprises, financial trading enterprises and the government sector, and an account for external sector. These accounts identify the amounts of saving, borrowing and lending undertaken by the various institutions, and allow those variables to be constrained if required. Secondly, it describes income sources for 100 household types differentiated by size of income, and expenditure patterns for 600 household types differentiated by size of income (10 groups) and household composition. The two classifications are connected via a (100 x 600) disposable income matrix.
This arrangement allows changes in the distribution of income by household to feed back into changes in expenditure by commodity. Again like MLME, MIDE is used in a top-down configuration with MMRF in the present simulations, and hence does not impose any constraints on the results of the latter.

[4] Much of the development work on these models is due to Pang (2010).

**Table 6. Emission Intensities and Employment Deviations, Selected Occupations**

| Code | Occupation | (1) Emission Intensities | (2) | (3) Employment Deviations | (4) |
|---|---|---|---|---|---|
| | | Intensity | Rank | Deviation | Rank |
| 7 | Farmers and Farm Managers | 0.1362 | 79 | 2.161 | 1 |
| 8 | Natural and Physical Science Professionals | 0.0022 | 8 | 0.709 | 6 |
| 9 | Building and Engineering Professionals | 0.0849 | 76 | -0.832 | 62 |
| 14 | Medical Practitioners | 0.0011 | 4 | 0.105 | 15 |
| 15 | Nursing Professionals | 0.0010 | 3 | 0.093 | 18 |
| 17 | School Teachers | 0.0008 | 2 | 0.115 | 14 |
| 18 | University and Vocational Education Teachers | 0.0016 | 5 | 0.089 | 19 |
| 31 | Enrolled Nurses | 0.0007 | 1 | 0.098 | 16 |
| 39 | Electrical and Electronics Tradespersons | 0.1436 | 80 | -2.021 | 74 |
| 40 | Structural Construction Tradespersons | 0.0048 | 20 | -2.713 | 77 |
| 41 | Final Finishes Construction Tradespersons | 0.0033 | 15 | -2.740 | 78 |
| 42 | Plumbers | 0.0063 | 24 | -2.960 | 80 |
| 47 | Wood Tradespersons | 0.0030 | 13 | 1.690 | 3 |
| 49 | Textile Clothing and Related Tradespersons | 0.0044 | 18 | 0.775 | 5 |
| 50 | Miscellaneous Tradespersons and Related Workers | 0.1104 | 78 | -1.240 | 67 |
| 61 | Carers and Aides | 0.0016 | 6 | 0.034 | 20 |
| 65 | Intermediate Stationary Plant Operators | 0.0864 | 77 | -2.877 | 79 |
| 66 | Intermediate Textile Clothing and Related Machine Operators | 0.0150 | 42 | 0.860 | 4 |
| 69 | Intermediate Mining and Construction Workers | 0.1538 | 81 | -3.051 | 81 |
| 78 | Mining Construction and Related Labourers | 0.0202 | 50 | -2.342 | 76 |
| 79 | Agricultural and Horticultural Labourers | 0.0496 | 70 | 1.808 | 2 |
| 82 | All occupations | 0.0267 | 82 | -0.560 | 82 |

Notes. 1. Intensities are expressed as emissions per unit of labour input in 2004-05. Emissions are measured in kilotonnes of $CO_2$ equivalent. Labour is measured in thousands of hours.
2. The deviations in column 3 are the differences between employment in 2024-25 for the Basecase and CPRS-5 scenarios (see Table 4). They are expressed as a percentage of employment in 2004-05.

The MMSE model consists of a unit record data file containing 13605 person records derived from the Australian Income Distribution Survey (ABS, 1998) but modified to form a fully integrated system with the MLME database and MMRF database when aggregated to the national level. Consistency is imposed by adopting a hierarchy of sources in which the data at each level is a disaggregation of the data at the preceding level. The main components of the hierarchy are:

- the National Accounts organised into an aggregate social accounting matrix,
- the Input-Output Table,
- the Labour Force Survey,
- the Survey of Education and Work;
- the Income Distribution Survey, and

- The Household Expenditure Survey.

Results from the MMRF and MLME models are used to update many aspects of the unit records in the MMSE model. However, additional information is required to allocate changes in labour force status. To this end, a 2004-05 population matrix is compiled which cross-classifies 83 labour force status categories (employed persons differentiated by occupation, unemployed persons and persons not in the labour force) with 193 demographic categories (12 age groups, two sexes and eight regions). Projections to 2024-25 for the 81 occupations are available from MLME. Projections for the demographic groups and the remaining labour force categories are derived from published estimates by various public and private forecasters. The whole cross-classified matrix is then updated using the RAS method. The updated matrix, in its turn, provides the where-with-all to revise the weights attached to the unit records.

Table 7 shows results for one of the nine institutional accounts that make up the social accounting matrix in MIDE, namely, the *Household current account*. MIDE contains enough theory to determine the values of all the categories in the account except *Net saving*, which is the residual between the income and expenditure sides. Note that the theory is not always particularly sophisticated, with several categories assumed to move with GDP.

Table 8 shows the corresponding projections for disposable income. *Disposable income* ($631,510m in 2004-05) in Table 8 can be derived from *Total gross income* ($808,252m) in Table 7 by subtracting *Consumption of fixed capital*, *Interest payments*, *Income taxes* and *Other taxes on income, wealth, etc*. As with the output and employment results, the effect of the mitigation policy on incomes is small compared to the income growth that is projected to occur between 2004-05 and 2024-25 whether the policy is adopted or not.

It has already been indicated that a change in *Compensation of employees* is the cumulative effect of changes in the employment of 81 occupations on the wages of the 13605 persons recognised in the MMSE model. Similarly, a change in *Income from own business* is the cumulative effect of changes in the return to capital in 17 different industries. The income distribution survey generally contains some persons who sustained losses from self employment in the year of the survey. To accommodate this kind of negative income, an estimate is made of the size of the capital stock in the self–employed sector, and the stock then allocated between the relevant

**Table 7. Household Current Account**

| Industry | (1) 2004-05 | (2) Basecase 2024-25 | (3) Basecase 2024-25 | (4) CPRS-5 2024-25 | (5) CPRS-5 2024-25 |
|---|---|---|---|---|---|
| | Level ($m) | Level ($m) | Growth (%) | Level ($m) | Growth (%) |
| Direct income from factors of production | 571330 | 998864 | 89.80 | 960461 | 81.73 |
| Gross operating surplus, dwellings | 63690 | 99544 | 67.55 | 95991 | 60.86 |
| Gross mixed income | 99210 | 188957 | 108.55 | 181777 | 99.87 |
| Compensation of employees | 408431 | 710364 | 88.71 | 682694 | 80.58 |
| Domestic producers | 407358 | 708498 | 88.71 | 680900 | 80.58 |
| Foreign producers | 1073 | 1866 | 88.71 | 1793 | 80.58 |
| Transfers from households | 2530 | 4905 | 112.69 | 4743 | 104.98 |
| Transfers from non-financial corporations | 16238 | 31486 | 112.69 | 30443 | 104.98 |
| Transfers from financial corporations | 89427 | 173404 | 112.69 | 167661 | 104.98 |
| Transfers from general government | 128282 | 243858 | 108.11 | 236153 | 100.91 |
| Transfers from external sector | 445 | 863 | 112.69 | 834 | 104.98 |
| **Total gross income** | 808252 | 1453381 | 95.78 | 1400296 | 87.90 |
| Private final consumption expenditure | 544241 | 928381 | 84.70 | 909825 | 80.61 |
| Domestic commodities | 471203 | 783229 | 79.46 | 766928 | 75.31 |
| Imported commodities | 34666 | 78734 | 152.54 | 77959 | 149.86 |
| Taxes less subsidies on products | 38372 | 66417 | 87.71 | 64939 | 83.08 |
| Direct taxes | 96727 | 155082 | 72.40 | 149940 | 66.02 |
| Income tax | 94108 | 150799 | 72.29 | 145797 | 65.91 |
| Other current taxes on income wealth etc | 2619 | 4283 | 76.27 | 4143 | 69.85 |
| Current transfers to households | 2530 | 4905 | 112.69 | 4743 | 104.98 |
| Current transfers to non-financial corporations | 5834 | 11312 | 112.69 | 10938 | 104.98 |
| Interest payments | 5803 | 11253 | 112.69 | 10880 | 104.98 |
| Other | 31 | 60 | 112.69 | 58 | 104.98 |
| Current transfers to financial corporations | 74642 | 144734 | 112.69 | 139940 | 104.98 |
| Interest payments | 39051 | 75723 | 112.69 | 73215 | 104.98 |
| Other | 35590 | 69011 | 112.69 | 66725 | 104.98 |
| Current transfers to general government | 417 | 808 | 112.69 | 781 | 104.98 |
| Current transfers to external sector | 3879 | 7521 | 112.69 | 7272 | 104.98 |
| Net saving | 30900 | 116188 | 331.21 | 95576 | 251.17 |
| Consumption of fixed capital | 49082 | 84449 | 86.47 | 81280 | 78.72 |
| Dwellings owned by persons | 24588 | 38430 | 67.55 | 37058 | 60.86 |
| Other | 24494 | 46019 | 105.45 | 44222 | 96.65 |
| **Total use of gross income** | 808252 | 1453381 | 95.78 | 1400296 | 87.90 |

**Table 8. Household Disposable Income**

| Industry | (1) 2004-05 | (2) Basecase 2024-25 | (3) Basecase 2024-25 | (4) CPRS-5 2024-25 | (5) CPRS-5 2024-25 |
|---|---|---|---|---|---|
| | Level ($m) | Level ($m) | Growth (%) | Level ($m) | Growth (%) |
| Income from dwellings, landlords | | | | | |
| Gross operating surplus | 17002 | 26573 | 56.29 | 25624 | 50.72 |
| *less* consumption of fixed capital | 6563 | 10258 | 56.29 | 9892 | 50.72 |
| *less* interest payments | 6111 | 9551 | 56.29 | 9210 | 50.72 |
| Income from own business | | | | | |
| Gross mixed income | 99210 | 188957 | 90.46 | 181777 | 83.22 |
| *less* consumption of fixed capital | 24494 | 46019 | 87.88 | 44222 | 80.54 |
| *less* interest payments | 8039 | 15278 | 90.06 | 14711 | 83.00 |
| Compensation of employees | 408431 | 710364 | 73.93 | 682694 | 67.15 |
| Actual interest | 24786 | 48062 | 93.91 | 46470 | 87.48 |
| Dividends | 12391 | 24028 | 93.91 | 23232 | 87.48 |
| Unemployment benefits | 7621 | 9891 | 29.78 | 9936 | 30.37 |
| Other taxable benefits | 73258 | 142051 | 93.91 | 137346 | 87.48 |
| Other current transfers, taxable | 16779 | 32535 | 93.91 | 31457 | 87.48 |
| Income from dwellings, owner occupiers | | | | | |
| Gross operating surplus | 46688 | 72971 | 56.29 | 70367 | 50.72 |
| *less* consumption of fixed capital | 18025 | 28172 | 56.29 | 27167 | 50.72 |
| *less* interest payments | 16784 | 26232 | 56.29 | 25296 | 50.72 |
| Imputed interest | 33703 | 65352 | 93.91 | 63187 | 87.48 |
| Social assistance benefits, non-taxable | 20144 | 39060 | 93.91 | 37766 | 87.48 |
| Other current transfers, non-taxable | 48239 | 93539 | 93.91 | 90440 | 87.48 |
| *less* Income taxes | 94106 | 150797 | 60.24 | 145795 | 54.93 |
| *less* Other taxes on income wealth etc | 2619 | 4283 | 63.56 | 4143 | 58.21 |
| **Disposable income** | 631510 | 1162790 | 84.13 | 1119860 | 77.33 |

generally contains some persons who sustained losses from self employment in the year of the survey. To accommodate this kind of negative income, an estimate is made of the size of the capital stock in the self–employed sector, and the stock then allocated between the relevant persons in the microsimulation model. In particular, persons who achieved large profits *or* sustained large losses in the survey are allocated relatively large amounts of capital. Then, when a change occurs, profits are distributed in proportion to capital ownership rather than in proportion to income from own business.

**Table 9. Distribution of Household Disposable Income**

| Industry | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | 2004-05 | | Basecase 2024-25 | | CPRS-5 2024-25 | |
| | Level ($m) | Share (%) | Level ($m) | Share (%) | Level ($m) | Share (%) |
| **Nominal incomes** | | | | | | |
| Income deciles | | | | | | |
| 1st | -429 | -0.068 | 1515 | 0.130 | 1384 | 0.124 |
| 2nd | 10296 | 1.630 | 19058 | 1.639 | 18421 | 1.645 |
| 3rd | 24052 | 3.809 | 44727 | 3.847 | 43238 | 3.861 |
| 4th | 33975 | 5.380 | 63505 | 5.461 | 61426 | 5.485 |
| 5th | 40127 | 6.354 | 74168 | 6.378 | 71723 | 6.405 |
| 6th | 49311 | 7.808 | 90394 | 7.774 | 87134 | 7.781 |
| 7th | 61876 | 9.798 | 112882 | 9.708 | 108610 | 9.699 |
| 8th | 80639 | 12.769 | 146596 | 12.607 | 140945 | 12.586 |
| 9th | 109810 | 17.389 | 199893 | 17.191 | 192242 | 17.167 |
| 10th | 221854 | 35.131 | 410052 | 35.264 | 394738 | 35.249 |
| | 631510 | 100.000 | 1162791 | 100.000 | 1119860 | 100.000 |
| Income percentiles | | | | | | |
| 10th | 434 | 0.069 | 799 | 0.069 | 772 | 0.069 |
| 90th | 12783 | 2.024 | 23211 | 1.996 | 22332 | 1.994 |
| 90th/10th | | 29.472 | | 29.058 | | 28.938 |
| **Real incomes** | | | | | | |
| Income deciles | | | | | | |
| 1st | -429 | -0.068 | 1518 | 0.131 | 1385 | 0.124 |
| 2nd | 10296 | 1.630 | 19049 | 1.647 | 18324 | 1.646 |
| 3rd | 24052 | 3.809 | 44705 | 3.865 | 43144 | 3.875 |
| 4th | 33975 | 5.380 | 63326 | 5.475 | 61079 | 5.486 |
| 5th | 40127 | 6.354 | 73902 | 6.389 | 71331 | 6.406 |
| 6th | 49311 | 7.808 | 90021 | 7.783 | 86644 | 7.782 |
| 7th | 61876 | 9.798 | 112272 | 9.706 | 107895 | 9.690 |
| 8th | 80639 | 12.769 | 145833 | 12.608 | 140082 | 12.581 |
| 9th | 109810 | 17.389 | 198809 | 17.188 | 191211 | 17.173 |
| 10th | 221854 | 35.131 | 407247 | 35.208 | 392350 | 35.238 |
| | 631510 | 100.000 | 1156682 | 100.000 | 1113444 | 100.000 |
| Income percentiles | | | | | | |
| 10th | 434 | 0.069 | 799 | 0.069 | 772 | 0.069 |
| 90th | 12783 | 2.024 | 23087 | 1.994 | 22208 | 1.993 |
| 90th/10th | | 29.472 | | 28.894 | | 28.784 |

One outcome of this treatment is that the income of the bottom decile tends to be relatively volatile, increasing move than average when the economy expands and decreasing more than average when the economy contracts. The outcome is evident in the distributional results shown in Table 9, where the bottom decile increases is share by a relatively large amount between 2004-05 and 2024-25. More generally, the mitigation policy tends to reduce the amount of income inequality, with the ratio of the nominal disposable incomes of the 90th and 10th percentiles falling from 29.058 to 28.938. The table also shows the effect on real disposable incomes where the change in the nominal income of each percentile has been deflated by the percentile-specific consumer price index. The policy again reduces the inequality index. The results do not lend any support to the conjecture that mitigation policy is likely to penalise low-income groups because they spend a disproportionate amount of their income on commodities whose prices will rise, particularly electricity.

## 4. Concluding Remarks

The Australian Treasury's analysis of the economics of climate change mitigation has been called "the most thorough, comprehensive and well documented modelling exercise ever conducted in Australia"[5]. This paper has sought to build on this modelling effort by extending an associated MMRF analysis to address distributional issues. The Treasury concluded that "large reductions in emissions do not require reductions in economic activity because the economy restructures in response to emission pricing."[6] The results presented here suggest that the same sentiment is apposite for distribution.

This relatively benign assessment is somewhat at odds with much of the policy debate concerning climate change and its mitigation. A suitable example of the kind of response such assessments evoke is provided by the UNEP in its influential 2008 report on green jobs:

[5] See Parkinson (2009), p.9. Parkinson is the head of the Australian Department of Climate Change.

[6] Australian Treasury (2008), p.137.

> "(Some) studies, based on macro-economic calculations, do not focus on green industries but seek to determine the likely overall effect on the economy arising from policies aiming to reduce greenhouse gas emissions or other environmental impacts. They focus on the ways in which production costs may change, how demand for products and technologies may be altered by new regulations and standards, etc. The results of such analyses are heavily influenced by the basic assumptions that go into them. … The nature of these and other assumptions inevitably colors the general nature of the findings. Thus, skeptical assumptions about reducing greenhouse gas emissions or other environmental measures will likely produce studies that predict job losses, just as more positive assumptions will yield upbeat results. Most studies agree, however, that the likely impact is a small positive change in total employment."[7]

Having drawn attention to the existence of such studies, and to the effect on aggregate activity they predict, the UNEP then proceeds to ignore them throughout the rest of its report. Its attempt to dismiss economy-wide analyses on the grounds that they are "heavily influenced by the assumptions that go into them" is, of course, completely spurious. All analyses are heavily influenced by the assumptions that go into them.

The same kind of idea sometimes surfaces in defence of simple models for analysing distributional issues. It is argued that because the values of behavioural parameters are often not well known, it is desirable to assume no behavioural response and rely entirely on income accounting. But "no behavioural response" is itself an estimate of the values of the relevant behavioural parameters, and is a choice that cannot usually be supported empirically. Similarly, analysts sometimes prefer to estimate the "morning after" effects of a policy change on the grounds that forward-looking analyses are too uncertain. Again, if such analyses were really thought to be of no relevance to the day after "the morning after", they would be of little interest. Policy analysis cannot escape from adopting positions, either explicitly or implicitly, on all the matters that affect the outcome of the policy under consideration.

More specifically, the results presented here depend in part on the view that Australia is unlikely to experience large increases in unemployment over the forecast period. In that case, persons working in occupations adversely affected by the mitigation policy are deemed to able to pick up

[7] UNEP (2008), p.37.

jobs in other occupations. Hence there is little scope for employment changes to impact significantly on income inequality. Similarly, persons on low-incomes may spend a larger share of their budget on electricity, but the variation in budget shares across income groups is not generally large enough to drive substantial changes in inequality and, even then, its effect will be ameliorated by economic adjustment to the change in relative prices.

But perhaps the most important implication of the analysis is that the distribution of employment and income in 2024-25 will not be determined so much by mitigation policy as by the ranec scenario.

**References**


Australian Treasury (2008), *Australia's Low Pollution Future: The Economics of Climate Change Mitigation*, Canberra, October. Available from http://www.treasury.gov.au/lowpollutionfuture/.

Adams, P.D., J.M Horridge and G, Wittwer (2003), "MMRF-GREEN: A Dynamic Multi-Regional Applied General Equilibrium Model of the Australian Economy", *Working Paper No. G-140*, Centre of Policy Studies, Monash University, October. Available from www.monash.edu.au/**policy**/ .

Centre of Policy Studies (2008), *Model Development and Scenario Design: MMRF Modelling to Support a Study of the Economic Impacts of Climate Change Mitigation*. Available from http://www.treasury.gov.au/lowpollutionfuture/consultants_report/downloads/Model_Development_and_Scenario_Design.pdf.

Dixon, P.B. and M.T.Rimmer (2002), *Dynamic General Equilibrium Modelling for Forecasting and Policy: A Practical Guide and Documentation of MONASH*, North-Holland, Amsterdam.

Pang, Felicity. (2010), *A General Equilibrium Analysis of Fiscal Incidence in Australia*, Ph.D thesis, Monash University, forthcoming.

Parkinson, M. (2009), "Australia in the Low Carbon Economy", paper presented to the Australian Financial Review Carbon Reduction Conference, Melbourne, July. Available from http://www.climatechange.gov.au/en/media/speeches.aspx.

United Nations Environment Programme (2008), *Green Jobs: Towards Decent Work in a Sustainable, Low-carbon World*, Nairobi, Kenya, September. Available from www.unep.org/civil_society/Publications/index.asp.