CENTRE of POLICY STUDIES and the IMPACT PROJECT

Eleventh Floor, Menzies Building
Monash University, Wellington Road
CLAYTON Vic 3800 AUSTRALIA

Telephone:	from overseas:
(03) 9905 2398, (03) 9905 5112	61 3 9905 2398 or 61 3 9905 5112
Fax:	
(03) 9905 2426	61 3 9905 2426
e-mail:	impact@buseco.monash.edu.au
Internet home page:	http//www.monash.edu.au/policy/

Structural Change in the Australian Electricity Industry During the 1990s and the Effect on Household Income Distribution

by

GEORGE VERIKIOS
Centre of Policy Studies
Monash University

AND

XIAO-GUANG ZHANG
Productivity Commission
Melbourne

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STRUCTURAL CHANGE IN THE AUSTRALIAN ELECTRICITY INDUSTRY DURING THE 1990s AND THE EFFECT ON HOUSEHOLD INCOME DISTRIBUTION

George Verikios
Centre of Policy Studies, Monash University, Clayton, Victoria, Australia 3800.

Xiao-guang Zhang
Productivity Commission, Melbourne, Victoria, Australia 3000.

Abstract

We develop a framework for estimating the direct and indirect effects on household income of industry changes; it combines a computable general equilibrium model with a microsimulation model in a two-stage simulation procedure. We apply the framework to analysing changes in the Australian electricity industry during 1990s and their effect on household income across households. Almost all income deciles are found to have benefited from the changes but the pattern of effects meant that there was also a small increase in income inequality.

JEL codes: C68, C69, L94, D31.

Keywords: computable general equilibrium, electricity, household income distribution, microeconomic reform, microsimulation.

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1. Introduction

In the early 1990s Australian governments introduced a series of microeconomic reform policies for infrastructure industries (e.g., electricity, gas, water, etc.); Productivity Commission (PC) (2002) summarises these reforms. The reforms were part of the process produced by the Hilmer Report and, subsequently, the *National Competition Reform Act 1995* and the Competition Principles Agreement between Australian governments. The Hilmer Report's terms of reference focused on government businesses and regulations that had created protected enterprises: these had been a feature of industry policy in Australia for most of the 20th century. Hilmer argued for the introduction of competition policy in these areas in order to promote competition for the purpose of promoting community welfare, i.e., economic efficiency and other social goals (King and Maddock 1996). Thus, a major aim of the policy initiatives was to bring about market competition that, in turn, would lead to productivity improvements and attendant increases in real incomes, as well as better choice and services for consumers. Early in the reform process the Industry Commission (IC) estimated that the reforms could increase national output by around 5.5% of its current value at the time (IC 1995).[1] Since the initial introduction of the reforms, the affected industries have undergone significant structural changes that are observable in their cost structure and output prices. PC (2002) documents some of the infrastructure price changes in different Australian regions over the period 1990–91 to 2000–01.

As major service providers, changes in infrastructure industries can potentially have far-reaching impacts on other industries, businesses and households. Both PC (1999) and Madden (2000) noted that the competition policy reforms were regarded by many in the community as being responsible for the increased economic divide between capital cities and regional Australia. Related to this, there has also been natural community concern over the impact on income distribution of sectoral changes, in general, and infrastructure industry changes, in particular, viewed as a result of the microeconomic reforms.

There is a paucity of Australian studies that have analysed the distributional effects of the Hilmer reforms with only two notable exceptions. In PC (1996a), an input-output model and household survey data are used to estimate the effects on household expenditure of price reforms by government trading enterprises (GTEs) in the electricity industry and the water, sewerage and

[1] Filmer and Dao (1994) estimated that a wider package of microeconomic reforms, including those related to infrastructure industries, could raise GDP by between 12% and 15%.

drainage services industry. In a companion paper (PC 1996b), a more sophisticated approach is adopted. A computable general equilibrium (CGE) model in conjunction with an income distribution model is used to analyse the effects of a specific set of reforms on the sources of household income. Each of these studies concentrates on only one side of the household budget, so the overall impact on household real income remains unclear. Moreover, input-output models, as applied in PC (1996a), do not capture effects generated from sectoral reallocation of resources that are arguably the most important effects of any policy change. As a result, the effects of a policy change derived from such a model may be misleading.

As a response to the shortcomings of previous studies, we conduct a more comprehensive analysis of the effects of industry changes on household income distribution. We analyse the distributional effects of sectoral changes that have occurred at the same time as the implementation of microeconomic reform policies, by integrating both sides of the household budget to capture the total (direct and indirect) effect on household real income. An ideal approach to such an analysis is to use a CGE model directly incorporating individual households. Unfortunately, such a highly disaggregated multi-household model is unavailable for Australia.[2] Data limitations are a serious impediment to the development of such a model.[3]

Given these limitations, we adopt a simple but informative two-step approach in which a multi-region CGE model is first simulated by industry-specific changes to generate aggregate changes in the prices of goods and services, and productive factor returns. The resulting aggregate effects are then applied to a separate and highly disaggregated microsimulation model for a detailed analysis of changes in individual household expenditure and income. This approach is readily applicable to analysing the distributional effects of any policy or non-policy changes in the national or regional economies of Australia. We use the structural changes in the Australian electricity industry over the reform period of the 1990s to illustrate the method. Thus, this work makes two contributions to the analysis of the distributional effects of the

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[2] Regardless, there has been some progress in recent years in this area for other countries, e.g., for the US (Slemrod 1985), for Madagascar (Cogneau and Robilliard 2000), for the UK (Plumb 2001), for Nepal (Cockburn 2006), and for the Philippines (Cororaton and Cockburn 2007).

[3] A number of studies have contributed to the development of such an approach for Australia. Rimmer (1995) incorporates household expenditure data distinguishing 100 distinct households into the MONASH model. Nevertheless, the income side remains aggregated to a single representative household. Dixon and Rimmer (1995) extend this framework, disaggregating total factor income by each distinct household's (of which there are 100) share of income in total income. But the share of factor income from each source (i.e., capital, labour, etc) is assumed to be equal for each distinct household.

microeconomic reforms motivated by the Hilmer Report. One, it adds to the few Australian studies that have attempted to estimate the effects on income distribution of structural changes due to microeconomic reform. Two, it represents a methodological advance on these existing studies by estimating the effects on both sides of the household budget, i.e., expenditure and income effects.

2. Microeconomic reform during the 1990s

2.1 Changes in Australian infrastructure industries[4]

At the beginning of the 1990s Australian governments began an extensive process of microeconomic reform of Australian infrastructure industries, including electricity, gas, water, sewerage, urban passenger transport, port services, rail freight, telecommunications and postal services. The main objectives of these reforms were to increase competition and performance in these industries, and thus bring about higher living standards.

Prior to the commencement of the reform process almost all infrastructure industries were dominated by GTEs providing services with monopoly rights. Thus the reform process has been largely concerned with improving the performance of GTEs. With respect to GTEs, the reform process can be categorised into four broad areas: commercialisation; corporatisation; capital market disciplines; and competition policy.

Commercialisation. This involves GTEs taking a more market-driven approach to service provision and pricing. To aid the commercialisation process, competitive tendering and contracting out of service provision have been introduced, community service obligations are now funded in a more direct and transparent way, and GTE regulatory functions have been transferred from GTEs to independent regulators.

Corporatisation. This focuses on making GTEs autonomous entities, within the public sector, with commercially-oriented boards pursuing commercial objectives without ministerial interference. Financial and non-financial performance monitoring and reporting regimes were set up to measure and compare performance. Price regulation has also been largely transferred from ministerial control to independent regulators.

Capital market disciplines. Traditionally, GTEs were not required to earn a commercial rate of return on their assets in the way that private sector firms must. This has now changed, with many

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[4] This section draws on PC (2002), section 1.3.

governments requiring GTEs to either reduce negative rates of return or earn higher positive rates of return.[5]

Competition policy. The implementation of the National Competition Policy Agreement has focussed on removing existing entry barriers to infrastructure industries and thereby stimulating competition and increasing contestability. Increased competitive pressure is aimed at lowering prices and increasing service provision and quality.

2.2 Changes in the Australian electricity industry[6]

The Australian electricity industry has undergone significant reform over the 1990s under the ambit of the Hilmer reforms. This includes corporatisation of electricity utilities, the introduction of competitive neutrality measures, and reform of market and tariff structures. These reforms have led to significant reductions in employment in the industry, along with more flexible work practices. The introduction of competitive neutrality measures has required that governments fund community service obligations directly, thus reducing cross-subsidisation between customer groups. Further, utilities are now required to pay dividends and taxes to governments.

The market structure reforms mainly consisted of separating contestable market elements from non-contestable market elements. Thus entry barriers to electricity generation and retailing were removed, while electricity transmission and distribution continued to be provided by a regulated monopoly supplier. The introduction of competition in generation and retailing over the 1990s led to the establishment of the National Electricity Market, which operates as a trading pool, made up of generators, retailers and wholesale customers.

Tariff reforms have focussed on removing cross-subsidies, so that each customer group pays a price that reflects the cost of supplying them. One effect of tariff reform has been an increase in the weight given to access charges relative to usage charges in total electricity charges. Another effect of tariff reform has been the introduction of time-of-use tariffs, where access and usage charges vary depending on the time of day, so that charges are higher at times of peak demand and lower at other times. Some states and territories have also created

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[5] Analysis by Loundes (2001) indicates that this process does not seem to have improved the financial performance of GTEs.

[6] This section draws on PC (2002), section 2.1.

independent price regulators who are responsible for imposing controls on prices or revenues, a responsibility previously subject to ministerial discretion.

3. Method

Our modelling approach links two separate analytical frameworks for the purpose of generating results at a high level of household detail without a complex CGE model that fully integrates individual households.

3.1 The history of linked models

As the inventor of microsimulation, it is not surprising that Orcutt (1967) was the first to describe a process for linking models that operate at differing levels of aggregation. He envisaged multiple models being linked through "...adaptors and key variables used as intermediaries..." (p. 120). The approach involved models that describe part of the economy being linked as modules that together would describe the overall system. The most succinct summary of alternative approaches to linking micro and macro models is provided by Bækgaard (1995) who identifies the following methods:

1. a top-down approach in which the micro model is adjusted to match an exogenous macro aggregate;
2. a bottom-up approach in which a change generated in the micro model is used to adjust the macro model;
3. a recursive linkage approach in which there is a two-way lagged interaction between models; and
4. an iterative approach in which the two models are solved simultaneously within each period.

A fifth approach proposed by Toder et al. (2000) involves the micro and macro models being solved separately over the full simulation period, with the models then calibrated and resolved until convergence is achieved. A further alternative is to build a model that inherently includes both a micro and macro dimension (Davies 2004). In principle, such a fully integrated model is preferred; in practice, most models in the literature take a recursive-linkage approach.[7] This reflects the practical difficulties of including both dimensions within the one model.

A common feature of linked CGE-microsimulation models developed to date is a focus on labour supply (e.g., Aaberge et al. (2007), Arntz et al. (2008), Fredriksen et al. (2007). Recent examples of linked models developed to assess distributional issues include Herault (2006) and Herault (2007). Within Australia, there have been only limited attempts to link micro and macro models. As far as we are aware, the earliest Australian example is provided by Meagher and Agrawal (1986) in which output from a CGE model was used to reweight the 1981–82 National Income and Housing Survey. Their approach was updated by Dixon et al. (1996), who also foreshadowed an iterative linking of a CGE model to either a static or dynamic microsimulation model. In related work, Polette and Robinson (1997) used the top-down approach to link an aggregated version of the MONASH dynamic CGE model to a microsimulation model of the Australian income support system.

Of the two Australian studies that have analysed the distributional effects of the Hilmer reforms, PC (1996b) follows the pioneering work (in the Australian context) of Meagher and Agrawal (1986) by using a CGE model in conjunction with an income distribution model to analyse the effects of some of the Hilmer reforms on the sources of household income. PC (1996a) applies an input-output model and household survey data to estimate the effects on household expenditure of price reforms by GTEs in the electricity industry and the water, sewerage and drainage services industry. But input-output model are inappropriate for analysing distributional effects.[8] Each of these studies concentrates on only one side of the household budget, so the overall impact on household real income is unclear.

3.2 Analytical framework: a linked CGE-microsimulation top-down approach

Most of the Australian studies mentioned above have focused on linking a CGE model to a detailed microsimulation model of household income. Thus, they have mostly ignored the differences in expenditure patterns across households and their effect on estimates of distributional effects. As a response to these shortcomings, we develop a more comprehensive

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[7] See footnote 2 for some examples of fully integrated models.

[8] Input-output models assume all prices, including factor prices, are fixed. In reality, any reallocation in resources across sectors will alter factor prices and incomes. Thus, using input-output models to analyse structural change rules out, by assumption, any effects on factor prices and income.

framework for analysing distributional issues by integrating both sides of the household budget to capture the direct and indirect effects on household real income.[9] We do this by adopting the top-down approach. That is, a multi-region CGE model – the Monash Multi-Region Forecasting (MMRF) model (Peter et al. 1996, Naqvi and Peter 1996) – is first simulated using industry-specific changes to generate aggregate changes in the prices of goods and services, and factor returns. The resulting aggregate effects are then applied to a separate and highly disaggregated microsimulation model – the MMRF Income Distribution (MMRF-ID) model – for a detailed analysis of changes in individual household expenditure and income; Figure 1 gives a diagrammatic representation of the analytical framework. The approach is readily applicable to analysing the distributional effects of a wide range of changes in the national or regional economies of Australia. We use the structural changes in the Australian electricity industry to illustrate the use of this approach.

3.3 The MMRF model

3.3.1 A linear equation system

The MMRF model is represented by equations specifying behavioural and definitional relationships. There are *m* such relationships involving a total of *p* variables and these can be compactly written in matrix form as

$$A\boldsymbol{v} = \boldsymbol{0}\,, \qquad (1)$$

where A is an $m \times p$ matrix of coefficients, $\boldsymbol{v}$ is a $p \times 1$ vector of *percentage* changes in model variables and $\boldsymbol{0}$ is the $p \times 1$ null vector. Of the p variables, e are exogenous (e.g., taxes). The e variables can be used to shock the model to simulate changes in the $(p-e)$ endogenous variables. Many of the functions underlying (1) are highly nonlinear. Writing the equation system like (1) allows us to avoid finding the explicit forms for the nonlinear functions and we can therefore write percentage changes (or changes) in the $(p-e)$ variables as linear functions of the percentage changes (or changes) in the e variables. To do this, we rearrange (1) as

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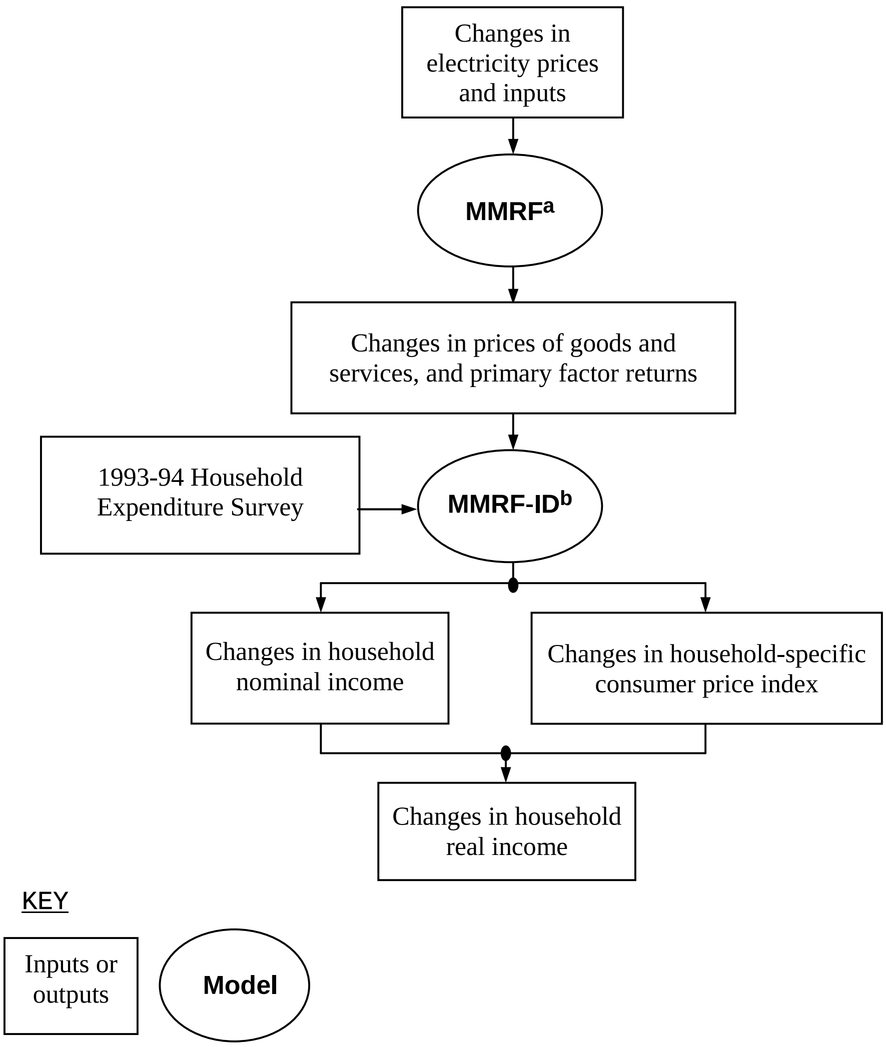
[9] A change in a given infrastructure industry fundamentally affects household real income in two ways. First, a change in the price of the service will affect household real expenditure. This is usually referred to as the 'direct effect'. Second, a price change could be the result of changes in a service provider's cost structure, such as raw material usage, primary factor inputs or new technologies. Such changes alter factor returns and the income of factor owners, i.e., households. Further, the prices of other goods and services may also be affected. These effects are usually referred to as 'indirect effects'.

Figure 1 Linkages between the MMRF and MMRF-ID models



[a] Monash Multi-Region Forecasting model. [b] MMRF Income Distribution model.

$$A_n \boldsymbol{n} + A_x \boldsymbol{x} = \boldsymbol{0}, \tag{2}$$

where $\boldsymbol{n}$ and $\boldsymbol{x}$ are vectors of percentage changes in endogenous and exogenous variables. A_n and A_x are matrices formed by selecting columns of A corresponding to $\boldsymbol{n}$ and $\boldsymbol{x}$. If A_n is square and nonsingular, we can compute percentage changes in the endogenous variables as

$$\boldsymbol{n} = -A_n^{-1} A_x \boldsymbol{x}. \tag{3}$$

Computing solutions to an economic model using (3) and assuming the coefficients of the A matrices are constant is the method pioneered by Johansen (1960).

Equations (1) represent the percentage-change forms of the nonlinear functions underlying the model; these forms are derived by total differentiation. Thus, (1) is an approximation based on marginal changes in the independent variables. So (3) only provides an approximate solution to the endogenous variables $\boldsymbol{n}$; for marginal changes in $\boldsymbol{x}$ the approximation is accurate but for discrete changes in $\boldsymbol{x}$ the approximation will be inaccurate. The problem is the standard one of numerical integration.

The problem of accurately calculating $\boldsymbol{n}$ for large changes in $\boldsymbol{x}$ is equivalent to allowing the coefficients of the A matrices to be nonconstant. The problem is solved by breaking the change in $\boldsymbol{x}$ into i changes. The multistep solution procedure requires that there are $(i-1)$ intermediate values of the underlying (levels) values of $\boldsymbol{n}$, i.e., $\boldsymbol{N}$. The intermediate values of $\boldsymbol{N}$ are obtained by successively updating the values of $\boldsymbol{N}$ after each of the i steps is applied. Once the values of $\boldsymbol{N}$ are updated for any given step, the coefficients of the $\boldsymbol{A}$ matrices in (3) are recomputed before (3) is solved again.[10]

3.3.2 Theory

The MMRF model describes the supply and demand side of commodity and factor markets in the eight Australian states and territories. Each region contains five types of representative agent – producers, physical capital investors, households, governments and foreigners. In the version applied here, there are fifty-four producers or industrial sectors in each region, each producing one commodity. Commodities are traded between regions and are also exported. There is a single representative household, and nine government sectors (eight regional and one national). Foreigners supply imports to each region at fixed c.i.f. prices, and demand commodities (exports) from each region at variable f.o.b. prices.[11]

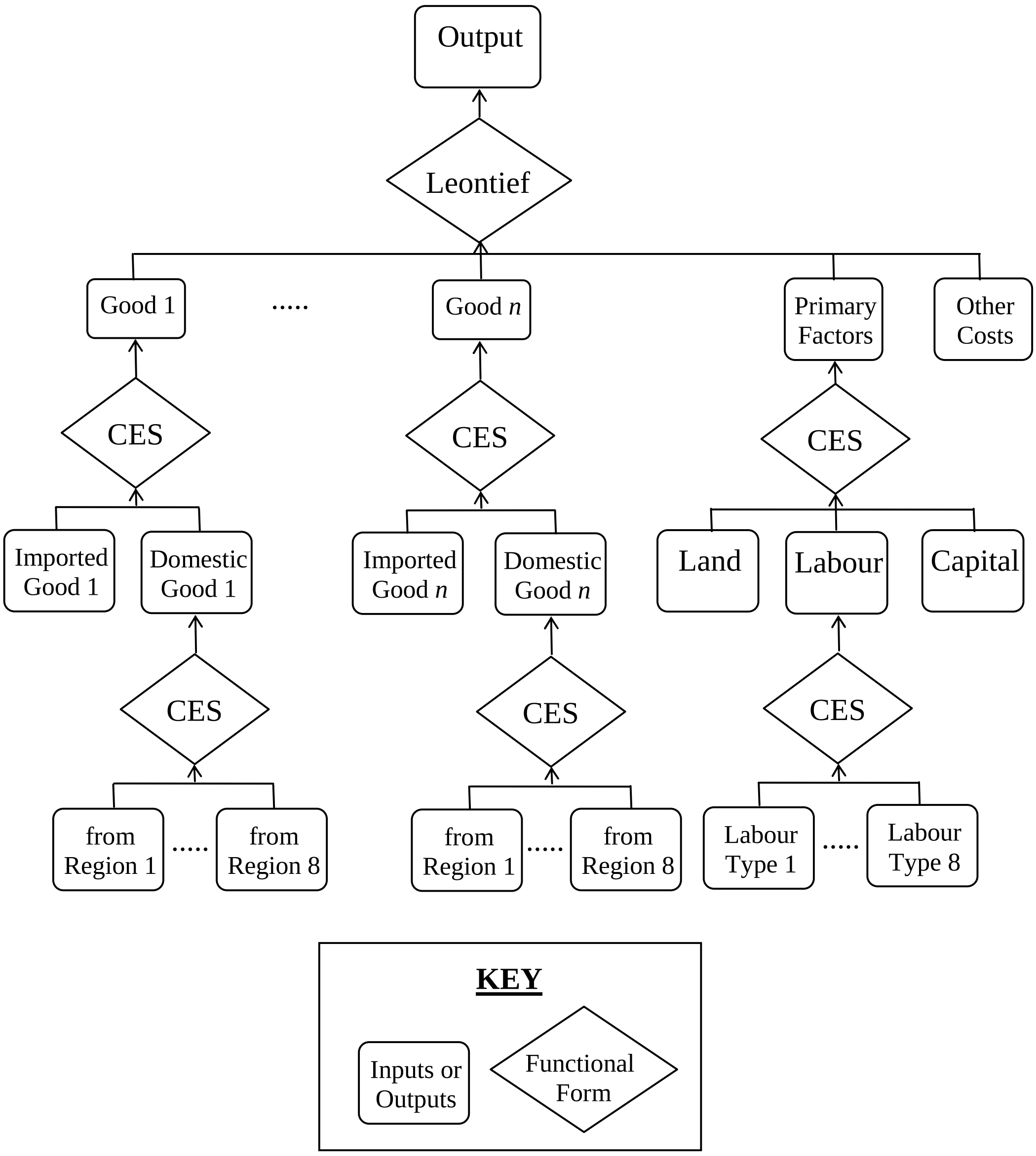
Regional supplies and demands for commodities are derived from optimising behaviour of agents operating in competitive markets. Producers employ constant-returns-to-scale technology and combine primary factors (land, labour and capital) and intermediate inputs using a series of

[10] The model is implemented and solved using the multistep algorithms available in the GEMPACK economic modelling software (Harrison and Pearson 1996).

[11] Thus, MMRF assumes export commodities are imperfectly substitutable with exports from other countries in the tradition of Armington (1969). This formulation means the terms-of-trade are endogenous and Australian regions are modelled as ‘almost small’.

nested Leontief and CES production functions; see Figure 2. Land use is confined to, and fixed within, the agricultural sectors.

Figure 2 Production technology for a regional sector in MMRF



Source: Peter et al. (1996).

In this comparative static version of MMRF the national supply of capital is fixed whereas in reality capital can vary in the long run. But this study is concerned with the reallocation of existing factors rather than growth effects. This means that any excess demands for capital at initial prices (due to electricity industry changes) are partly reflected in rental price changes and partly reflected in the reallocation of capital across regions and sectors: capital moves between industries and across regions to maximise its rate of return.

MMRF specifies the labour input into the primary factor bundle as a constant-elasticity-of-substitution (CES) combination of eight occupational categories.[12] In original form, the CES prices for these occupational categories are identical. Thus, the CES demand function for labour operates like a Leontief (fixed proportions) production function. The MMRF-ID model (see Section 3.4) specifies labour income for households according to these occupational categories. In order to exploit the richness of the labour income data in MMRF-ID, the MMRF model is modified to allow for an occupation-specific price of labour in each region. This allows MMRF to use the occupational wage bill data for each industry to differentially affect demand for, and therefore the price of, each occupational category. To implement occupation-specific wage rates, the MMRF theory and data relating to the labour market is modified (see Verikios and Zhang (2005) for further details); below we describe further changes made for this work.

On the demand side of the labour market, the price paid by firms in industry *j* for labour of (occupation) type *m* in region *r*, PL_{jmr},

$$PL_{jmr} = W_{jmr} T_{jr}, \quad (4)$$

where W_{jmr} is the wage received by workers and T_{jr} is the power of the payroll tax rate paid by firms in industry *j* in region *r*, i.e., $T_{jr} = 1 + t_{jr}$ where *t* is the tax rate. In the original model, W_{jmr} is only defined over industries and regions. For a given PL_{jmr}, firms will determine their cost-minimising demand for each labour type.

On the supply side, the supply of labour type *m* in region *r*, LS_{mr},

$$LS_{mr} = RW_{mr}^{\beta}, \quad (5)$$

and

$$RW_{mr} = \frac{W_{mr}}{CPI_r}, \quad (6)$$

[12] The occupational grouping used is the Australian Standard Classification of Occupations (first edition) (ABS 1986).

where W_{mr} is the average wage paid to labour type *m* in region *r*, and CPI_r is the consumer price index in region r. Thus, the supply of each labour type is a positive function of the real wage, RW_{mr}, and β, the labour supply elasticity. β is set at 0.15 reflecting econometric evidence on labour supply in Australia (Kalb 1997). In the original model, LS_{mr} is only defined over regions.

Labour market equilibrium (including unemployment) is determined by imposing a relation between real wages and employment L_{mr} of the form,

$$L_{mr} = RW_{mr}^{1/\gamma}, \qquad (7)$$

where $1/\gamma$ represents the real wage elasticity of employment, i.e., the responsiveness of employment to changes in the real wage. In any perturbation of the model, $1/\gamma$ determines the degree to which increases (decreases) in the demand for the *m*-, *r*-th labour type will be reflected in higher (lower) employment or in a higher (lower) real wage. We calibrate γ so that employment responses are half as large as real wage responses. This value is based on casual empiricism of the Australian labour market where real wages grow faster than employment; regardless, we conduct sensitivity analysis with respect to the value of γ.

The national consumer price index (CPI) is the numeraire, thus nominal price changes are measured relative to this composite price.

3.4 The MMRF-ID model

MMRF-ID is a microsimulation model that represents the distribution of real incomes across households in the eight Australian regions; it is constructed for the purposes of this study. It only comprises equations specifying definitional relationships.

3.4.1 Theory

Two measures commonly used to compute the benefits that accrue from a price change are compensating variation (CV) and equivalent variation (EV). Both compute the amount of money that would bring the consumer back to their original utility level prior to a price change. The CV values this amount at new prices while the EV values it using original prices. Consumer surplus is a related measure. Both CV and EV apply a ‘money-utility’ concept rather than utility itself.

A modified version of the CV is based on redefining real income as constant purchasing power; i.e., the amount of money that allows the consumer to purchase the same bundle of goods as before the price change. Applying this concept to measure changes in real income means there is no need to make any specific assumptions about consumer preferences or utility functions. This approach is in line with Slutsky's decomposition of price change effects.

The computation of CV normally assumes unchanging household income and, therefore, emphasises only the role of each household's different consumption patterns in determining the welfare impact of a price change. But in a general equilibrium framework household income is not constant. As a result, the above definition of CV can be usefully extended to account for changing income. Similar to the expenditure side, the income side of the modified CV can be interpreted as the amount of money that would encourage the household to supply the same amount of factors as prior to any price change.

For a household, real income can then be defined as nominal factor earnings and transfers received from different sources deflated by a household-specific consumer price index (HCPI). Then, the first-order approximation to the percentage change in the *i*-th household's CV, relative to the initial consumption bundle and factor ownership, can be expressed as

$$cv^i = -\left(w^i - p^i\right), \tag{8}$$

where w^i is the percentage change in income received by household *i*, and p^i is the percentage change in the HCPI for household *i*. p^i is the average of the percentage changes in the prices of goods and services, weighted by their expenditure shares,

$$p^i = \sum_n \theta_n^i p_n , \tag{9}$$

where θ_n^i is the *i*-th household's expenditure share for good *n*, and p_n is the percentage change in the price of good *n*.

Differences in the sources of income w^i for the *i*-th household can be expressed as

$$w^i = \sum_f \phi_f^i w_f , \tag{10}$$

where ϕ_f^i is the share of income source *f* in the *i*-th household's income, and w_f is the percentage change in the factor price of income source *f*. If the HCPI rises relative to income, compensation will be required $\left(cv^i > 0\right)$ in order to keep the household at its initial level of consumption.

The income side of our modified CV is the amount of money that would encourage households to supply the same amount of factors as prior to any price change. But we know that the general equilibrium effects of industry changes will lead to changes in factor supply and employment as well as factor returns. To account for such changes, we redefine w^i as

$$w^i = \sum_f \phi_f^i w_f q_f \ , \qquad (11)$$

where q_f is the percentage change in the demand (or employment) of income source *f*. Thus, our modified CV assesses the impact of a policy change on a given household or household group via the computation of the change in real income.

In computing real household income changes in MMRF-ID, p_n, w_f and q_f are set equal to the values generated in MMRF; θ_n^i and ϕ_f^i are calculated from the MMRF-ID database.

3.4.2 Data

The MMRF-ID data are based on unit-record household survey data taken from the 1993–94 Household Expenditure Survey (HES93) (ABS 1994). The survey contains detailed information on household consumption patterns and income sources of 8,389 sample households in existence around the beginning of the 1990s across the eight Australian states and territories. On the income side, the HES93 lists not only private income sources, such as wages and salaries from eight occupations and non-wage income from investment or business sources, but also various government transfer payments, such as family allowances, unemployment benefits and age pensions (see Table 1). It also contains detailed expenditure data on more than 700 goods and services. These items are aggregated to 54 groups consistent with the commodities in MMRF. This information is used to calibrate the MMRF-ID database.

Table 1 Mapping between household income sources in MMRF and MMRF-ID

MMRF model	MMRF-ID model
Labour income sources	Managers, Professional, Para-Professional, Trades Persons, Clerks, Sales Persons, Plant/Machine Operators, Labourers.
Non-labour income sources	Interest, Investment, Property Rent, Superannuation, Business, Workers Compensation, Accident Compensation, Maintenance, Other Regular Sources, Private Scholarship, Government Scholarship, Overseas Pensions.
Government benefits	Sickness Benefits, Family Allowance, Veteran's Pensions, Unemployment Benefits, Age Pensions, Widows Pensions, Disable Pensions, Sup Par Benefits, Wife's Pensions, Other Australian Government Benefits, AUSTUDY Support, Carer's Pensions, Other Overseas Government Benefits.
Income tax	Direct tax.

In reporting distributional effects from MMRF-ID, we group households according to regional income deciles. Given the focus of this work is the effect of electricity industry changes, Table 2 presents the national share of household expenditure allocated to electricity across income deciles. As expected, the share falls as household income rises reflecting the very stable nature of demand for electricity with respect to income, i.e., a low income elasticity of demand. Table 2 also presents the distribution of household income across income sources for each decile. It shows that government benefits are the dominant source of household income for the first three deciles, whereas labour income is the most important income source for the remaining seven deciles. The data also show a steadily rising direct tax rate as income rises. The data patterns are as expected.

Table 2 Electricity expenditure and income source shares in MMRF-ID, national (fraction)

Income decile	Share of electricity expenditure in total expenditure	Share of household income by income source				
		Non-labour income	Labour income	Government benefits	Direct taxes	Total
Lowest	0.027	-0.125	0.318	0.778	0.029	1.000
Second	0.026	0.074	0.393	0.476	0.057	1.000
Third	0.027	0.124	0.318	0.498	0.060	1.000
Fourth	0.024	0.084	0.459	0.373	0.085	1.000
Fifth	0.022	0.143	0.556	0.179	0.122	1.000
Sixth	0.020	0.119	0.633	0.106	0.142	1.000
Seventh	0.020	0.128	0.651	0.066	0.156	1.000
Eighth	0.018	0.105	0.700	0.026	0.168	1.000
Ninth	0.016	0.098	0.704	0.014	0.184	1.000
Highest	0.015	0.147	0.621	0.006	0.225	1.000

Source: MMRF-ID database.

4. Calculating electricity-industry-specific changes

Determining changes specific to the electricity industry over the 1990s is an important input to this work. The structure of the electricity industry at the end of the 1990s was markedly different from that at the beginning of the microeconomic reform process in the early 1990s. While it seems reasonable to attribute most of these changes to the reform process directed specifically to the electricity industry, changes have occurred in the other parts of the economy that are likely to also have influenced the changes observed in the electricity industry.[13] But we do not wish to consider all historical events that have reshaped the electricity industry over the 1990s, but rather to isolate all electricity-industry-specific changes. To estimate such changes, the observed changes in the electricity industry need to be adjusted to remove the effects of external factors. If complete information on changes in the quantities of industry inputs and outputs was available, these changes could be imposed directly as shocks in the model to generate the requisite equilibrium prices and quantities for electricity, as well as other commodities and primary factors. But information is only available on two industry variables: employment and output prices.

The observed changes in industry gross employment contain an expansionary effect caused by economy-wide output growth (due to changes in productivity, tastes and preferences, technology, etc.), which may be unrelated to industry-specific changes. To remove this effect, employment per unit of output is used to simulate the change in the electricity industry's employment. Employment per unit of output is calculated as observed gross employment divided by the quantity of output, or more precisely, employment per kilowatts (per hour) supplied.

In imposing the changes in employment per unit of output on the CGE model, this typically endogenous variable must bet set as exogenous. This is accommodated by setting labour-augmenting technical change as endogenous. This implicitly assumes that any change in unit-output employment can be attributed to a change in industry-specific labour productivity.

In calculating the electricity price shocks, we want to remove the effects of non-electricity-industry factors, e.g., inflation, income growth, population expansion, etc. The impacts of these external effects on the price of electricity can be removed, to a large extent, by calculating a 'real price index', i.e., the observed market price divided by the consumer price index (CPI). If the

[13] For an *ex ante* analysis of the effects of microeconomic reform on the electricity industry, see Quiggin (1997) and Whiteman (1999).

CPI is taken as a proxy for the price index of all goods and services, the real price of electricity can be conveniently interpreted as a relative price. Any deviation of the real price from the CPI can then be interpreted as indicating changes caused purely by electricity-industry-specific factors.

The real price of electricity is typically an endogenous variable in a CGE model. To impose the price change in MMRF, we set it as exogenous and all-input-augmenting technical change is set as endogenous. This implies that any price change can be attributed to a change in the technology affecting the use of all inputs in the production of electricity.

Like many infrastructure industries, the electricity industry charges different prices for different customers. For instance, at least three sets of prices are reported by electricity firms: industrial, business and residential (see ESAA 1992). Over the 1990s, the basic cost structure of producing and distributing electricity changed, along with prices for different customers. Nevertheless, price data indicates that the changes in prices for different customers were not always in accordance with underlying cost changes. This indicates electricity firms have rebalanced prices for different customer groups (PC 2002). When a public utility company is privatised or corporatised, for example, any existing subsidies for residential households, imposed by the government at the expense of industrial or business users, are likely to be removed or phased out. This could lead to household and business prices moving in opposite directions.

To account for price rebalancing, the MMRF model is modified as follows. In each region, instead of shocking a single price of electricity, two price shocks are introduced: one for producers who use electricity as an intermediate input, and the other for households who use it for consumption. The supply price of electricity by the industry is then a weighted average of the two prices, which is set equal to the total cost of production.[14]

Changes in the electricity industry are also likely to affect government revenue. To neutralise the effect of changes in government revenue in the analysis, we fix the federal budget deficit and endogenise the income tax rate. We also fix the budget deficit for all state governments and endogenise their payroll tax rates. This assumes that for a given level of public expenditure, any additional tax revenue raised due to the changes in the electricity industry will be automatically returned to households though a reduction in their income tax rates, and higher

[14] Zero pure profits in production is assumed for all industries.

pre-tax wage rates due to lower payroll tax rates on firms. These assumptions are likely to be important in determining how any efficiency gains are distributed across households, so we conduct sensitivity analysis where these assumptions are varied. To explore the effects of parameter uncertainty, we also conduct sensitivity analysis with respect to a number of important model parameters.

On the government expenditure side, real government consumption expenditure is a fixed share of real household consumption expenditure; this is also subject to sensitivity analysis where we fix real consumption by all governments. In turn, household consumption expenditure is fixed share of household disposable income. Similarly, government investment expenditure is a fixed share of total (private and public) investment expenditure. Private investment expenditure moves in line with any changes in each industry's capital stock.

5. Results

5.1 Economy-wide effects

In this section the estimated changes in the real price and employment per unit of output in the electricity industry are used to shock MMRF to project the aggregate effects of these changes on the general economy. The shocks are estimated from published statistics and are reported in Table 3.[15] We see that employment per unit of output decreased significantly in all regions for the period 1989–90 to 1999–00, from a maximum of -80% in Victoria to a minimum of -45% in the Australian Capital Territory (ACT). Also, in general, real prices fell significantly or increased only slightly over the period, with business prices falling in all regions relative to household prices.

Table 3 Estimated changes in electricity industry variables: 1989–90 to 1999–00 (percentage change)

Variable	NSW	Vic	Qld	SA	WA	Tas	NT	ACT
Employment per unit of output	-65.1	-80.0	-46.8	-69.5	-59.3	-59.4	-54.1	-45.3
Business prices	-60.1	-47.6	-34.8	-45.4	-22.9	-66.3	-19.6	-33.8
Household prices	-11.0	8.5	-16.3	6.5	-12.9	6.5	-8.1	-2.3

Source: ABS (1992, 2001b) and ESAA (1992, 1998, 2001a, 2001b).

15 See ABS (1992, 2001) and ESAA (1992, 1998, 2001a, 2001b).

A CGE model captures both the direct and indirect effects of a given shock to the economy. The major determinant of the direct effects of changes in the electricity industry is its importance in the economy as a whole. Our model data indicates that electricity output comprised around 2.3% of national output in 1993-94 (our base year); the share of the electricity output in total output was largest in Tasmania (4%) and smallest in the ACT (1.4%). This suggests that changes in the electricity industry will lead to significant direct effects, but of varying magnitudes across regions.

The major determinant of the indirect effects of changes in the electricity industry is its importance to other industries, as indicated by its sales as an intermediate input to production. Our model data indicates that intermediate input usage makes up around three-quarters of total electricity sales, with household consumption comprising the remainder. This suggests that there will be large indirect effects from changes in the electricity industry.

The results of applying the estimated changes in employment and prices to MMRF are reported in Table 4. The estimated changes in unit-output employment will determine the changes in labour productivity.[16] The estimated changes in business and household prices are aggregated in MMRF, weighted by their shares in total sales, to determine the changes in the basic price index of electricity. In turn, the change in the basic price determines the change in the productivity of all inputs, i.e., all primary factors and intermediate inputs. The change in labour and all inputs productivity is summed to give an average productivity change. This change is closely related to the change in the basic price for the industry. The projected change in average productivity is highest in New South Wales (NSW) and Tasmania and lowest in South Australia (SA), Western Australia (WA) and the Northern Territory (NT), with the remaining regions somewhere in between. The effects of these industry changes on primary factor incomes, government benefits, direct taxes, and the prices of goods and services are reported in Table 5.

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[16] When referring to productivity changes in discussing model results, we are referring to the model equivalent of input per unit of output. Thus, a negative change in productivity represents an improvement.

Table 4 Electricity industry effects due to changes in unit-output employment and relative output prices between 1989–90 and 1999–00 (percentage change)

Variable	NSW	Vic	Qld	SA	WA	Tas	NT	ACT
Labour productivity[a]	-59.7	-91.1	-48.8	-78.4	-74.3	-53.7	-68.3	-46.6
All inputs productivity[a, b]	-35.8	-10.8	-19.7	-10.8	-4.7	-31.9	3.7	-12.2
Basic price	-52.8	-36.3	-31.5	-36.5	-21.3	-53.3	-18.0	-28.4
Average productivity[a]	-42.0	-25.8	-24.0	-17.6	-16.1	-36.6	-13.8	-21.8

Source: MMRF simulation.

a This is the input requirement per unit of output; thus, a negative sign signifies an improvement. **b** This relates to all primary factors and intermediate inputs.

Table 5 Regional effects of changes in the electricity industry between 1989-90 and 1999-00 (percentage change)

Variable	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aust
Labour income	2.9	1.3	1.6	1.1	0.6	5.1	0.0	3.3	2.0
Managers & administrators	3.4	2.6	1.6	1.4	1.2	5.2	1.1	3.9	2.5
Professionals	0.6	-1.5	0.6	0.4	-1.6	2.3	-1.9	2.6	-0.1
Para-professionals	3.4	1.4	2.2	1.5	0.7	6.2	0.0	3.9	2.3
Tradespersons	1.0	-1.5	0.4	-0.2	-1.2	2.8	-2.0	1.1	0.0
Clerks	3.8	2.8	2.2	1.7	1.7	6.2	1.2	4.1	3.0
Salespersons & personal service workers	3.7	2.7	2.2	1.6	1.6	6.0	1.0	3.7	2.9
Plant & machine operators; drivers	5.3	3.5	2.8	1.4	2.5	8.4	1.2	3.4	3.8
Labourers & related workers	3.9	2.9	1.8	1.4	1.5	5.9	1.0	3.7	2.9
Non-labour income	1.7	0.8	1.0	1.1	0.9	2.3	0.6	3.1	2.5
Unemployment benefits	-5.3	-2.1	-3.4	-2.0	-1.8	-7.4	-0.7	-7.6	-0.1
Other government benefits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct tax rate									-1.2
Real household disposable income	2.1	1.1	1.3	0.9	0.8	3.1	0.4	2.4	1.5
CPI	0.1	0.0	-0.1	0.0	-0.2	0.5	-0.3	0.5	0.0

Source: MMRF simulation.

The national changes in relative occupational incomes indicate which occupations are favoured by the electricity industry changes; these show falls only for Professionals and Tradespersons. This is because wage payments in the electricity industry are dominated by these two occupations. Thus, when significant labour shedding occurs in this industry it is primarily Professionals and Tradespersons who are affected, and consequently the wage rates for these two occupations must fall for them to be reemployed in other industries. The combination of industries that benefit the most from labour shedding in the electricity industry, in terms of expanded output and employment, determines the occupations that experience the largest increases in relative incomes; these are Plant and machine operators, and drivers (PMODs), and Clerks.

The national pattern of relative changes in occupational incomes is repeated at the regional level but with different absolute changes across regions. For instance, labour incomes rise the most in NSW, Tasmania and ACT, and less in other regions. The relative movements in labour income across regions reflect the relative productivity improvements across regions; higher relative productivity improvements give higher relative labour incomes.[17]

Non-labour income also increases nationally reflecting increased demand for capital and land.[18] The relative changes in non-labour income across regions reflect the pattern of movements in labour income across regions. Unemployment benefits fall in all regions reflecting increased employment in all regions; employment increases the most in regions that experience the largest productivity improvements.

Besides the changes in primary factor incomes, the direct tax rate will also affect household post-tax income. With the assumption of a fixed federal budget deficit and an endogenous direct tax, changes in the direct tax rate are driven by the effect of changes in the electricity industry on total tax revenue. Changes in total tax revenue are driven by the effect of changes in the electricity industry on the level of economic activity. As productivity improves in all regions, there is overall stimulatory effect on economic activity nationally. Thus, tax revenue increases and this is returned via a lower direct tax rate.

The changes in the electricity industry affect not only different household income sources but also the prices of goods (and services). Given a household's preferred bundle of goods, changes in the prices of goods directly affect a household's expenditure. The regional CPI reported in Table 5 is the expenditure-weighted average of the prices of goods consumed in each region. The CPI effects indicate that the cost of household expenditure rises slightly in NSW, Tasmania and ACT, is steady in Victoria and SA, and falls slightly in all other regions. The CPI effects reflect the average change in the basic price of goods in each region. The changes in the basic price of goods can be traced back to the size of the improvement in average productivity in each region's electricity industry presented in Table 5. Regions with the largest improvement in productivity experience the largest increases in average prices and, therefore, household expenditure costs. This pattern reflects our assumed real wage elasticity of employment of 2, as

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[17] The exception is ACT where economic activity is dominated by federal government spending, which responds positively to the productivity improvements in all regions.

[18] Non-labour income is the sum of capital and land rentals. It is used in the MMRF-ID model to shock all non-labour sources of household income.

productivity improvements in a region are mainly reflected in higher real wage rates (and prices) rather than higher employment. This is in spite of the falls in electricity prices and goods intensive in the use of electricity.

5.2 Household effects

The changes in the prices goods and factor incomes projected by MMRF are used as shocks to the MMRF-ID model to compute changes in individual household real income. These results are presented by income deciles for each of the eight regions and nationally in Table 6. At the national level all income deciles gain from the changes in the electricity industry but there is a regressive pattern to the changes as confirmed by the rise in the Gini coefficient. The regressive pattern is driven by the predominance of government benefits as an income source for the first four deciles; government benefits fall overall due to the reductions in the number of unemployed due to the productivity improvements. The top six deciles benefit from the fall in the direct tax rate as they pay a much higher relative tax rate. All deciles benefit from higher factor incomes.

Table 6 Changes in household real income and inequality (percentage change)

Income decile	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aust
Lowest	-0.1	0.2	0.0	0.3	0.3	-0.3	-0.2	0.0	0.1
Second	1.2	0.7	1.0	0.1	0.9	0.9	0.7	0.8	0.9
Third	1.2	0.3	0.9	0.0	0.6	0.9	0.0	2.4	0.8
Fourth	1.7	0.8	1.2	0.2	0.7	0.5	1.3	2.8	1.2
Fifth	2.2	1.0	1.7	1.2	0.8	2.3	0.1	3.3	1.6
Sixth	2.8	1.2	1.8	1.1	1.1	3.5	1.0	3.2	2.0
Seventh	2.9	1.5	1.9	1.2	1.2	3.8	0.9	3.2	2.1
Eighth	3.0	1.8	2.0	1.3	1.1	5.1	0.3	3.3	2.3
Ninth	3.1	1.6	2.0	1.5	1.3	4.6	0.7	3.4	2.3
Highest	3.0	1.4	2.0	1.6	1.1	4.2	0.0	3.4	2.1
All deciles	2.6	1.3	1.7	1.1	1.1	3.4	0.5	3.0	1.8
Gini coefficient	0.4	0.2	0.3	0.3	0.1	0.9	-0.1	0.4	0.3

Source: MMRF-ID simulation.

While the average effect varies across regions, the national pattern of higher income deciles gaining more than the lower income deciles is also replicated at the regional level: there is a small rise in inequality in all regions except NT. Although not reported, the detailed results show that income effects rather than price effects dominate the changes in real income for middle and higher income deciles in most regions. It is also interesting to note that the result for household real income by region estimated by MMRF-ID is not too different from that estimated by MMRF.

6. Sensitivity analysis

It is possible that our results are sensitive to many assumptions underlying the implementation of MMRF. Therefore, it is appropriate to investigate the sensitivity of the model results with respect to key assumptions and parameters so as to assess the robustness of the results. We undertake two types of sensitivity analysis: *ad hoc* and systematic.

Ad hoc sensitivity analysis is applied for model assumptions that are binary, e.g., closure choices; Table 7 reports the results of *ad hoc* sensitivity analysis. These results are relative to our central case results reported in Section 5, so that we vary one set of assumptions from the central case and all leave all other assumptions unchanged. In our central case simulation real government consumption expenditure is a fixed share of real household consumption. Holding real expenditure fixed for all governments allows more revenue to be returned to households via a lower direct tax rate; relative to our central case, this benefits all deciles nationally and in all regions except ACT. It also means increased inequality as higher deciles pay a higher average tax rate and thus benefit more from a lower tax rate. The ACT experiences a lower real income gain because of its reliance on federal government spending, which is lower when government expenditure is held fixed. Letting all government budget deficits vary and fixing all tax rates means budget deficits fall and government debt is reduced. This effectively removes all real income gains coming from lower tax rates and gives smaller overall real income gains; this affects higher income deciles more than lower income deciles. Thus, the income changes are less unequal than in our central case.

Table 7 Results of *ad hoc* sensitivity analysis: household real income and inequality (percentage change)

Variable	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aust
					1. Central case				
All deciles	2.6	1.3	1.7	1.1	1.1	3.4	0.5	3.0	1.8
Gini coefficient	0.4	0.2	0.3	0.3	0.1	0.9	-0.1	0.4	0.3
					2. Exogenous government spending				
All deciles	3.1	1.5	2.1	1.4	1.3	4.5	0.7	1.3	2.2
Gini coefficient	0.5	0.3	0.3	0.4	0.2	1.2	-0.1	0.2	0.4
					3. Endogenous federal & state budget deficits, exogenous tax rates				
All deciles	2.2	0.8	1.4	0.7	0.8	2.9	-0.1	2.0	1.5
Gini coefficient	0.3	0.1	0.2	0.2	0.0	0.8	-0.2	0.2	0.2
					4. Verikios and Zhang (2008)				
All deciles	0.7	0.7	0.6	0.8	0.7	0.8	0.4	0.7	0.7
Gini coefficient	-0.2	0.1	-0.1	0.2	-0.1	0.3	-0.3	-0.2	0.0

Source: MMRF-ID simulation.

Table 7 also presents the results of Verikios and Zhang (2008), of which this work is an extension. In many respects our analytical framework is very similar to Verikios and Zhang's (2008). Nevertheless, we do apply different assumptions in key areas when implementing the electricity industry changes in MMRF; thus, Verikios and Zhang (2008) presents another example of sensitivity analysis. Relative to our central case, Verikios and Zhang's (2008) results show three main differences: one, the overall increase in real income is smaller; two, the gains across regions are more evenly distributed; three, income inequality is unchanged.

In Verikios and Zhang (2008) increases in government revenue from productivity improvements are not fully returned to households in the form of lower direct (payroll) taxes applied by the federal (regional) government(s). A portion of these are returned in the form of lower direct taxes applied by regional governments, whereas in our work extra regional government revenue is returned via lower payroll tax rates. Lower payroll tax rates reduce the relative price of hiring labour and generate increased employment and, therefore, output and income.[19] Another portion of increased federal government revenue is returned via higher government benefits by indexation to wage rates, which themselves rise in response to the productivity improvements. This causes lower income decile households to benefit about the same as higher deciles from the electricity industry changes; so income inequality is static. Verikios and Zhang (2008) also assume labour moves between regions to eliminate regional wage differences, so productivity improvements in one region are largely spread evenly across all regions via labour mobility. In contrast, we assume labour market equilibrium operates at the regional-occupational level [see equation (7)], so productivity improvements in one region largely remain in the same region. Thus we observe more uneven income gains across regions.

Systematic sensitivity analysis is undertaken to evaluate various model parameters (elasticities). This is done by applying a Gaussian quadrature that chooses the optimal number of simulations required to estimate the means and standard deviations for all endogenous variables (DeVuyst and Preckel 1997). The procedure assumes that: (i) simulation results are well approximated by a third-order polynomial in the varying shocks and parameters; (ii) varying shocks and parameters have a symmetric distribution; (iii) shocks and parameters do not both vary at once; (iv) shocks and parameters either have a zero correlation or are perfectly correlated

[19] Another, less important, reason for lower overall gains in Verikios and Zhang (2008) relative to our central case is they assume smaller reductions in business prices than we do.

within a specified range (±50%) (Arndt and Pearson 1996). The sensitivity analysis consists of calculating means and standard deviations for the welfare effects with respect to key parameters.

Table 8 presents the mean and standard deviations for household real income and inequality with respect to systematic variation in parameters. In calculating means and standard deviations, the industry/commodity dimension of each parameter value is varied together whereas the regional dimension is varied independently.[20] The results indicate that our estimates of household real income and inequality effects are remarkably robust with respect to nearly all model parameters. The only exception to this is the real wage elasticity of employment. The larger is this parameter, the greater are the benefits to the economy from the productivity improvements and vice versa. Besides this caveat, we can be reasonably confident of the size of the overall effect on households' welfare and inequality, at the regional and national level, from the estimated changes in the electricity industry. This suggests that our results are largely a product of our data and the size of the estimated changes in the electricity industry; smaller changes would give us smaller increases in overall income and inequality.

7. Concluding remarks

We develop a simple framework for analysing the distributional impacts of structural changes in the national or regional economies of Australia. This framework combines an existing general equilibrium model and a microsimulation model, with detailed household income and expenditure data, to analyse the direct and indirect effects on household income owing to structural change. Using the electricity industry as a case study, our results show that changes in the industry over the 1990s have benefited households, in terms of real income, in almost every income decile in all regions; the national benefit is in the order of 1.8%. Nevertheless, these benefits come at the expense of a small increase in income inequality in nearly all regions, with the national Gini coefficient estimated to have increased slightly by 0.3%.

[20] So in testing the sensitivity of substitution between occupations, elasticities are varied together for all industries in a given region by ±50% while maintaining the size of the same values in all other regions. This requires running 16 (=2×8 regions) simulations.

Table 8 Results of systematic sensitivity analysis: household real income and inequality (percentage change)

Variable	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aust
					1. Mean				
All deciles	2.6	1.3	1.7	1.1	1.1	3.4	0.5	3.0	1.8
Gini coefficient	0.4	0.2	0.3	0.3	0.1	0.9	-0.1	0.4	0.3
					2. Elasticity of substitution between occupations				
All deciles	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.01	0.00
Gini coefficient	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00
					3. Elasticity of primary factor substitution				
All deciles	0.03	0.01	0.03	0.03	0.03	0.02	0.04	0.06	0.02
Gini coefficient	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
					4. Elasticity of import-domestic substitution				
All deciles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gini coefficient	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					5. Elasticity of intra-domestic substitution				
All deciles	0.01	0.00	0.01	0.01	0.00	0.04	0.02	0.04	0.00
Gini coefficient	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
					6. Elasticity of export demand				
All deciles	0.02	0.04	0.00	0.01	0.01	0.06	0.03	0.00	0.02
Gini coefficient	0.00	0.01	0.00	0.01	0.01	0.02	0.00	0.00	0.00
					7. Elasticity of employment with respect to the real wage				
All deciles	0.11	0.04	0.06	0.03	0.03	0.14	0.03	0.08	0.07
Gini coefficient	0.05	0.03	0.03	0.02	0.02	0.08	0.01	0.01	0.04
					8. Elasticity of labour supply				
All deciles	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00
Gini coefficient	0.01	0.01	0.01	0.01	0.01	0.02	0.00	0.01	0.01

Source: MMRF-ID simulation.

The reform-driven improvement in electricity industry productivity lowers the prices of electricity and, to a lesser extent, other goods and services. This tends to benefit low income households more than high income households, as the share of expenditure allocated to electricity is higher in the former than in the latter. The improvement in productivity increases nominal income for most income deciles, however, the highest income increases are experienced by those households who derive most of their income through employment. As a result, this tends to benefit higher income households more than lower income households. The results show that the income effect is much stronger than the price effect and, as a result, leads to income distribution effects that favour high income households more than low income households. We feel that the overriding implication of the analysis is that almost all income deciles were better off due to changes in the electricity industry over the 1990s, which themselves were partly driven by the implementation of microeconomic reform polices.

This work makes a number of contributions. One, it is readily applicable to analysing the distributional effects of structural change in the national or regional economies of Australia, whether the result of policy or non-policy changes. Two, it adds to the few Australian studies that have attempted to estimate the distributional effects of structural changes due to microeconomic reform motivated by the Hilmer Report. Three, it represents a methodological advance on these existing studies by estimating the effects on both sides of the household budget, i.e., expenditure and income effects.

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