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Paper title: A review of the economic modelling on the impacts of the Australian carbon tax

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Abstract:

When the Australian government foreshadowed a carbon price, Australian modellers were ready. This paper outlines the history of carbon pricing policy to date in Australia and describes peer-reviewed, published studies of carbon pricing undertaken from 2007. These studies are then reviewed against some critiques of aspects of climate change modelling; a general critique of macroeconomic modelling emerging since the Global Financial Crises; and two years of real world operation of an Australian carbon tax.

The Australian modelling stands out for its focus on policy relevant questions, and its attempt to use realistic assumptions and details in the most important sectors. Much of the criticism from current anti-economic modelling sentiment is therefore not generally applicable to the carbon tax modelling. More recently, attention has also been directed towards how to achieve greater empirical validation of CGE models; for example, running historical simulations, or running 'forecasts' of earlier time periods when variables are known. Such steps would further anticipate criticism of CGE assumptions and methods.

The paper does question exactly what the baseline or base case is, in climate change mitigation modelling. In non-climate policy, the base case, against which the simulation results are compared, can be regarded unambiguously as the future, in the absence of the policy being modelled. In climate mitigation modelling, when the base case does not include (or indeed cannot include, because of the profound uncertainty) the impacts of the externality, it is misleading if papers describe it as the ‘without policy’ future.

As to the findings of the Australian studies, whilst the results of differently structured models cannot be compared, there was broad agreement that the

short and long run impacts of an Australian carbon price would be mild, and successful in reducing emissions. Recycling revenues is an effective means of addressing equity, competitiveness and other efficiency concerns. The real world data for the two years of operation of a carbon tax in Australia appear to confirm these conclusions. The tax did not ‘drive a wrecking ball’ through the economy.

Introduction

Australia's somewhat erratic carbon pricing policies have offered useful modelling opportunities. It is likely that there will be more opportunities to come. In this paper we review the modelling of Australian carbon pricing that has been published to date. To place these in context, we begin with a brief history of carbon pricing policy in Australia in Section One. Section Two describes six peer-reviewed published general equilibrium modelling studies undertaken between 2007 and 2014. Many other commissioned studies and industry specific reports were produced over this period. Since some of these are clearly more objective than others, and because criteria for choosing between them would be arbitrary, they have not been included[1]. In Section Three we review the modelling, firstly, in the light of specific published critiques of it, and secondly against the two most common accusations currently being levelled at general equilibrium modelling in a post-Global Financial Crisis condemnation of economic modelling. Section 4 examines the broad conclusions of the modelling against actual experience with the Australian carbon tax between 1 July 2012 and its repeal from 1 July 2014. Section 5 sums up the main conclusions of the paper.

Section One: The history of Australian carbon pricing policy

During 1999, the (then) Australian Greenhouse Office (AGO) released four discussion papers exploring the principles and framework for a national emissions trading scheme. Follow up action was delayed until seven years later when somewhat of a maze of inquiries and political positioning and repositioning began.

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[1] Nelson et *al.* (2012) examine the grey (non-academic) literature, including reports from prominent consultancies. They developed a simple test for assessing the consistency of these studies in relation to carbon pass-through. They find that the studies are entirely inconsistent in the estimation of carbon pass-through and Nelson et *al* (2012) are unable to establish why this is so.

In August 2006, the six state and two territory governments established a National Emissions Trading Taskforce (NETT) and released a discussion paper on a possible design for a national emissions trading scheme (NETT 2006). The Taskforce did not include the national government, but the state and territory governments did issue a statement to the national government expressing their expectation that the national government would join them in committing to a scheme. If it did not, however, the state and territory governments indicated they would commence a scheme without the national government by the end of 2010. [2]

Shortly after, the national government under Prime Minister John Howard set up its own Prime Ministerial Task Group on Emissions Trading. This Task Group reported in May 2007 (the 'Shergold Report').

Both the NETT Task Force (state and territory) and the Task Group (Shergold Report) concluded that the benefits would outweigh the costs if Australia were to adopt an appropriate emissions trading scheme earlier rather than later. Both noted that an emissions trading scheme alone would not be enough. For such a large, widespread and complex problem, other policies would be needed.[3]

By the time the state and territories' NETT Taskforce issued its final report in December 2007 (NETT 2007) then, all governments in Australia had agreed to a national emissions trading scheme. In December 2007, national government co-operation was secured in any case, when a new Prime Minister, Kevin Rudd from the Australian Labor Party replaced Mr Howard, from the conservative Liberal-National Party Coalition. There was also a short period after the election of Mr Rudd when an emissions trading scheme had bi-partisan support, since it was the conservative side of politics that had initiated the Shergold Report (2007).

Immediately after his election, Prime Minister Rudd offered the national government's full support to an independent review of the impacts of climate change on the Australian economy. Professor Ross Garnaut was appointed to head this task. The 'Garnaut Review' presented its Final Report on 30 September

[2] Productivity Commission (2007), p.1.
[3] NETT (2007), p vii.

2008 (Garnaut 2008). Recognising the 'free rider' and 'prisoner's dilemma' nature of collective action to address climate change (each country benefits by doing less of the mitigation itself and relying on others; and what one country does will depend on what others do) and describing the challenge as 'diabolical', the Garnaut Review (2008) described the impacts of climate change on Australia and recommended a comprehensive policy framework. The centrepiece of the framework was a 'well-designed' emissions trading scheme.[4] One month later, the modelling which underpinned the conclusions of the Garnaut Review (2008) was released. This report was entitled 'Australia's Low Pollution Future: The Economics of Climate Change Mitigation' (Australian Treasury 2008). The report describes the most complex and comprehensive modelling ever undertaken in Australia.

Australia's first emission trading scheme legislation, the Carbon Pollution Reduction Scheme (CPRS) was introduced into the Parliament in May 2009. In August 2009, however, the Australian Senate rejected the legislation (the Greens Party, which held the balance of power in the Senate sought more ambitious emission reduction targets). A second attempt was made, followed by a third attempt, in October and November 2009, but again, the legislation was rejected in the Australian Senate. In the meantime, a change of leadership in the opposition Liberal-National Party Coalition also removed the bi-partisan support for emissions trading.

After further political manoeuvrings, this time on the Labor Government side of the Australian Parliament, the (new) Prime Minister, Julia Gilliard, was successful in securing agreement to an emissions trading scheme as part of 18 Bills comprising the *Clean Energy Act* 2011. This Act was passed in November 2011. The Garnaut Review (2008) was updated (Garnaut 2011), as was the Treasury modelling (Australian Treasury 2011a, 2011b). The scheme itself was to start with a three year fixed price, after which the market would determine the price. Negotiations with the European Union subsequently secured agreement to accept Australian

[4] Garnaut Review (2008:xi).

permits into the European Emissions Trading Scheme at the time they were to be freed. This would have caused the Australian price of permits to converge to the European price.

The fixed price permits, starting at $23 per tonne of carbon dioxide equivalent (CO2e), became known as the 'carbon tax' and finally came into effect from 1 July 2012. Only businesses exceeding a threshold level of emissions were liable to pay the tax. In the event, the tax applied to about 350 large businesses. Between them, these businesses produced about 60 per cent of Australian emissions.[5] Australian emissions intensive industries (coal mining, coal –based electricity generation, aluminium, civil aviation, steel and diversified mining) were 'shielded' from the impact of the tax, but on a tighter, more formulaic basis than that originally negotiated under the 2009 legislation.[6] Revenue from the allocation of permits was therefore recycled back into the economy by way of the shielding payments and also (principally) by way of lifting the income tax threshold for payment of income tax.

In September 2013, the leader of the Australian parliamentary opposition party, Tony Abbott, was elected Prime Minister in a national election. Mr Abbott had campaigned strongly against the carbon tax, and on winning government commenced action to repeal the legislation. The tax was finally repealed with effect from 1 July 2014. It had operated for two years.

Prime Minister Abbott's new government passed legislation to introduce its climate change policy, termed Direct Action, in November 2014. The Direct Action policy establishes an Emission Reductions Fund (ERF). Essentially, the Fund will be used to purchase abatement commitments from polluting firms.

Under ERF rules, firms must first accredit their abatement proposals with the Clean Energy regulator (CER). The proposals must reduce emissions below the level that they would otherwise have been without the proposed abatement project (the 'baseline'). The baseline will be determined using emissions data reported to

[5] Freebairn (2014a) p.67
[6] Garnaut (2014) p.11

government over the period 2009/10 to 2013/14. If proposals are approved by the CER, proponents must enter into a contract with the CER to receive Australian Carbon Credit Units (ACCUs). One ACCU is issued for each tonne of carbon dioxide equivalent (CO2e) of sequestered carbon or avoided emissions. Only then do project proponents enter a reverse auction process (lowest bid per ACCU is successful) with the CER. If successful, the CER pays the proponent firms for the ACCU's reduced emissions, provided the abatement has been delivered according to the agreed schedule and at the price specified in the bid.

In essence, the Emission Reduction Fund (ERF) policy is a taxpayer funded pollution abatement payment scheme replacing a polluter pays abatement scheme. The ERF currently has $A2.55 billion to distribute to contracted projects and the government's preference is for five-year contracts. It is currently estimated however, that dispersion of the $A2.55b will take 10 years. Budget Paper No. 2 of the 2014-2015 Commonwealth Budget allocates only $1.147b for the four years to 2017-2018. [7]The government believes the projects contracted under the ERF will be sufficient for Australia to meet its emissions target by 2020: five per cent emissions reduction below levels of the year 2000.

Although the ERF has replaced the carbon tax for current Australian emissions mitigation policy, an emissions trading scheme is still an option for future years. In December 2014, the current Minister for the Environment requested the government's Climate Change Authority (CCA), the body which advises the government on climate change mitigation initiatives, to conduct an inquiry into whether Australia should have an emissions trading scheme in the future. In conducting the inquiry, the Authority has been asked to take into account the nature and stance of other countries' climate policies including the USA, China, Japan, Republic of Korea and the European Union; Australia's obligations under the United Nations Framework Convention on Climate Change UNFCCC) and

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[7] See Australian Parliament, Department of the Parliamentary Library, 'The Emissions Reduction Fund', Alex St John and Kai Swoboda: http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/BudgetReview201415/Emissions

the Kyoto Protocol; and what Australia's future emissions reductions targets should be if Australia is to make an 'effective and equitable global response to climate change'.[8] The CCA's draft report on appropriate future emissions reduction targets for Australia is due by 30 June 2015; the draft report on whether Australia should have an emissions trading scheme is due by 30 November 2015; and the final report is due by 30 June 2016. International talks to negotiate future global agreements will take place in Paris in December 2015.

[8] Wording of the Minister for the Environment's letter to the CCA, dated 10 December, 2014. http://www.climatechangeauthority.gov.au/files/files/special-review-request.pdf accessed 15 March 2015.

Section Two: Australian modelling studies

(i) Adams 2007

The decision as to whether to implement a carbon pricing policy such as an emissions trading scheme, can be framed in terms of asking 'should the nation take out an insurance policy against the predicted catastrophic impacts of climate change; and if so how much would the insurance policy cost?' This is the approach adopted by Adams (2007). The study models an emissions trading scheme similar to that envisaged in the NETT (2007) and Shergold (2007) Reports mentioned in Section One. It appears to be a study that lays the groundwork for the economic component of the extensive modelling undertaken a little later for the Garnaut Review (2008, Treasury 2008, 2011a,b). Adams uses the MMRF model, which is a dynamic; multi-sectoral, multi-regional model of 52 industries, 56 products, 8 states/territories and 56 sub-state regions. Importantly, the model is supplemented by input from energy specialists McLennan, Magasanick Associates (MMA) on how the energy sector might respond to a carbon price. Growth rates for electricity generation, including from which technology type, are predicted by MMA for the period 2004 to 2030.

The modelling first determines a baseline, or 'business as usual' projection to 2030 of the Australian economy and territories. The baseline is constructed from a sequence of MMRF's annual forecasts of macro and sectoral variables, using input from specialist external forecasting agencies. The forecasts also include extrapolations of recent trends in industry technologies and household tastes. Adams (2007) states that the baseline shows what might be expected to happen if there were no national emissions trading scheme and no change in other greenhouse gas policies. It should also be noted that the baseline also assumes no climate change impacts.

The second step of the modelling is the emissions trading scheme simulation. As noted, the design of the scheme is similar to that considered by the NETT (2006) and Shergold reports (2007). The scheme applies only to Australia and is not linked to any other international scheme. Electricity generators are assumed to receive a free allocation of permits to compensate for losses, and the EITES receive full (100 per cent) compensation for increased energy costs. The results from the simulation are presented as deviations from the baseline.

Adams (2007) describes in detail how the baseline was constructed, the assumptions of the emission trading scheme scenario; how emissions were calculated, how the time path out to 2030 of the carbon permit price was determined; and the results of the simulation for the macroeconomic; sectoral, and regional variables. Because the approach paves the way for the later study of Adams and Parmenter (2013, Adams et *al* 2014) as part of the Garnaut Review (2008, Treasury 2008, 2011a,b) modelling, we postpone further description. The 2007 study does report important findings. As might be expected, the emissions trading scheme does have a cost; the extent of this cost depends on the amount of abatement and the permit price; and the distribution of this cost depends on the method of compensation to the industries and how permits are allocated. More importantly, perhaps, the economy grows strongly even with stringent abatement targets, and the revenues from the permits can be recycled to cushion the impacts on the economic welfare of Australians. Adams (2007) concludes that taking out the insurance policy is a worthwhile option.

(ii) Adams and Parmenter (2013) Adams, Parmenter and Verikos 2014).

The Terms of Reference for the Garnaut Review (2008) requested modelling of the impacts of climate change as well as modelling of policy interventions to mitigate climate change. There is no doubt that this task and the teams assembled to undertake the task – the Review team, the Centre of Policy Studies (COPs), the Australian Treasury and specific industry modelling expertise – was the largest modelling exercise ever undertaken in Australia.

Garnaut (2008) distinguished four types of costs of climate change of which only the first type of costs could be estimated with enough confidence to include in a general equilibrium model. Other categories included impacts that do not go through markets (e.g. ecosystem services) and impacts that may have 'fat tails' (i.e., those for which there is a low probability of extremely damaging outcomes). Garnaut (2008) considered these latter categories were too uncertain to be estimated reasonably.

The climate change damages that are avoided become the *benefits* of a climate mitigation policy. An important part of the benefits of mitigation policy are therefore omitted from quantitative estimates. Meanwhile, the costs associated with mitigation policy itself *do* go through markets and are therefore more readily estimated. The MMRF modelling team at COPs made an important contribution to this task.

How the MMRF modelling was undertaken is explained at length in Adams and Parmenter (2013, Adams et *al*. 2014). To illustrate the issues, they describe the modelling of a global emissions trading scheme designed to achieve an outcome termed CPRS-5 in the Garnaut Review (2008). CPRS-5 is consistent with stabilisation of emissions in the atmosphere of 550 ppm in 2100. Translated into requirements for the emissions trading scheme, this means the global cap on emissions at 2050 is set to hold *global* emissions to five per cent below the level of emissions in the year 2000.[9] The global scheme allocates permits annually to achieve this cap. Adams and Parmenter (2013, Adams et *al.* 2014) report the effects of the scheme to 2030.

The emissions trading scheme starts in 2011 as a domestic scheme, but does allow permits to be purchased from pre-existing arrangements such as the Clean Development Mechanism. All emissions other than those for agriculture and transport are included in the scheme in the first year. From 2012, transport emissions are included and from 2015, emissions from agriculture are included. From 2020 onwards the scheme becomes a fully global permit trading scheme.

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[9] Australia's target for 2050 is 60 per cent below 2000 levels. It is higher because an allowance is made for emissions to rise in less developed countries. The CPRS-5 is described in Australian Treasury (2008), *Australia's Low Pollution Future*, p.xi.

Compensation is paid to emissions-intensive trade exposed industries (EITES) up to 2020 to shield them from the impacts of the carbon price. The EITES include agriculture and livestock industries, cement, iron & steel, aluminium and alumina, gas mining, paper products, basic chemicals and other non-ferrous metals industries.

A challenging and complex linking of models is a notable feature of this modelling of the emissions trading scheme. Firstly, MMRF – which itself is a recursive dynamic model with bottom up modelling of Australia's six states and two territories, now distinguishing 58 industries and 68 products – is linked with GTEM to enable MMRF to handle changes in Australia's external trading conditions. GTEM also models the global permit price and Australia's allocation of permits. After a mapping of the different aggregations of commodity classifications between the two models, the global permit price and Australia's permit allocation feed directly into MMRF from GTEM because they are naturally exogenous variables. Linking exports proves to be less straightforward because the relevant variables are endogenous in the both models, but this was accommodated by procedures to shift the relevant export demands in MMRF.[10]

A second critical linking is made in the modelling by linking MMRF "bottom up" to Frontier's energy model named WHIRLYGIG. In the first step of this linking, MMRF gives WHIRLYGIG information on electricity demand by industry and region, and on fuel and other costs. From this, WHIRLYGIG optimises the energy system and gives out details of generation type (e.g. coal fired electricity generation, renewable energy of various types, etc.). Fuel use, wholesale and retail prices and the emissions associated with the least cost combination are also given from WHIRLYGIG back to MMRF. In this way, WHIRLYGIG effectively overrides the electricity sector in MMRF. This is done basically because WHIRLYGIG has, for example, many more types of generation technologies, can take account of the 'lumpy' nature of investment decisions in electricity generation, and can also

[10] The procedure is described and illustrated in Adams and Parmenter (2013) p.512-3.

take into account aspects such as the requirement to meet Renewable Energy Targets.

The costs of the emissions trading scheme are gauged by comparing the results of the trading scheme simulations against a baseline projection of model variables spanning the same time period. As with Adams (2007), estimating a credible baseline projection is a major undertaking for the modelling and is critical to the model results. The baseline projects economic growth to 2030 in the absence of mitigation policy and again, in the absence of any impacts of climate change. Using a wide range of forecasts from expert bodies (e.g. forecasts of population and labour force participation rates from Treasury, ABARES for forest sequestration) MMRF modelling, with a forecast closure, estimates the baseline variables.

The results of the modelling of the emissions trading scheme are again presented as deviations from the hypothetical baseline. The macroeconomic variables show remarkably little deviation. Average annual growth in GDP is only 1.1 per cent lower in 2030 than it is in the baseline case. Some regions are actually better off, Tasmania (with forestry) and also the Northern Territory. Queensland (with coal mining and coal based electricity generation) is worst off, but that state is still only 1.8 per cent lower than the base case annual growth.

There are a few industries favourably affected by the emissions trading scheme, notably forestry and electricity generation by renewables and gas. The shielding of the EITES prevents contraction of these industries and they are favoured in any case by a lower real exchange rate. Coal production falls by 12.8 per cent compared to the baseline. This is due to rapid uptake of clean coal technology (see below). Industry-commissioned studies in 2009 argued these falls in coal production would be much greater.

The subregional (within state) impacts of the scheme reflect the industry results. For example, the Hunter Region in New South Wales is adversely affected because it has coal mining and coal-electricity generation. The same applies to two regions in Queensland – Fitzroy and Mackay. The forestry areas of northern Tasmania are favourably affected.

By 2030, total domestic emissions are down by 25.6 per cent compared to base case values. Abatement in stationary energy is significant and is achieved by reduced industry activity, fuel switching and technology changes. In regard to the technology changes, WHIRLYGIG projects significant uptake of clean coal technology towards the later years to 2030.

Australia's total abatement is almost twice as much as its domestic abatement however, because there is a steadily rising requirement for Australia to purchase permits from overseas. This is a particularly significant insight from the modelling. The annual financing cost of purchasing permits reaches $8 billion in 2030. The permit price is $50 per tonne at that time.

(iii) Clarke and Waschik (2012)

The issue that Clarke and Waschik (2012) are particularly interested in is how will the carbon tax affect the international competiveness of the Energy Intensive and Trade Exposed Sectors (EITES). Energy intensive exports will be disadvantaged, as will Australia's import competing energy intensive industries, if trading partners do not have a carbon tax or equivalent policy. Introducing compensation to affected industries does increase the complexity of the policy, Clarke and Waschik (2012) argue. Given a propensity for vested interests to exaggerate impacts, it is necessary to try to ascertain objectively what the likely quantitative impacts might be. Specific questions which Clarke and Waschik (2012) seek to address are: How much shielding from the high cost impacts of the carbon tax is needed and for which industries?; and how do the impacts of the carbon tax compare when the tax is levied unilaterally versus when Australia is part of an international scheme?

Clarke and Waschik (2012) model the effects of a carbon tax in a situation where Australia acts unilaterally, rather as part of a global scheme, as Adams and Parmenter (2013, Adams et *al.* 2014) modelled. Given the lack of agreement in international negotiations, Clarke and Waschik thought it unlikely that a global market for traded carbon permits would emerge in the near future. They argue that if Australia nevertheless acts unilaterally, it would set a good example and encourage reciprocity, and may counter-balance the deliberate misinformation being circulated on climate science.

Starting with GTAP7, with data for 2004, the authors construct a single country static CGE model for Australia. They assume Australia faces the small country conditions of fixed world terms of trade and relative output prices. Their paper explains refinements made to the modelling of production and consumption. Carbon emissions are attached to the production and consumption of energy goods via a fixed coefficient of carbon dioxide (CO2) emissions intensity of the energy goods (coal, oil, gas, petrol, gas distribution). For example, if an energy good is used in an industry's production structure, then the emissions for that industry are calculated simply as the amount of the energy good used multiplied by the emissions intensity coefficient.

The simulations are conducted in an unusual way. Clarke and Waschik (2012) assume an initial endowment of carbon permits exactly equal to total carbon emissions in Australia. Then the number of permits available is gradually reduced from 0 to 30 per cent. The carbon price will rise according to the amount of abatement undertaken, up to 30 per cent. Drawing on the Garnaut and Treasury modelling, an abatement of 27 per cent is assumed broadly to meet Australia's 2020 target of 5 per cent below 2000 emissions. The abatement contracts the economy, but the effects are asymmetrical: the more emissions intensive industries contract the most. To ascertain whether compensation is needed for a given sector, the authors examine the projected sectoral impact of a carbon price on exports, imports and domestic demand in that sector. For example, for the coal industry, a carbon price will cause a significant decrease in domestic demand for coal used in electricity generation and a fall in the domestic price of coal. It is now more advantageous for firms to export coal and, at 27 per cent abatement, the increase in exports almost offsets the decrease in domestic demand. No coal is imported, so overall, there appears to be no strong case for compensation to the coal industry: the decline in domestic demand is offset and improved competitiveness of imports is irrelevant. The situation is quite different for the non-ferrous metals sector. For this sector, the combined effect of the direct carbon tax on the sector and the indirect effect of increased electricity prices *is* quite significant. Exports would decrease and imports increase, and a case for compensation can be made. The model explores various formulae for compensation – basically compensating for the direct carbon price, versus compensation for both the direct price and the implied price increase resulting from the increase in the price of electricity. A significant conclusion answering the authors' first research question regarding which industries and how much, is that a carbon tax, in the absence of the compensation to the EITES does not result in significant cost impacts or adverse impacts on competitiveness in any sectors other than the non-ferrous metals sector.

The simulations are run without, and then with, compensation to the EITES. The author's confirm, as might be expected, that if compensation is paid to the EITES, then the non-compensated sectors must do more of the abating and a higher price is needed to achieve this. If the EITES are not compensated, the resulting carbon price will be lower.

With regard to the second research question then - that is, the difference it makes when Australia is part of a global permit scheme versus acting unilaterally - the authors conclude that being in a global market does make a big difference. The crucial role played by a global market is highlighted when it comes to estimating how much it would cost to shield the non-ferrous sector. In a global market, the carbon price is fixed externally and does not change when compensation is given locally. When Australia acts unilaterally, the carbon price must rise (to achieve a given abatement) when compensation is paid to the EITES. The abatement burden on the remaining firms is higher. The study finds that the required rise in the carbon price is significant.

(iv) Meng, Siriwardana and McNeill (2013)

Contrasting with the long run modelling undertaken in Adams (2007), Adams and Parmenter (2013, Adams et *al.* 2014) and Clarke and Waschik (2012), Meng et al. (2013) model the short run impact of a carbon tax of $23 per tonne CO2e. The (then) Australian government had agreed on this starting price for a carbon tax by the time the modelling was undertaken. The authors used a simple static single country CGE model constructed at the University of New England, and based on ORANI-G (Horridge 2000). The data is based on the Australian Input-Output (I-O) Tables of 2004-5, and aggregates the 109 sectors of the I-O tables into 35 industry sectors and 35 commodities. Energy fuels are disaggregated into eight separate sectors (black coal, brown coal, oil, gas, auto petrol, kerosene, LPG and other petrol) and the electricity sector is disaggregated into black coal electricity, brown coal electricity, oil electricity, gas electricity, renewable electricity and one electricity distributor. These disaggregations use energy data published by the Australian Bureau of Agricultural and Resource Economics and Science (ABARES).

Emissions for each sector are calculated from carbon emissions accounting published by the (then) Department of Climate Change and Energy Efficiency. The database for the model is formed into a Social Accounting Matrix (SAM), which uses household expenditure survey data from ABS (2006) to disaggregate the household sector into ten household groups according to income level, and labour supply is disaggregated into nine occupation groups.

Emissions intensity co-efficients are pre-calculated for fuel used in stationary energy generation and multiplied by the amount of fuel used in each case. Similarly, emissions intensity co-efficients per unit of output were pre-calculated based on the emissions data for industry sectors other than electricity generation, and then multiplied by the output level in each sector. The model simulates a carbon tax of $A 23 per tonne of CO2e, exempting the agriculture, road transport and household sectors, as did the real world tax. To keep the model simple, the only compensation assumed was a one hundred per cent return of all carbon tax revenue, in lump sum form, divided equally amongst all household deciles.

Meng et al. (2013) find that a carbon tax of $A23 per tonne of CO2e causes a mild contraction of the economy, but is effective in cutting emissions. The compensation plan, as modelled, had little impact on the emission cuts, but did mitigate the effects of the carbon tax on the economy. The authors fully acknowledge the limitations of such a simple, static model, especially single country modelling where the mitigation policies (or lack there of) of other countries can have a significant bearing on results.

(v) Clarke, Fraser and Waschik (2014)

As outlined in Section One, the present Australian government, elected in September 2013, has repealed the carbon tax and replaced it with a 'Direct Action' policy. The new policy has established an Emissions Reduction Fund (ERF) of $A2.55 billion. It is envisaged that firms accredit proposals with the Government Clean Energy Regulator CER), promising to reduce emissions below a baseline. The baseline is determined from the firm's emissions for the period 2009/10 to 2013/14. The proposals then enter a reverse auction process, and if successful, receive funding according to an agreed abatement schedule.

Two important questions which immediately arise are: how much abatement will the $A2.55 billion ERF funding buy? ; and will this amount be sufficient to meet the government's emission target of five per cent below year 2000 levels by 2020? These are the central questions addressed in Clarke et *al.* (2014).

The study begins with some theoretical and practical considerations regarding the ERF. One key difference between the ERF scheme and a carbon tax is that under the ERF, the government pays the cost of the abatement, a process termed the Provider Gets Principle (PGP), whilst with a carbon tax, the polluters' pay the carbon price – the Polluter Pays Principle (PPP). The policy instrument under the ERF is a subsidy, that is, a lump sum payment to a firm; the instrument under the previous scheme was a tax. In theory, and ignoring transactions costs, both policy instruments can achieve the same level of abatement *at the individual firm level*, but the budgetary implications are different[11]. The ERF is a direct cost to the federal budget. The carbon tax brings in revenue to the federal budget. The carbon tax would only be a net cost if more revenues were paid out in compensation to firms and households than were received.

One concerning aspect of the ERF, noted by Clarke et al. (2014:317), is the prospect of 'gaming' the baseline. Firms may be able to exaggerate their initial emissions in order to get a higher subsidy payment.

Returning the central issue of how much abatement the ERF will buy, Clarke et *al.* (2014) take a novel approach by constructing an aggregate marginal abatement curve (MAC) for the Australian economy as a whole. After describing their single country CGE model (similar to Clarke and Waschik 2012, but with updated GTAP8 data for the year 2007 and some structural modifications) the authors explain how they solve their CGE model to arrive at the various carbon prices necessary to achieve varying levels of abatement. For example, to reduce total emissions in the economy (472.4 megatonnes C02) by 10 per cent (to 425.1megatonnes CO2), a carbon price of $16.23 per tonne of CO2 is needed. To reduce total emissions by 20 per cent, a price of $39.20 is required, and so on until a 40 per cent abatement requires a price of $122.33 per tonne. These simulations trace out a curve that plots the carbon price against the percentage of emission reductions achieved, and this curve is the nation's estimated MAC curve. The assumption is that Australia is a small open economy facing fixed world prices.

Of particular interest to Clarke et al. (2014), again, is the 27 per cent level of abatement because this is the level which the Garnaut and Treasury modelling had determined would meet the Australia Government's target of a 5 per cent

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[11] We have added this emphasis and qualification. Freebairn (2014b) provides a very good analysis of why the *economy-wide* abatement under a scheme such as the ERF will be less than that which can be achieved with a carbon tax. One notable reason is the lack of a carbon price pass-through effect passing along the supply chain to input suppliers, or to households which can abate readily.

reduction by 2020, of year 2000 emission levels (Australian Treasury 2008 cited in Clarke et *al*. 2014: 323-324). A 27 per cent level of abatement requires a carbon price of $61.11, raises just over $21 billion in carbon tax revenue and achieves abatement of 344.8 megatonnes of CO2. If the ERF is used instead of a carbon tax, then the area under the MAC between the starting point, 472.4 megatonnes of CO2 and the 27 per cent abatement point of 344.8 megatonnes of CO2, will be the total cost of achieving the 27 per cent level of abatement. The integral under the MAC curve between these two points is equal to $3.3b. This equates to approximately one-third of one per cent of 2007 GDP.

Returning to the starting questions: the analysis suggests that if roughly one-third of one per cent of GDP is still needed under an ERF to meet Australia's target, then with GDP at $1558.1b (2013-2014 GDP), the ERF (of $2.55b) would buy only about 50 per cent of the required emissions reduction.

It might be noted that the integral between the two points under the MAC curve will measure the cost of the ERF only if the government *is* able to 'discriminate' between firms to achieve the different individual rates of subsidy. Freebairn (2014b: 239) thinks this may not be possible, in which case the cost to the ERF to achieve a given amount of abatement will be greater. If this is the case, the $A2.55b allocated under the ERF will achieve less than the 50 per cent of required abatement estimated by Clarke et *al.* (2014)

The authors acknowledge that because their model does not take technological change into account, the carbon prices that bring about given levels of abatement may be overstated. Also since Australian emissions have not grown at levels originally predicted, the carbon price or amount of ERF funding needed to meet the target abatement might be less.

Section Three: Critiques of the modelling, including post GFC general critiques.

(i) Ergas and Robson (2012)

The Australian carbon tax policy itself was criticised in academic literature (see, e.g., Spash (2010); Spash and Lo (2012); and Ergas (2012), but literature criticising the Australian *modelling* of a price on carbon is harder to find. An exception is Ergas and Robson (2012). Ergas and Robson (2012) were critical of the fact that the data and assumptions of the modelling for the Garnaut Review (Garnaut 2008, 2011) and Treasury modelling (Australian Treasury 2008, 2011a, 2011b) had not been released to the public.

It is certainly true that there are many assumptions that are hidden away in such a comprehensive modelling exercise. It is true also of the CGE modelling component. For example, there are closure assumptions affecting how the economy adjusts to a carbon price; and there are the chosen parameters, elasticities and technology assumptions affecting the ease with which households and firms adjust to changing prices. Delving further back, there are many other assumptions made for pragmatic reasons when constructing databases and aggregating industries. There are also, of course, the unrealistic assumptions assisting the manageability of models based on neoclassical microeconomics. Examples are firms as price takers, rational agents, non-increasing returns to scale, one representative utility function for all households, and so on. It is almost impossible for an'outsider' to the modelling to gain an understanding of all the assumptions, including which are the more critical. Ergas and Robson's (2012) frustration is understandable.

It is difficult to respond to this Ergas and Robson(2012) criticism however, without knowing exactly which data and assumptions they were seeking. This is especially so given that the Treasury did release in October 2008, seven Technical Papers containing a good deal of the data and assumptions of the modelling.

Many of the important assumptions of the Treasury modelling are also discussed at length in Adams and Parmenter (2013, Adams et *al.* 2014). Writing in 2012, Ergas and Robson (2012) would not have had access to this discussion, which may have allayed some of their concerns.

Ergas and Robson (2012) did describe several instances where they believed that the assumptions of the Garnaut and Treasury modelling appeared to be overly optimistic. These included, for example, the assumptions that all countries may be taken at their word on their abatement pledges; (and hence) the assumption that a global unified price on carbon could emerge; and the assumption that carbon capture and storage could be deployed as early as 2024. The authors also query why China or Russia would stay on a global abatement scheme when their losses, according to the modelling, appeared to be quite substantially higher than, say, those of the United States. Perhaps most seriously, however, for Ergas and Robson (2012) is what they see as one-sidedness in the modelling. The costs of mitigation are assessed over a period to 2050 but not the benefits:

> '(the modelling) does not examine the benefits of imposing such a tax; indeed the analysis specifically notes that it does not include the economic impacts of rising global emissions on Australia';

and that the analysis:

> 'does not compare costs to alternatives, most importantly that of adapting to climate change rather than avoiding it' (Ergas and Robson 2012: 9-10).

As noted earlier, the Garnaut Review (Garnaut 2008) did consider the costs of climate change impacts, the avoiding of which comprises the benefits of climate mitigation policy. Costs of climate change impacts that could be estimated with some degree of confidence *were* included in the Garnaut Review, but not in the economic modelling. The Review reported on the difficulty of estimating costs that did not go through to markets, such as damage to ecosystem services and costs of extreme events, which are difficult to predict. Ergas and Robson (2012) appear to underestimate the difficulty of calculating the costs of the impacts of climate change and of 'adaptation' to these, whatever that may mean. Economic modelling of an emissions trading scheme that was 'balanced' by estimates of the impacts of climate change is likely to be strongly criticised for including areas of such profound uncertainty. Perhaps also, for such 'non-marginal' impacts as natural disasters, and other impacts spanning centuries and costing human lives, conventional economics may not be the 'right language', as Spash (2002, 2007), DeCanio (2006) and others have suggested.

(ii) For mitigation policy modelling, what exactly *is* the baseline or base case against which mitigation costs are compared?

One comment can be made relating to ambiguity of the baseline and the wording that describes it, in Adams and Parmenter (2013, Adams et *al.* 2014). For long run simulations of non-climate related-policies such as tariff changes, the baseline is constructed as the reality that might have arisen in the absence of the tariff policy, and may be described accurately as an attempt to describe a 'realistic picture of the economy of the future' without the policy (Dixon, 2006: 10). For simulations of climate mitigation policies, however, the baseline does not include climate change impacts at all, and is therefore no longer any kind of realistic future in the absence of the policy being modelled (see e.g., Dietz and Stern 2015). Wording such as:

> '…real GDP at market prices is projected to be 1.1% lower than it otherwise would have been'; and
>
> '… continuing strong growth in the economy that would have been enjoying strong growth in the absence of the ETS' (Adams and Parmenter 2013: 617 and 611)

may not apply to a real world future that is experiencing climate change. The estimated baseline GDP may be some kind of 'without externality' yardstick, but it is not a possible alternative future.

It seems it is easy to misunderstand the practice of using such a baseline. For example, the Australian newspaper reported on April 14, 2014 a page 1 headline that said 'Climate action could cost 10pc of GDP, says the IPCC'. The story mentioned only the costs of mitigation. It gives a misleading implication that

Australia would be better off *with* the alternative option, that is, the 10 per cent higher GDP; in other words, that Australia should not choose to attempt any mitigation of climate change because it would be very costly. In this instance, the yardstick appears to be being interpreted as a real world alternative.

Comparing a mitigation pathway against a base case projection that optimises the future, assuming that the marginal social cost of emissions is zero can be problematic for theoretical reasons, as well as practical reasons. The point is beyond the scope of this paper, but is made in Foley et. *al* (2013) and Rezai et *al* (2009). It is difficult to know how to address the point, given such uncertainty concerning the social cost of carbon, as mentioned. The most important implication arising from Foley et *a.l* (2013, however, concerns how mitigation is financed.

(iii) From the wider critique of modelling: 'unrealistic assumptions', 'results empirically unverified.

It can hardly have escaped notice that there has been much questioning and criticism of macroeconomic theory, policy and modelling since the Global Financial Crisis. New institutes (such as the well funded 'Institute for New Economic Thinking'), new books, new journals, many Special Issues in existing journals, conferences on what should be taught in economics, innumerable blogs and even walk-outs from classes by students, testify.[12] The momentum does not

[12] Some of the better critiques are Quiggin (2010); the various presentations at the Institute for New Economic Thinking's 'Paradigm Lost' Conference in Berlin in 2012:
http://ineteconomics.org/conference/berlin/welcome-remarks-inets-paradigm-lost-conference-berlin-2012
For recent views, see two conferences: one in Germany ,'Teaching economics after the crises';
https://www.youtube.com/watch?v=jTfJS6WVPAQ
and one in New York on March 2015, 'what's wrong with the economy and with economics?':
http://www.nybooks.com/blogs/gallery/2015/mar/29/whats-wrong-with-the-economy/
Paul Krugman's blog is also useful:
http://economistsview.typepad.com/economistsview/macroeconomics/

seem to be dissipating. Somewhat surprisingly, the British magazine *The Economist* writes in January 2015 that[13]:

> Not only have macroeconomists been embarrassed by a decade of failed predictions, but they are also losing their edge…
>
> (They) are puritans, creating theoretical models before testing them against data…(and) macroeconomists should get out more.

A little later in the magazine, they add:

> Mocking economists is easy sport. They try to predict the future yet missed the 2008 crash, and make bizarre assumptions that cannot hold true. Other offences on the checklist include their narrow academic outlook and lack of exposure to the "real world" of business. The onslaught is common, and hard to refute.

On close inspection, much of the criticism in this new literature as it relates to modelling, appears to have in mind the Dynamic, Stochastic, General Equilibrium (DSGE) models, although this is often not stated clearly. Yet, there appears to be no doubt that the criticism is being generalised to all mainstream modelling (if not all economists!).

The two most frequently repeated criticisms of economic modelling in this new literature are that (i) the assumptions are unrealistic and irrelevant to real world conditions and policy issues; and (ii) that the results are inadequately verified[14]. The Australian modelling of a carbon tax has a strong defence on both counts. By its nature, the modelling of a carbon price is addressed to an issue of real world importance. Adams and Parmenter (2013,Adams et *al.* 2014) were commissioned directly by the Australian government during the planning for the emissions trading scheme. Clarke and Waschik (2012-3) are concerned with the

[13] The quotes come from *The Economist*, January 10, 2015, Print edition, pages 8 and 63.

[14] A third point that is frequently emphasized is that conventional modeling pays insufficient attention is issues of to ethics and equity. See, for example, Quiggin, J. (2012: 244-47) *Zombie Economics*, Princeton University Press, New Jersey. Other arguments, for example from ecological economics seeking to replace equilibrium approaches (because they do not incorporate environmental feedback as economies grow) with system analyses, are beyond the scope of the present paper.

important practical issue of how much is needed to shield industries from carbon tax impacts. Meng et *al.* (2013) address the short run impacts of the tax once policy-makers had set its (first year) price, and Clarke et *al*. (2014) focus on a question of central concern regarding the new Emission Reduction Fund policy.

The importance of including detail relevant to a policy issue is also a central focus, especially exemplified in Adams and Parmenter (2013, Adams et *al.* 2014). The authors first pose the question, and then demonstrate how they included as much realism as possible, in the each of following areas when modelling a carbon price:

- the level of detail on the stationary energy sector;
- the lumpiness in electricity generation investment;
- the global modelling of an emissions trading scheme and how it links back into a single country model;
- how the shielding of the EITES is modelled; and
- the manner in which carbon price revenue is recycled.

The Australian modelling also pays close attention to finding causal explanations. If the assumptions of a model *are* unrealistic, then even if some key predictions appear to be empirically verified, it will be impossible to trace through a useful causal explanation of the mechanisms in the model to explain the successful prediction. Taking an extreme example, if a model can predict successfully the inflation rate in year T using a variable describing the average height of male Oscar award winners in year T-1, then tracing out the connecting sequences in the model that might explain the prediction could indeed, be very difficult.15 Here again, however, the modelling described in Section Two pays particular attention to finding the causal mechanisms at work within the each model and how these might be explained to policy-makers. For example, Adams *et al.* (2014: 342) state that:

[15] The example is Paul Pfleiderer's in Pfleiderer (2014:15).

> Users of economic models are often faced with sceptical audiences of policy advisors who may have some economic training, but have little knowledge of economic modelling. In this context, a key to modelling success is interpretation of results. On the one hand interpretation is about telling a story true to the modelling outcomes without referring to the technicalities of the modelling. This is difficult, but essential for the general acceptance of the results.

The authors add that successful interpretation is also about explaining results in quantitative detail. For this they suggest Back of the Envelope (BOTE) calculations and 'stylized models'. Regarding the stylized models, an example of which is given in the Appendix of Adams and Parmenter (2013: 639-655), the authors write:

> 'Calculations with stylized models are the only way to understand the full model; to isolate those assumptions which cause particular results by seeing which real-world phenomena have been considered and which have been ignored' (Adams and Parmenter 2013:637).

Regarding the second general criticism of economic modelling, Dixon (2006: 20) observes that 'CGE models are vulnerable to the criticism that their behavioural specifications (e.g. utility maximisation and cost minimization) are imposed without empirical validation'. These are the assumptions of the micro-foundations of CGE modelling noted earlier. Dixon suggests responding to concerns about such assumptions by paying more attention to model validation in the future. Demonstrating the depth of thought given to this task in the intervening period, Dixon and Rimmer (2013: 1272) introduce a new direction in modelling, which, they hope, will encourage new modellers to be 'ambitious about checking and explaining the results of their model'. The authors ask:

> 'What assurances can producers of CGE results give to consumers that a CGE analyses is (i) computationally sound, (ii) uses accurate up-to-date (iii) adequately captures behavioural and institutional characteristics of the relevant part of the economy, (iv) is consistent with history and (v) is based on a model that has forecasting credentials?' (Dixon and Rimmer 2013:1271)

The chapter then illustrates, at length, eight ways in which these questions can be addressed. They suggest:

- running test simulations for which the correct-results are known *a priori*;
- including in a model variables that will check national accounting identities;
- constructing a BOTE model to explain results from a particular application of the full model;
- using regression analysis to test explanation of results;
- estimating parameters via econometric methods using time series data; or, because econometric estimation has 'proved to be more difficult and less valuable than anticipated':
- testing a model's ability to reproduce outcomes for endogenous variables given the true value of exogenous variables;
- running historical simulations in which a model is forced to track history (and then checking the plausibility of the implicit changes in important shift variables); and
- running say, a seven year ' forecast' covering an earlier time period where the variables are now known, then introducing successively the true values of key variables and assessing the difference they make. This suggests which variables are most important to try and get right for future forecasting.

These suggestions appear to address many of the central concerns of those currently criticising modelling. Not only this, they open up challenging new avenues for research and promise a much greater understanding of the role played by different assumptions in CGE modelling.

Section Four: How did the modelling fare against two years of real world data?

The results of models with different assumptions about the mitigation actions of the rest of the world, different time paths, model structures, databases, closures, and so on, cannot be compared meaningfully. Nevertheless, it is clear that all the models surveyed in this paper did find that the impact of a carbon price was relatively mild, in the short run and also the long run. Recycling the permit or tax revenues to shield industries and compensate households can address concerns about equity, loss of competitiveness, and tax efficiency aspects. A question arises then as to whether these predictions were borne out, at least for the short run of the two years of operation of the tax in Australia?

With many economic forces acting on an economy at a point in time, the effect of the carbon tax is difficult to disentangle – this is, after all, one reason why models are devised. In Australia over the 2012-2014 period, for example, the effects of the carbon tax are competing with a downturn in the mining industry after a prolonged boom, a relatively high exchange rate and depressed activity in non-resource sectors (OECD 2014: 15-17). Nevertheless, it appears certain that the carbon tax has been something less than a 'wrecking ball.'[16] Table 1 describes the movement in three key macro variables during the two years of operation of the tax, and the predictions for these for 2014-15. Real GDP, during the two years of operation of the tax, grew by 2.6 per cent (2012-2013) and 2.5 per cent (2013 – 14). Real GDP is forecast to grow by 2.5 per cent again in 2014 – 15, the first year since the tax was repealed. Unemployment did grow from 5.6

[16] The Prime Minister, Tony Abbott, had foreshadowed at one stage, whilst in opposition, that the effect of the carbon tax would be like taking a wrecking ball to the economy. See for example, Stephanie Peating, Sydney Morning Herald, 'Abbott admits carbon tax not a catastrophe', 26 August, 2012, online edition: http://www.smh.com.au/federal-politics/political-news/abbott-admits-carbon-tax-not-a-catastrophe-20120825-24t62.html

per cent (2012-2013) to 6 per cent (2013 – 14), but it is expected to climb slightly higher to 6.25 per cent in the first year after the tax.[17]

Table 1.Real GDP, Unemployment rate and CPI 2012-13 to 2014-15

	Real GDP	Unemployment rate	CPI
2012-13	2.6	5.6	2.4
2013-14	2.5	6.0	3.0
2014-15	2.5	6.25	2.25

Source: MYEFO (2013-14) and MYEFO (2014-15): Table 2.3.

The consumer price index rose 2.4 per cent (2012-2013) to 3 per cent (2013-14) and the index is expected to fall to 2.25 per cent for 2014 – 15.

Household electricity prices have a significant influence on the consumer price index. Again, it is difficult to disentangle co-incident influences, but the upgrading of the electricity network (the 'poles and wires') appears to have had a far more significant effect on electricity prices than the carbon tax. For New South Wales, for example, the Productivity Commission has estimated that of a total annual (average) household electricity bill of $2230 in 2012-13, 52 per cent comprised the 'poles and wires' charges; 25 per cent was charges for actual energy used; 10 per cent was retailers' add-on; 5 per cent was the cost impact of the solar subsidies and other green schemes; and 7 per cent comprised the price impact of the carbon tax.[18]

A careful analysis of the impact of the carbon price on the electricity sector by O'Gorman and Jotzo (2014: 40-41) has concluded that during the two years of the operation of the carbon tax, household electricity prices rose by an average

[17] The data on real GDP, unemployment and CPI come from MYEFO 2014-15 and 2013-2014.
[18] Productivity Commission (2013) *Electricity Network Regulatory Frameworks*, Report No. 62, p.5.

of 10 per cent and industrial electricity prices, by an estimated 15 per cent.[19] The authors found that these price rises did reduce electricity demand from households and industry, and also led to lower average emission intensity of the electricity supply. Taken together, this meant that emissions in Australia's electricity sector – more than one third of Australia's total emissions – were significantly reduced. The overall conclusion from the ex-post analysis of O'Gorman and Jotzo (2014:41) is that carbon pricing was effective, but it must be accompanied by an expectation that the policy will remain in place for the longer term, for it to have a full effect. The success of the political campaign to remove the carbon tax has been attributed to the power of vested interests in politics.[20]

Since the repeal of the carbon tax, coal-fired generation of electricity supply has risen. Total emissions in the year to January 2015 were 2.6 per cent higher than in the year to June 2014, and the emissions intensity of the National Electricity Market was 3.3 per cent higher (Pitt & Sherry 2015).

Conclusions

The main conclusions of the paper are that when carbon mitigation policy began to emerge as a possibility, Australian modellers, particularly those of the Centre of Policy Studies, were poised. The task had many new challenges, and it appears that much thought was given to the level of detail required,and how to link to other models that could help with this. Other modelling studies concentrated on central issues within carbon pricing, such as whether and where, industry compensation was needed to limit damaging effects on the

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[19] The Garnaut and Treasury modelling had predicted that the carbon price would increase household electricity prices in the short run by 10 per cent. (See Australian Treasury 2011a: 10).
[20] See, for example, Ross Garnaut, *Dog Days*, Black Ink, Melbourne, 2013, p.75-76: and Tony Windsor 'No guts, no glory on clean energy' *The Saturday Paper*, September 13, 2014. The power of the fossil fuel lobby has been described in Pearse G. (2009) Quarry Vision, *Quarterly Essay,* Issue 3.3.

competitiveness of industries.

Australian modelling stands out for its focus on policy relevant questions, and its attempt to use realistic assumptions and details in the most important sectors. Criticisms from current anti-economic modelling sentiment are therefore not generally applicable to the Australian carbon tax modelling. More recently, attention has also been directed towards how to achieve greater empirical validation of CGE models. Such steps further anticipate criticism of CGE assumptions and methods.

The results of different models cannot be compared, except insofar as they all indicate that the economic impacts of a carbon price are mild, especially if the revenue is recycled in ways that address the main concerns. All modelling indicated that carbon pricing would be effective in reducing emissions.

This paper does question exactly what the baseline or base case is, in climate change mitigation modelling. In non-climate policy, the base case, against which the simulation results are compared, can be regarded unambiguously as the future, in the absence of the policy being modelled. In climate mitigation modelling, when the base case does not include (or indeed cannot include, because of the profound uncertainty) the impacts of the externality, it is misleading if papers describe it as the ‘without policy’ future

During the two years of the operation of the carbon tax, it would appear that the predictions of the modelling were borne out. It did not act as a wrecking ball to the economy. Studies examining the impact on electricity sector emissions support the contention that the tax did reduce emissions intensity and total emissions from the sector. Since the repeal of the Australian carbon tax, the emissions intensity of electricity generation has increased.

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