ACCESS ECONOMICS

Preliminary economic modelling of a national consumption-based approach to greenhouse gas emission abatement policy

24 August 2009

Report by Access Economics Pty Limited for

Committee for Economic Development of Australia

Contents

Tables

Figures

Glossary

ABS	Australian Bureau of Statistics
AE-RGEM	Access Economics Regional General Equilibrium Model
AGO	Australian Greenhouse Office
CO_2-e	Carbon dioxide-equivalent
CPRS	Carbon Pollution Reduction Scheme
EITE	Emissions intensive trade exposed
ETS	Emissions Trading Scheme
GDP	Gross Domestic Product
GNP	Gross National Product
GST	Goods and services tax
GTAP	Global Trade Analysis Project
NEM	National Electricity Market

Executive Summary

Following its inquiry, the report by the Senate Select Committee on Climate Policy raised a number of questions about the form of, and alternatives to, the emissions trading scheme (ETS) proposed by the Commonwealth Government – the Carbon Pollution Reduction Scheme (CPRS).

One option, amongst five alternatives proposed by the Select Committee, was a national emissions consumption-based carbon tax.

The Select Committee requested that modelling be undertaken to evaluate the relative merits of all of these alternative options as well as the Government's CPRS.

This report presents a brief, 'proof-of-concept' preliminary modelling analysis of the economic effects of a national consumption-based carbon emissions tax compared with two variants of the Government's CPRS.

The modelling shows, for the same assumed carbon price:

- The projected decline in welfare, as measured by GNP, per tonne of CO_2-e abated within Australia, is smaller for the consumption-based approach than a production-based CPRS approach.
- Falls in exports per tonne of emissions abated are much smaller under the consumption-based approach than either variant of the production-based CPRS approach.
- However, a consumption-based approach results in a lower absolute level of emissions abatement in Australia than a production-based scheme. This is largely driven by a lower reduction in output under a consumption-based approach compared to the CPRS model, while the avoidance of 'carbon leakage' under the consumption-based approach is also a factor.
- The concept of 'carbon leakage' reflects the shifting of Australian emissions offshore under the CPRS, in order to avoid the costs of emissions reduction in Australia. Globally, this effect may result in a net increase, no change, or a reduction, in global CO_2-e emissions. Therefore there is a need to consider the net global emissions result in determining which option is most efficient at emissions abatement.
- Generally, on a per-industry basis the consumption-based approach results in smaller declines in production when compared with a CPRS-style production-based approach without trade assistance.
- However the results are more mixed when the consumption-based approach is compared with a CPRS production-based approach with assistance for emissions-intensive trade-exposed (EITE) industries. For example, petroleum products, alumina, aluminium products and other nonferrous metal products fare better under a consumption-based approach. In contrast, non-metallic minerals products (cement) fare better under the EITE-adjusted CPRS.
- This finding reflects the imprecision of the 'trade exposed' sector adjustments under the CPRS compared with the more precise adjustments possible under the consumption-based approach.

Assuming the modelling results are linear, these preliminary results suggest that a consumption-based carbon tax, with a higher carbon price, could achieve the same CO_2-e abatement as the CPRS scheme but with smaller welfare impacts.

However, further modelling is required to better understand the response of the model to higher carbon prices under the consumption based approach and the potential impacts of the approach on incentives to switch to lower emission intensive fossil fuels given changes to the pass through of carbon prices in, for example, electricity markets.

As such, the analysis should be viewed as a preliminary 'proof of concept' analysis.

Accordingly, at this stage, the report is not an endorsement of a consumption-based carbon tax, but rather a contribution to the ongoing debate about Australia's climate change response.

Access Economics

24 August 2009

1 Introduction

In May 2009 the Government introduced the Carbon Pollution Reduction Scheme (CPRS) Bills (2009) into Parliament. These were passed through the House of Representatives on 4th June, introduced into the Senate on 15th June 2009, and rejected by the Senate on 13 August 2009. The Government has signalled its determination to re-introduce these bills to the Senate within three months.

The main policy mechanism of the CPRS is an emissions trading scheme (ETS). An inquiry by a Senate Select Committee on Climate Policy produced a report raising questions about the form of, and alternatives to, the proposed ETS. One option, amongst five alternatives specifically mentioned, was a consumption-based carbon tax.[1] The Select Committee asked for consideration (and further modelling) of all six options (including the CPRS).

The analysis in this report considers a national emissions consumption-based carbon tax as one possible alternative to an ETS. The analysis has been prepared under tight timeframes, and can only be considered as preliminary in nature (or a proof of concept analysis). There are several technicalities that have not been addressed in the modelling (referred to throughout the document). These need to be addressed in order to compare different policy options.

The aim of this preliminary report is to contribute to the public debate in the context of developing Australia's climate change response policy. It is not an endorsement of a consumption-based carbon tax, but rather a high level 'proof of concept' analysis.

The report proceeds with a discussion of the policy background and the differences between producer and consumer based approaches to emission abatement (chapter 2). An overview of the modelling framework is provided in chapter 3. The results of the analysis are presented in chapter 4, with conclusions summarised in chapter 5.

[1] The Senate Select Committee Inquiry requested five alternate schemes be considered, apart from an emissions trading scheme along the lines of the CPRS. These were (i) a conventional baseline-and-credit scheme, (ii) an 'intensity' model, (iii) a production-based carbon tax, (iv) a consumption-based carbon tax and (v) the McKibbin 'hybrid' model. All of these, except option (iv), are variants on a national production-based model.

2 Background

In May 2009 the Government introduced the Carbon Pollution Reduction Scheme Bills (2009) into Parliament. These were passed through the House of Representatives on 4th June and introduced to the Senate on 15th June 2009. The Senate considered but did not vote on the Bills then, but voted the bills down when it reconvened on 13th August 2009.

Two Government reviews, the Senate Standing Committee on Economics and The Select Committee on Climate Policy, submitted their reports on 15th June 2009. The Select Committee recommended that further modelling of climate policies be undertaken, including of five alternative schemes to the CPRS.

The CPRS is currently proposed to commence on 1 July 2011, after a recent decision to delay its introduction by one year. Under the CPRS, the government has committed to reducing Australia's greenhouse gas emissions 5% below 2000 levels by 2020. The commitment will increase to 25%, conditional on an appropriate international agreement being reached.

The CPRS is a 'cap-and-trade'-style emissions trading scheme targeting national production of emissions. Liable scheme parties must surrender emissions permits equal to their emissions in each year. Under the scheme, the allocation of emissions permits totals a level of emissions lower than would otherwise have occurred. When demand for permits exceeds the supply, scarcity exists and the permits have value in the form of the permit price (referred to herein as the carbon price).

Key features of the proposed scheme are:

Price controls

The scheme has a five year transition period in terms of ramping up the maximum carbon prices. Permits will sell for \$10/t CO_2 for the first year beginning 1 July 2011 with unlimited supply. It is expected that a price cap of \$40/t CO_2, escalating at 5 per cent per annum will be in place over the period 2012-2015 after which prices will be market determined.

In effect, for the first five introductory years of the scheme, there is no emissions 'cap'; rather, there is a carbon price 'cap'. Beyond 2015, in principle, carbon price caps do not apply, and the carbon price will be determined by the interaction between emissions caps set by the Government and demand for emissions in the Australian market (albeit influenced by scope to purchase permits overseas).

Scope

Permits to emit CO_2 emissions will be required by all businesses that emit more than 25,000t CO_2 emissions per annum (roughly 1,000 businesses across Australia).

Sectoral coverage

The scheme covers the stationary energy sector, transport, fugitive emissions, industrial processes and waste. These sectors account for approximately 75 per cent of Australia's emissions (excluding any transitional issues arising from petroleum). Options exist for the forestry sector to opt into the scheme, and agriculture, while not initially included, is likely to be included from 2015 onwards.

International linkages

Under the CPRS, purchases of eligible permits from overseas schemes are unlimited. Sales of Australian permits are allowed after the first five years of the scheme.

Banking and borrowing

Unlimited banked of permits will be allowed after 2011 (permits under the price cap of $10/t CO_2 in 2011 are not bankable) and a limited proportion of permits (up to 5 per cent of an entities liability) can be borrowed.

Emissions intensive trade exposed industries

The Australian Government has proposed emissions-intensive trade-exposed (EITE) industries will receive partial free allocation of emissions permits. In the CPRS White Paper, it was proposed that permits be allocated in the following proportions:

- 90% for activities with emissions intensity of at least 2,000t CO_2-e/$m revenue or 6,000t CO_2-e/$m value-added
- 60% for activities with emissions intensity between 1,000t CO_2-e/$m and 1,999t CO2-e/$m revenue or between 3,000t and 5,999t CO_2-e/$m value-added

In May 2009 The Government proposed to amend the permit allocation rates to 94.5 per cent and 66 per cent respectively.

A firm must meet four requirements in order to be eligible for EITE exemptions:

- Emissions intensity – the firm must be a high-emitter to be eligible;
- Exposure to cost increases due to the introduction of an ETS;
- Trade exposure, meaning their product is competing with foreign-made equivalent products; and
- The competing countries do not have any comparable scheme in place.

The EITE assistance will be slowly removed in line with progress towards international commitment to reduce greenhouse gas emissions.

2.1 International experience

2.1.1 The US Waxman-Markey Climate Change Bill

The American Clean Energy and Security Act 2009, known colloquially as the Waxman-Markey bill, was passed by the US House of Representatives on June 26. The legislation seeks to establish a "cap and trade" program to regulate greenhouse gas emissions, and simultaneously promote investment in alternative energy sources.

The Waxman-Markey bill proposes a sliding scale of renewable energy standards, with 6% of electricity to come from renewables by 2012, rising to 20% by 2020. Up to 5% of this can be met through energy efficiency savings.

Targets for overall emissions cuts are indexed to 2005 levels of emissions. Emissions targets have been set to progressively increase over four decades:

- 3% below 2005 levels (economy-wide) by 2012;
- 20% below 2005 levels by 2020;
- 42% below 2005 levels by 2030; and
- More than 80% below 2005 levels by 2050.

Similar targets have been set for sources covered by the emissions trading scheme, including electricity generators.

Emissions intensive trade exposed industries

Waxman-Markey provides EITE assistance of up to 100% of direct and indirect costs for eligible industries, subject to the maximum limit on proportion of permits that can go towards free allowances and as long as less than 70% of total global output of that sector is produced in countries with similar emissions constraints (i.e. a form of 'disadvantage test'). This will be allowed until 2025, at which time this rate will be reduced by a straight 10% per annum to zero by 2035.

The share of permits that will be allocated to EITEs starts low, at 2% for each of 2012 and 2013, as industrial sources are excluded in these years. This limit becomes 15% in 2014 when industrial sources are included, and then declines at the rate at which the cap declines for each year thereafter (1.75% per annum for 2015 to 2020, and then 2.5% per year to 2025).

To be eligible for EITE assistance under the US scheme, the following criteria must be met:

- Production has an energy intensity of at least 5%, calculated as electricity and fuel costs per dollar of revenue; or
- Emissions intensity of at least 2,500 tonnes CO_2-e per million dollars of revenue; and
- Trade intensity (value of imports and exports divided by valued of domestic production plus imports) of at least 15%.

The requirements to meet in order to receive EITE assistance under the US system are broadly at a similar threshold to the Australian system, albeit framed and calculated slightly differently.

2.1.2 The EU ETS

The EU climate and energy package establishes targets for emissions reductions in Europe. It currently covers around 40% of greenhouse gas emissions from the 27 member states.

Under the EU scheme, emissions reductions targets have been set for 2020. As with Australia, these targets are variable and contingent upon whether or not international agreements are reached. If a global agreement can be reached, the EU has committed to a reduction of 30% below 2000 levels by 2020. Without a global agreement, this target falls to 21% below 2005 levels. Irrespective of whether a global agreement can be reached, however, a target of 80% below 2000 levels by 2050 has been set.

Emissions intensive trade exposed industries

This system also contains assistance for EITE firms, under the premise that these sectors are at risk of carbon leakage, with operations off-shored to areas where emissions restrictions do not apply. To be eligible for exemptions under this assistance, one of three criteria must be met:

- EU ETS increases production costs by more than 5% of gross value added and the trade intensity (value of imports and exports divided by the total value of turnover and imports) exceeds 10%; or
- EU ETS increases production costs by more than 30% of gross value added; or
- Trade intensity (as defined above) is greater than 30%.

These apply only to entities that are using the best available technologies.

2.2 The production based nature of the proposed ETS

Differences between production- and consumption-based options

The consumption-based approach acts as a carbon tax (although application of an ETS is also possible), whereas the production-based proposed CPRS is a cap-and-trade arrangement (albeit operating as a production-based carbon tax for the first five years). The key difference between the approaches is the emissions *base* affected by the two policy options.

The way in which the emissions abatement problem is solved differs between the two options. Under the fully-operational CPRS, a target is set for the quantity of carbon emissions produced within Australia, and through the trading of permits, the system establishes the price or carbon required to meet that quantity.

In contrast, a tax approach sets a fixed price per tonne of carbon emitted. Under a production-based approach, a tax is levied at the point where carbon is emitted. Under the consumption-based approach, the tax is 'forwarded on' to consumers. Of course, the issue of formal versus actual tax burden remains. Under the production-based approach, taxes or costs will be shifted (backwards or forwards), based on demand-supply conditions. The same is true of consumer-based taxes. The actual incidence of either may not be that different ***except for exports and imports.*** For example, under the consumption-based approach, there will be no pass through of carbon taxes to exports.

Each of these options comes with a trade-off between emissions abatement and the cost of emissions abatement. However it is difficult to know at the outset which will achieve the required level of abatement for the least cost. The modelling that follows provides a high-level proof of concept modelling approach that considers this problem.

Carbon leakage and international trade

A key feature of the Australian ETS, and those schemes being proposed overseas, is the treatment of EITE. The support of EITE sectors is targeted at industries that produce traded goods that also have a significant exposure to a carbon price (an often cited example of which is aluminium). Assistance for EITE industries is aimed at reducing the likelihood of 'carbon leakage' through off-shoring activities in the period before ubiquitous international standards are adopted.

This is needed because an ETS essentially levies a carbon charge at the point at which emissions are released. This is point-source (or 'origin'-based) taxation, and in the design of a measure aimed at reducing emissions through a price mechanism, it is desirable to impose the price signal as close to emission generation activity as possible.

This means that when, for example, an electricity generator burns coal and releases a tonne of CO_2, it has to submit a permit for the release of that CO_2. The cost of releasing that tonne of CO_2 is reflected in the permit price and the electricity producer is free to pass on as much of this cost to customers as the market will bear.

This is a necessary, and indeed desirable, feature of an ETS. The advantage of using market mechanisms, such as an ETS, is that in response to the price signals, the market determines the scheduling of the emission abatement options based on their cost effectiveness. The carbon price internalises the environmental costs of greenhouse gas emissions, and passes these on to businesses and consumers.

Unfortunately, not all countries across the world are likely to adopt binding emission abatement targets. This is problematic for EITE sectors, as the price pass-through effect may encourage production to shift to countries that are not seeking to reduce greenhouse gas emissions (hence the term 'carbon leakage') (Dröge 2009).

Although exemptions mean that EITE and other exempted firms do not face the full costs of an ETS, in an economy-wide sense these costs do not simply disappear. Instead, these are passed on in a higher proportion to those who are not exempted, including businesses that do not fit under any of the exemption categories.

In particular, the burden shifts towards consumers, as they face higher costs, including the cost of electricity. Unlike businesses, however, households have no ability to pass the costs down the line, meaning that as the scope of assistance and exemptions increases households bear an increasingly large share of the cost of the ETS.

This is a key area in which the consumption approach differs. Under the national consumption-based approach, no business pays for their carbon emissions, with the cost of these emissions passed on to the final consumer, who pays for these in a form of charge akin to the GST, albeit with different rates depending upon the emissions required to produce the good. There are no EITE carve-outs or exemptions required. As with the goods and services tax (GST), goods that are exported and not consumed within Australia are exempt from the carbon charge in Australia (and ideally, subject to the appropriate charge in the importing country). Similarly, goods that are imported and sold within Australia do attract the carbon charge, at a rate in line with what is charged on equivalent domestic-produced goods. This approach levels the trade-competitiveness playing field for EITE industries and eases (possibly eliminates) carbon leakage threats.

This approach is not without its drawbacks, however. The consumption-based approach brings with it a need to record and monitor carbon emissions down the production chain, which may prove a high administrative burden (although there may be scope to 'piggy-back' on some existing GST infrastructure).

3 Framework of the analysis

The quantitative analysis undertaken in this report is based on Access Economics' in-house general equilibrium model called AE-RGEM (Access Economics Regional General Equilibrium Model). General equilibrium models like AE-RGEM are a widely accepted tool for estimating the direct and indirect impacts of policy changes, such as the imposition of carbon prices (or an emissions trading scheme). The main benefit of a model such as AE-RGEM is that greenhouse gas emissions arise from a range of activities across the economy; as such, policies designed to constrain emissions growth will have widespread economic consequences.

Of course, any economic model is highly dependent on its assumptions, parameters and data. Large scale general equilibrium modelling requires considerable amounts of each and so the results generated must be viewed with the appropriate caveats in mind. A key issue for this analysis is to acknowledge that the benefits of mitigation are not being accounted for in the modelling framework. Therefore, the analysis is looking at the greenhouse issue from a *cost-effectiveness* standpoint, not a *cost-benefit* standpoint. It is not uncommon for the focus of modelling results such as these to be on the economic costs only, while ignoring the benefits of greenhouse gas abatement because they are not explicitly accounted for in the analysis.

That said, the modelling takes reduction of CO_2-e emissions as a proximate indicator of wider economic benefits, and therefore looks at how much CO_2-e reduction 'bang' can be obtained from a given economic cost (eg, reduced GDP, employment) 'buck'.

3.1 AE-RGEM

AE-RGEM is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy. The model allows policy analysis in a single, robust, integrated economic framework. This model projects changes in macroeconomic aggregates such as Gross Domestic Product (GDP, or GSP at the State level), employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced.

AE-RGEM was developed specifically with climate change response policy in mind. It is based on Access Economics' more general model of the global economy that only details national regions, i.e., AE-GEM. AE-RGEM replaces the treatment of Australia as a single region with multiple regions representing the States and Territories. As such, each Australian sub-region is treated as a separate economy but operates within national constraints.

3.2 Base data

The base data of the model is derived from the Global Trade Analysis Project (GTAP). GTAP produces a global database for general equilibrium modelling used by over 700 researchers worldwide. The Australian component of the database is provided by the Productivity Commission, and is based on Australian input-output tables produced by the Australian Bureau of Statistics (ABS).

The model is primarily based on input-output or social accounting matrices, as a means of describing how economies are linked through production, consumption, trade and investment flows. For example, the model considers:

- direct linkages between industries and countries through purchases and sales of each other's goods and services; and
- indirect linkages through mechanisms such as the collective competition for available resources, such as labour, that operates in an economy-wide or global context.

AE-RGEM is based on Version 6.0 of the GTAP database. This has a 2001 base year with 87 countries and 57 industry sectors. Not all regions and sectors are relevant to this exercise, so the database is aggregated to the 39 sectors shown in Table 3.1. The Australian economy is split into each State and Territory (with the ACT included in NSW).

AE-RGEM uses the 2000-01 input-output, state and national accounts data from the ABS to calibrate the State-based components of the model. Consistent with the national accounts, the model is commodity or industry based rather than being a firm level model. That is, the commodities and industries represent state-wide aggregates, or the accumulation of individual firms, rather than firm specific data. In other words, a production function is assumed for each sector, rather than considering each firm's operations in detail.

In disaggregating commodities that are important to the analysis here but are not included in the original GTAP database, e.g., brown, thermal and coking coal, various sources besides the ABS are accessed including the Australian Bureau of Agricultural and Resource Economics (ABARE), the International Energy Association, and the National Electricity Market Management Company. Further data are sourced from the MMRF-NRA model used by the Productivity Commission in the *National Reform Agenda* report.[2]

[2] Productivity Commission, 2006, Supplement to *Potential Benefits of the National Reform Agenda*, Productivity Commission Research Paper, December, Canberra.

Table 3.1: Sectors and Regions in AE-RGEM

Number	Sectors	Number	Regions
1	Crop based agriculture	1	New South Wales (incl. ACT)
2	Livestock	2	Victoria
3	Other agriculture	3	Queensland
4	Forestry	4	South Australia
5	Brown coal	5	Western Australia
6	Thermal coal	6	Tasmania
7	Coking coal	7	Northern Territory
8	Oil	8	Japan
9	Natural gas	9	South Korea
10	Coal seam gas	10	China
11	Liquefied natural gas	11	India
12	Bauxite	12	North America
13	Other minerals	13	Europe
14	Processed food	14	Rest of the World
15	Lumber and wood products		
16	Petroleum and coal products		
17	Chemicals, rubber and plastics		
18	Non-metallic mineral products		
19	Iron and steel		
20	Alumina		
21	Aluminium		
22	Other non-ferrous metals		
23	Pulp, paper and printing		
24	Motor vehicles and parts		
25	Electronic equipment		
26	Other manufacturing		
27	Water		
28	Electricity generation (a)		
29	Electricity distribution		
30	Gas production and distribution		
31	Construction		
32	Trade		
33	Air transport		
34	Water transport		
35	Road and rail transport		
36	Communications		
37	Business services		
38	Government services		
39	Other services		

(a) Electricity is generated using brown coal, black coal, gas, oil-fired, nuclear, hydropower and other renewables.

3.2.2 Features specific for climate policy analysis

AE-RGEM has been developed principally for analysing climate change response policy. The industry detail allows for comprehensive accounting for greenhouse gas emissions at the State and Territory levels. AE-RGEM accounts for greenhouse gas emissions from fossil fuel combustion as well as fugitive emissions from mining activities. These data are calibrated to the latest greenhouse gas inventory numbers across states published by the Australian Greenhouse Office (AGO).

Apart from emission accounting, AE-RGEM has been developed to allow for energy substitution possibilities in response to the pricing of carbon. The model contains two production structures. The first applies to all industries apart from electricity generation. In these industries, products in each of the energy bundle (coal, gas, petroleum products and electricity), primary factor bundle and intermediate input bundle are combined using constant elasticity of substitution (CES) technology. The energy-factor bundle is formed from a CES combination of the primary factor bundle and the energy bundle, and is combined in fixed proportions with the intermediate input bundle. Depending on the value of the substitution elasticities at the various production nodes for an industry sector, substitution is possible between the four energy inputs and then between the energy bundle and the primary factor bundle. The structure does not, however, permit substitution between intermediate inputs and primary factors or the four energy inputs.

The production structure for electricity generation is based on a 'technology bundle' approach developed by ABARE (2006), although modified in AE-RGEM. For the electricity sector, the model accounts for 6 generation technologies: brown coal, thermal coal, gas, oil, hydro, nuclear (not in Australia) and other renewables. Electricity generators choose their pattern of technologies by minimising costs in response to changes in relative prices using a CES production function. However, each technology in the bundle uses inputs in fixed proportions to output. Trade in electricity across the National Electricity Market (NEM) is also allowed.

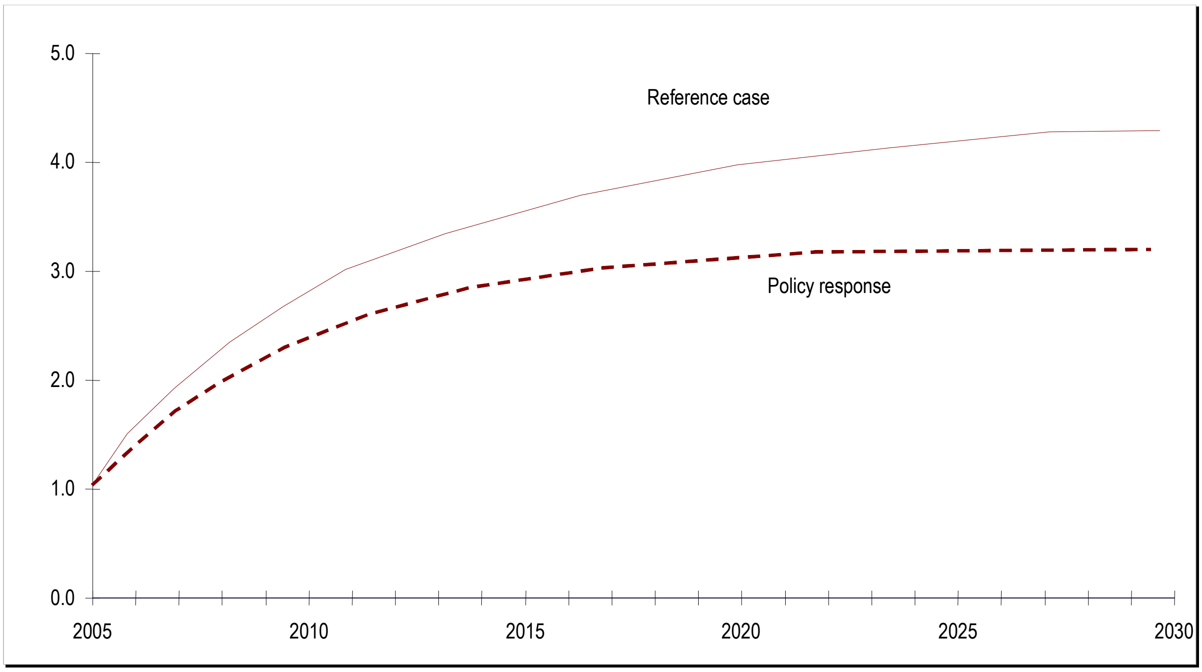
3.2.3 Dynamics

AE-RGEM is a recursive dynamic model that solves year-on-year over a specified timeframe. The model is then used to project the relationship between variables under different scenarios, or states, over a predefined period. This is illustrated in Figure 3.1. This shows the reference case scenario that forms the basis of the analysis. The model is solved year-by-year from time 0, which reflects the base year of the model (2001), to a predetermined end year (in this case 2030). Thus, the reference case in this example is a state of the world where only existing greenhouse policies and measures operate.

The variable represented on the vertical axis of Figure 3.1 could be one of the hundreds of thousands represented in the model ranging from macroeconomic indicators such as real GDP to sectoral variables such as the exports of thermal coal. In the figure, the percentage changes in the variables have been converted to an index (= 1.0 in 2005) and are projected to increase by 2030.

Set against the reference case scenario is a 'scenario projection'. This scenario represents the impacts of imposing a carbon price, say, on stationary energy. That results in a new projection of the path of the variable over the simulation time period. The impacts of the policy change are reflected in the differences in the variable at time T. It is important to note that the differences between the reference case and policy intervention scenario are tracked over the entire timeframe of the simulation.

Figure 3.1: Dynamic simulation using AE-RGEM

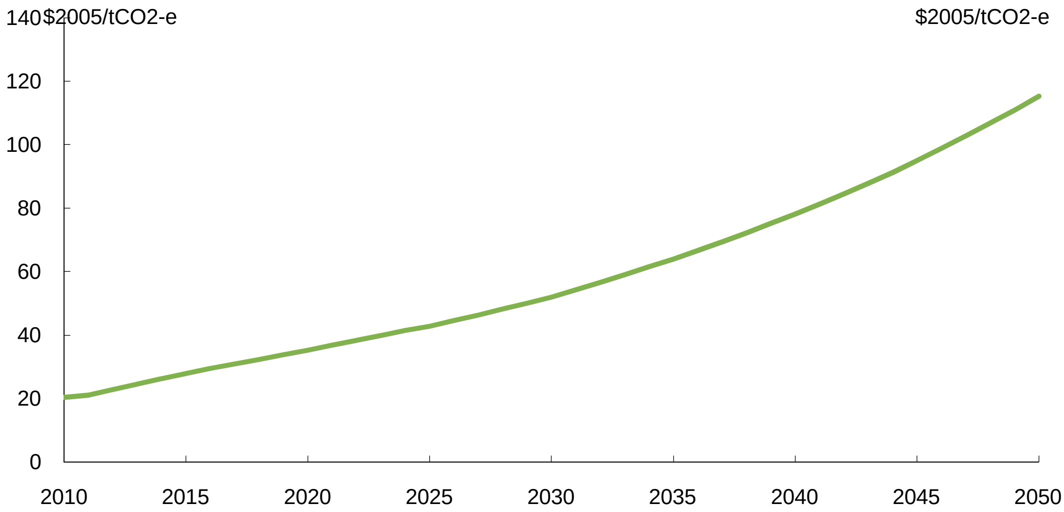


3.2.4 Scenarios considered

For this project AE-RGEM was used to model three climate change related scenarios. The first two scenarios are broadly based, yet simplified, versions of the Treasury modelling of the Federal Government's proposed CPRS5 scheme and associated emissions targets. The third scenario is a 'proof of concept' simulation based on applying an economy wide carbon tax on a national emissions consumption basis.

All three scenarios have the same carbon price over the period to 2030. The carbon price for the modelling was sourced from Treasury modelling of the proposed CPRS-5 policy. The CPRS-5 policy as modelled by Treasury had an exogenous emissions target of 5 per cent below 2000 emissions levels by 2020, and allowed for some international trading of emissions permits. The Treasury modelling produced results including a projected price of carbon over the period to 2050 (Figure 3.2) and it is this projected price of carbon that is the basis for the modelling in this paper.

Figure 3.2: Australian emissions price under CPRS-5, 2005 $A prices



Source: Treasury estimates from MMRF (Treasury 2008).

It should be noted that since the Treasury modelling was published a number of changes were made to the proposed CPRS-5 policy. These changes include a one year delay to the start of the scheme and a fixed price of $A10 per tonne CO2 in 2011. Also, the rates and scale of assistance to emissions intensive trade exposed (EITE) industries have been altered. Where possible, these changes are incorporated into scenarios 1 and 2.

In more detail, the three scenarios include the following characteristics:

- **Scenario 1 (the CPRS scenario)** is a relatively simple simulation where the CPRS-5 carbon price from Figure3.2 is fed into the model over the period to 2012 to 2030. A price of $A10 per tonne of carbon is used for the year in 2011 and there no carbon tax in 2010. The carbon price is applied at a macro level so that all industries face the same carbon price with no assistance to a subset of industries. The carbon price does not apply in other countries (it is levied in Australia only).
- **Scenario 2 (the CPRS plus EITE scenario)** has the same price path for carbon as scenario 1 along with the inclusion of an assistance package of EITE industries over the period to 2030. The assistance package is based, as closely as possible, on the latest government information about the proposed rates of assistance. Hence, the rates of assistance are higher than modelled by Treasury. Table 3.2 shows the rates of assistance and the industries include in the assistance package. The carbon price does not apply in other countries (it is levied in Australia only).
- **Scenario 3 (the consumption-based scenario)** applies the same carbon price path on a comprehensive consumption basis. In modelling terms, this means that intermediate users of fossil fuels and electricity are refunded their carbon tax payments as they pass them on down the supply chain. Final household and government consumption expenditure, both domestically produced and imported, is charged the full carbon tax inclusive price. In essence, all final consumption expenditure occurs at a set of prices similar to that of a world where there is a true global carbon price. While domestic producers are charged prices for energy related inputs at levels similar to a scenario of

no carbon price and hence maintain their international competitiveness. The carbon price does not apply in other countries (it is levied in Australia only).

Table 3.2: Rates of industry assistance, AE-RGEM industries

Industry	Per cent
Liquefied natural gas	66.0
Petroleum products	66.0
Non-metallic mineral products	73.5
Iron and steel	84.0
Alumina	66.0
Aluminium	94.5

Source: AE-RGEM modelling

An important assumption under scenario 3 is that the same fuel switching incentives exist in, for example, electricity under the consumption-based approach as the production based approach. Given the complexities of the electricity market, and the importance to any efforts to abate emissions, this is a potentially important assumption that requires further consideration given the potential impacts of the consumption-based approach on incentives to switch to lower emission intensive fossil fuels given changes to the pass through of carbon prices. This detailed analysis was beyond the scope of this study.

4 Results

The macroeconomic results of the preliminary modelling of the 3 scenarios are shown in Table 4.1. The broad pattern of results across the three scenarios is similar; the introduction of a carbon tax (whether production-based or consumption-based) leads to lower levels of economic activity, employment and investment across the economy, relative to the reference case.

Table 4.1: Macroeconomic impacts, per cent change, relative to the reference case

	CPRS		CPRS plus EITE		Consumption-based	
	2020	2030	2020	2030	2020	2030
Real GNP	-2.5	-2.7	-2.1	-2.3	-0.8	-1.1
Real GDP	-3.0	-3.7	-2.6	-3.2	-1.0	-1.3
Employment	-0.8	-0.8	-0.7	-0.8	-0.3	-0.3
Investment	-6.6	-6.1	-5.4	-5.2	-1.8	-1.8
Household Consumption	-2.9	-3.3	-2.5	-2.9	-1.1	-1.5
Export volumes	-3.4	-6.2	-3.0	-5.3	-1.2	-2.0
Import volumes	-5.2	-5.5	-4.6	-5.1	-1.6	-1.9
Terms of Trade	-0.1	0.6	0.0	0.5	0.0	0.2
Rates of Return	-3.5	-3.2	-2.8	-2.7	-0.9	-0.9
Emissions	-25.5	-31.5	-23.1	-28.9	-12.9	-16.7
Carbon Tax, $A	49	71	49	71	49	71
Real wages	-4.8	-5.5	-4.1	-4.9	-1.5	-2.0

Source: AER-GEM model results

The results show that by 2020 and 2030 a production-based carbon tax will lead to higher emissions abatement compared to a consumption-based tax. For the same carbon price, a consumption-based approach will lead to around half the emissions abatement of a production-based tax. However, for a production based tax, the fall in welfare, as measured by GNP, is greater per MT of CO_2-e abated.

Changes in export volumes across the scenarios also shows significant variation on a per tonne of abatement comparison. The consumption based approach shows a much smaller fall in exports per tonne of abatement since Australian exporters effectively face no Australian carbon tax, as they do under production-based carbon tax.

The reduction in adverse trade impacts when moving from a production-based approach to a consumption-based approach is reflected in real household consumption as well. This is mainly because, under each scenario, households face the same set of prices for domestically produced emissions intensive commodities, such as electricity and natural gas.

Broader impacts on GDP, exports and emissions

In Table 4.2, the projected impacts of each scenario on real GDP, export volumes and emissions from the Rest of the World (RoW) are presented per tonne of emissions abated in

Australia. For example, under the CPRS scenario, for every million tonnes of greenhouse gas emissions abated, real GDP is estimated to fall by $331 million (2008 dollars). This compares with an estimated reduction under the consumption-based approach of $218 million per tonne abated. As noted above, the welfare impacts per tonne of carbon abated in Australia (as measured by real GDP) are lower under the consumption based approach compared with the production based approaches.

Second, the expected impacts for emissions in the RoW, or the 'carbon leakage' outcomes, are shown. Under scenarios 1 and 2 at 2020, the projected decline Australian emissions is expected to lead to an increase in emissions from other countries. Yet, under a consumption-based approach emission abatement in the rest of world is negative due to the fact that Australia is putting a carbon price on imports.

Assuming the modelling results are linear, the preliminary modelling suggests that a consumption-based tax could, with a higher carbon price, achieve the same abatement as the CPRS scheme but with smaller welfare impacts. However, further modelling is required to better understand the response of the model to higher carbon prices under the consumption based approach.

Table 4.2: Impacts per MT of abatement

	Units	2020
CPRS		
Real GDP	$ million (2008 prices)	-331
Export volumes	$ million (2008 prices)	-82
RoW emissions	MT	0.04
CPRS plus EITE		
Real GDP	$ million (2008 prices)	-312
Export volumes	$ million (2008 prices)	-81
RoW emissions	MT	0.01
Consumption-based		
Real GDP	$ million (2008 prices)	-218
Export volumes	$ million (2008 prices)	-56
RoW emissions	MT	-0.12

Source: AE-RGEM modelling

Note: RoW indicates Rest of the World

Sectoral impacts

Table 4.3 shows the industry results at 2020 for a selected range of energy intensive commodities under each scenario. Generally the results shows smaller declines in production for the consumption-based approach compared to a CPRS with no assistance for energy intensive industries. Compared to a CPRS with EITE assistance, the pattern of results in the consumption based scenario is mixed depending on a range of factors including the level of EITEs assistance and trade exposure for each industry.

For the petroleum refining industry the projected decline in output at 2020, relative to the reference case, is smaller under the consumption-based approach compared with either production-based approach. This is for two key reasons. First, petroleum products are effectively not taxed at the intermediate usage stage as it is under the production-based scenarios. As such, business usage of petroleum products is higher under the consumption-based approach relative to the production based approaches (which is also reflected in lower emission abatement under the consumption-based approach). Second, under the consumption-based approach, the domestic petroleum industry is also assisted by the fact that imported final consumption of petroleum products will face a similar rate of tax and therefore the incentive to substitute imported for domestic petroleum products is reduced.

The aluminium sector is also projected to benefit from the consumption-based approach relative to the production-based approaches. This is because, given the export orientation of the aluminium sector, the consumption-based approach effectively provides a 100% insulation from cost increases through the imposition of a carbon tax (notably through electricity prices). This means the loss in international competitiveness associated with the production-based approach, notwithstanding the proposed EITE treatment for aluminium, is higher than the consumption-based approach which is reflected in the results shown.

As a key input into aluminium production, the impacts on alumina are closely related to those projected for aluminium.

Table 4.3: Output impacts, per cent, selected industries relative to the reference case, 2020

	CPRS	CPRS plus EITE	Consumption-based
Petroleum products	-11.8	-10.7	-4.2
Non-metallic mineral products	-9.9	-2.8	-5.2
Alumina	-40.1	-12.0	-9.7
Aluminium	-43.6	-17.3	-8.9
Other non-ferrous metals	-39.6	-40.1	-12.3

Source: AER-GEM modelling results

The projected impacts on other non-ferrous metals output are also similar to those exhibited by the aluminium sector. The key difference is that, because the sector has assumed to be granted no EITE status, the benefits to the sector of the consumption-based approach relative to the CPRS plus EITE scenario, are considerably higher. These relative benefits may be overstated because, given the other non-ferrous metals sector is so broad, it would be expected that some producers within this sector would qualify for EITE status which isn't reflected in this analysis.

The non-metallic mineral products sector is not projected to benefit under the consumption-based approach relative to the CPRS plus EITE scenario (although it does benefit relative to the CPRS scenario). Under the CPRS plus EITE scenario, the sector receives a relatively large (73.5%) shielding from the impacts of the carbon price, and the sector also benefits from a reduction in wages (see Table 4.1). Under the consumption-based approach, while the shielding is 100%, the input cost reduction associated with labour are not as significant. On balance, the CPRS plus EITE scenario results in input cost increases that are lower than the consumption-based scenario.

5 Conclusions

This modelling indicates that, for a given carbon price, the economic costs of a consumption-based approach in terms of GNP, employment and exports per tonne of greenhouse gas emissions are lower than a production-based approach in line with the CPRS.

The exports per tonne result, in particular, suggests that for a given carbon price, there is a lower reduction in exports per tonne of emissions abated. This seems to support the argument that the consumption-based approach results in less trade distortion.

However in terms of achieving the environmental objectives of emissions abatement, a production-based approach achieves a greater reduction in greenhouse gas emissions for the carbon price given here. However, this arises for two reasons:

- The reduction in output is lower under the consumption-based approach (the main reason for the difference); and
- There is no 'carbon leakage' from producers moving overseas under the consumption-based approach. This means that any reductions in emissions represent an emissions reduction globally, rather than a transfer of emissions to another country without abatement as may occur under the CPRS.

The preliminary modelling suggests, assuming the modelling results are linear, that a consumption-based tax could, with a higher carbon price, achieve the same abatement as the CPRS scheme but with smaller welfare impacts.

The modelling undertaken here, however, does not provide any indication as to whether the trade-off between cost and abatement is linear. Further work is required to determine the carbon price required for the equivalent level of emissions abatement under the consumption-based scheme, and only once this is done would it be possible to ascertain which is lest costly for the required reduction in emissions. An important component of this analysis would be to consider the potential impacts of the consumption-based approach on incentives to switch to lower emission intensive fossil fuels given changes to the pass through of carbon prices in, for example, electricity markets.

References

Productivity Commission, 2006, Supplement to *Potential Benefits of the National Reform Agenda*, Productivity Commission Research Paper, December, Canberra

Department of Climate Change 2008, *Carbon Pollution Reduction Scheme: Australia's Low Pollution Future*, December, Canberra

Styles J 2009, *The US Waxman-Markey Climate Change Bill*, Parliamentary Library Background Note, June, Canberra

Department of Energy and Climate Change 2009, *The EU Emission Trading System: Preparing for Phase III,* June, London

Dröge S, Brewer T, Fazekas D, Grubb M, Ismer R, Quirion P, van Asselt H, *Tackling Leakage in a World of Unequal Carbon Prices*, Climate Strategies, May

Geoff Carmody & Associates 2008, *Effective climate change policy: the seven 'Cs'*, Policy note 2, September, Canberra