Economic Effects of a Carbon Price on the Australian Economy: A Computable General Equilibrium Results

Disna Sajeewani, Mahinda Siriwardana, Judith McNeill

University of Wollongong, Australia

0540

The Asian Conference on Sustainability, Energy & the Environment 2013

Official Conference Proceedings 2013

Abstract

This paper analyses the macro-economic, sectoral and household effects of a $A23per tonne carbon price to achieve carbon dioxide (CO_2-e) emissions reduction targets in the Australian economy by employing a static computable general equilibrium (titled as A3E-G) model. The A3E-G model developed for this study is capable of handling endogenous substitution among energy inputs and alternative allocation of resources among energy and capital. The A3E-G model incorporates an explicit tax system that evaluates carbon price impact on the economy under both short-run and long-run closures. The model has been calibrated using an environmentally-extended social accounting matrix (ESAM) which is disaggregated to show detailed picture of carbon emissions by sectors, energy sources, electricity generating sectors, household income groups and various occupations.

Key words: Australia, carbon price, computable general equilibrium model, short-run, long-run.

Introduction

Scientific evidence suggests that greenhouse gases, especially carbon dioxide (CO_2) emissions from anthropogenic activities, have significantly contributed to climate change. These gases have the capacity to trap heat in the atmosphere and the resulting phenomenon is called 'global warming'. During the last 150 years, global surface temperatures have risen by 0.74 ± 0.18^0C with 11 of the last 12 years ranked the warmest years of the earth [8]. The consequences predicted as a result of global warming alarmed the national governments around the world. Accordingly, 172 countries participated at the *Earth Summit* in 1992 to establish an environmental treaty called the United Nations Framework Convention on Climate Change (UNFCCC). In order to strengthen the emission reduction commitments set under the UNFCCC, the *Kyoto Protocol* [12] was adopted in December 1997. The Kyoto protocol set countries binding emissions reduction commitments, and, the greenhouse gas emissions - most prevalently CO_2 emissions were identified as a negative externality. As a result, greenhouse gas emissions are viewed as a classical example of a market failure. Thus, the previously ignored external cost (climate change) of greenhouse gas emissions could be internalised into the private decisions of both producers and consumers. In summary, a market mechanism is expected to activate an emissions price (a carbon price) that would ultimately lower the emissions levels.

Pricing carbon has now been on Australia's political agenda over the past decade. In 2006, the Australian states (but not the Federal government) established the states and territories National Emissions Trading Taskforce (NETT). This was one of the significant milestones of Australia's attempt to reduce emissions using price signals. The Taskforce proposed to introduce a national emissions trading scheme. Next, in 2008, the Australian Government announced the Carbon Pollution Reduction Scheme (CPRS) which proposed a cap-and-trade emissions trading scheme as had the NETT Taskforce. Meanwhile, the Australian Treasury in partnership with other leading climate change economic modellers and the Garnaut Climate Change Review undertook comprehensive modelling projects to investigate the potential economic impacts of emissions reduction in Australia. The modelling undertaken by the Treasury is centered on three top-down CGE models namely Global Trade and Environment Model (GTEM), G-Cubed model and the Monash Multi-Regional Forecasting (MMRF) model. This was followed by integrating a series of bottom-up sector specific models for electricity generating, transport, land use change and forestry, and household micro simulation models to obtain projections at sector specific levels and household distributional levels. As it appears, the Treasury modelling is very complex. It has developed modelling scenarios integrating many CGE models as well as sector specific models. This is because the Treasury argues that no single model can adequately capture the global, national, state, industry, and household dimensions of the cost of climate change mitigation policy in Australia.

CGE models require enormous amounts of data. These data are mainly obtained from Input Output (IO) databases. CGE models employed by the Treasury have been calibrated with IO databases with an aggregate household sector representing the consumers in the economy. The micro simulation mode supplements the disaggregated household level details. However, that model only captures the flows of goods between industries and final consumers and it does not explain income flows between these institutions. An alternative way of obtaining distributional consequences of carbon price policy is to calibrate a CGE model with a Social Accounting Matrix (SAM) database. For instance, a CGE model calibrated with a IO table only captures sectoral interdependence in a detailed production account whereas a SAM based model elaborates and articulates the generation of income by activities of production and the distribution and redistribution of income between social and institutional groups [10]. Towards this end, Pang et al. [9] attempted to construct an aggregate SAM for Australia for the year 1996-97. Because this database is in its aggregate form, the distributional story of the household income and expenditure after a policy shock cannot be projected.

Therefore, two main research questions are addressed in this paper. First, there is a need for a less complex but more descriptive CGE model which is capable of simulating impacts on disaggregated industries and on households under a carbon price policy. Secondly, there is a need for constructing a disaggregated SAM database to calibrate the CGE model in order to measure distributional consequences of a carbon price policy. The rest of the paper is organised as follows. The structure of the A3E-G model is presented in Section 1. Section 2 describes the ESAM database and other necessary data for simulating the model. Section 3 presents macroeconomic, sectoral and household distributional effects of a $A23carbon price under both short-run and long-run economic environments. Section 5 draws concluding remarks.

1. The A3E-G model

The A3E-G model employed in this study is built based on the ORANI-G model [7], which is an applied general equilibrium model of the Australian economy. However, modifications have been included to incorporate energy industry details, multiple household accounts, and a carbon price mechanism into the model. The model has a theoretical structure that explains the behaviour of producers and consumers in the economy for a given time period. It is a static model which does not have any mechanism for the accumulation of capital. The model is based on the assumption of perfect competition where no individual buyer or seller is able to influence the price. Demand and supply equations for the private sector agents are derived from the solutions to the optimisation problem (cost minimisation, profit maximisation).

The production structure in the model allows each industry to produce several commodities, using intermediate inputs, labour of several types, land, capital and energy inputs. The combination of inputs used in the production process is different from the standard ORANI-G model, as the A3E-G model treats non-energy commodities and energy commodities separately (see similar type modeling structures in [6], [11], [13]). The model then allows price-induced substitution among different energy commodities used in the production process. The nested structure of the production in each sector is displayed in Figure 1. In this nested production structure, inputs are combined at different levels assuming imperfect substitution through a constant elasticity of substitution/transformation (CES/CET) functions or by zero substitution through a Leontief technology of fixed coefficients. Only the commercial electricity commodity is included in the composite energy group because it is the final form of energy (electricity), which can be utilised by various sectors in the economy. This structure assumes electricity is generated by black coal, brown coal, oil, gas and renewable energy, which supply electricity to the commercial electricity sector. As such, electricity generation is viewed as having normal composite intermediate demand (described by a Leontief function) and commercial electricity sector is treated as having energy demand for other sectors (described by a CES function).

CO_2 emissions are made proportional to the energy inputs (except for commercial electricity) used and/or to the level of economic activity. Carbon emissions are assumed to arise from stationary fuel combustion, industry activity and from household consumption. Emissions intensity - the amount of emission per dollar of inputs - is calculated as a coefficient. These emission intensities are assumed fixed in the model to reflect the unchanged technology and household preferences. Therefore, once the carbon price is introduced, the model re-calculates the market equilibrium based on emissions intensities associated within each sector.

2. The data sources

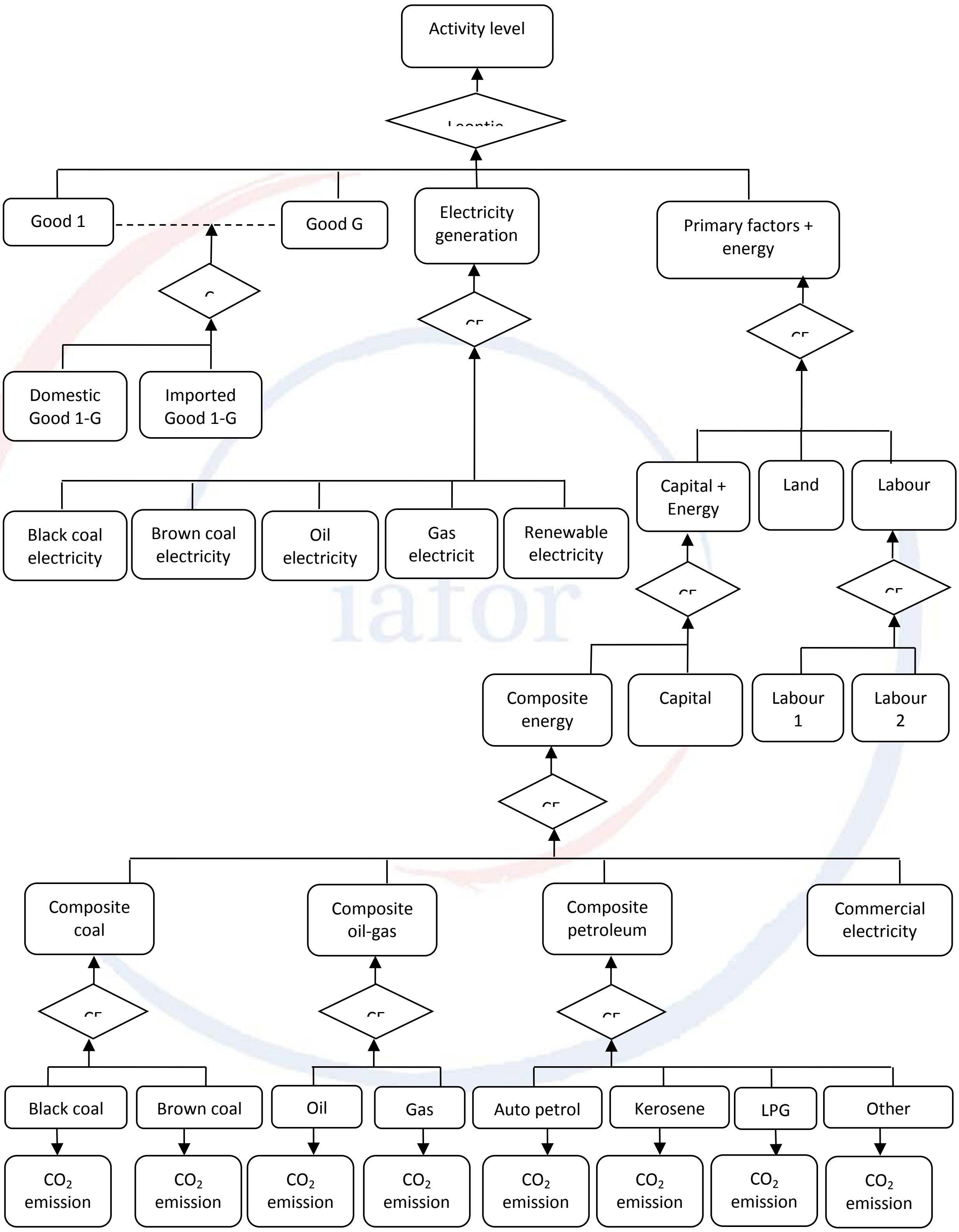
The main data source of the model is derived from the environmentally-extended social accounting matrix (ESAM) developed for Australia. The ESAM was constructed using input-output (IO) table and the system of national accounts (ASNA) published by ABS [1] and [2]. The original 119 sector classification given in the IO table was firstly, disaggregated into several sub-energy sectors and sub-electricity generating sectors and secondly, was aggregated into 35 sectors based on carbon emissions data published by the national greenhouse gas inventory (NGGI) of the Department of climate change and energy efficiency [5]. The ESAM disaggregates household account into 10 income groups and labour account into 9 occupations groups[1].

The carbon emissions resulting from the production and consumption process have been incorporated into the database under three emissions categories, namely input emissions activity emissions and consumption emissions. Input and activity emissions are related to the current production process whereas consumption emissions are related to the household consumption.

The numerous elasticity parameters (Armington elasticities, expenditure elasticities and substitution elasticities for capital-energy, electricity generation types, energy and labour) are extracted from outside sources or used authors' best judgment. The linearised version of the model is solved using GEMPACK [4] software.

[1] Due to limited space the detailed procedure of constructing the ESAM database is not presented, but can be provided on request.

Figure 1: Nested structure of production in each sector



3. Results and Discussion

The Australian government has implemented a carbon tax of $A23 per tonne of carbon dioxide equivalent to be effective from 1st July 2012 [3] and that price is used to draw simulations under both short-run and long-run economic environments (closures). The major differences between the short-run and long-run economic closures are that short-run assumes fixed capital stocks and real wages whereas long-run assumes fixed rates of returns and aggregate employment. Normally short-run assumes that the time period needed for economic variables to adjust to a new equilibrium after the policy shock is between 1 to 3 years and long-run assumes much longer time periods (more than 3 years) to adjust to a new equilibrium. To be consistent with the government policy, simulation results presented here exclude agricultural and transport sector emissions and household sector emissions. Therefore, a carbon price is directly imposed on input emissions and on output emissions of the rest of the sectors. These impacts are categorised into macroeconomic, industry and household distributional effects to facilitate the analysis.

Macroeconomic effects

The carbon price has reduced the real GDP relative to baseline levels in both short-run and long-run. In the short-run, reduction in GDP is 0.60 percent, whereas in the long-run, reduction in GDP is 0.67 percent. These effects arise due to distortions resulted from the carbon price which is implemented as a form of a tax. This can be seen as a reduction in economic efficiency, thus real GDP is slightly less after the tax. As a result, both the expenditure side and supply side components of GDP are shown to have negatively affected. With respect to supply side components of the GDP, a carbon price increases the cost of variable factors of production, which in turn reduce the incentive for producers to employ these factors in their production processes. For instance, the cost of labour increases in the short-run whereas cost of capital increases in the long-run leading to a reduction in GDP. In the short-run, nominal wages are indexed to the consumer price index. Therefore, increase in the consumer price index by 0.71 percent will lead to proportional increase in nominal wages. This creates a wedge between the price of spending and the average price of output in the economy. This can be observed as a rise in wages relative to the price of output leading to an increase in the real cost of labour. In the long-run, we assume rates of returns are fixed, which creates a wedge between the price of investment and the average price of output. This will result in the rise of capital rent relative to the average price of output, leading to an increase in real rental cost of capital.

As shown in Table 1, real household consumption has reduced by a much higher percentage under the long-run (-0.30 percent) as compared to the short-run outcome (-0.17 percent). This effect can be explained as a result of changes in real incomes available for consumption. For instance, short-run household income is largely affected by the reduction in aggregate demand for employment (-0.87 percent) whereas the long-run household income is largely affected by the reduction in demand for capital stock (-1.59 percent). The loss in household real income from capital (in the long-run) seems to be higher than the loss of real income from labour (in the short-run). Therefore, real consumption in the long-run has been largely influenced by those who own more capital as compared to labour.

Table1 Percentage change impacts of a $A23carbon price on macro economic variables

Macro variable	Short-run	Long-run
Real GDP	-0.60	-0.67
Aggregate employment	-0.87	0.00
Real household consumption	-0.17	-0.30
Aggregate capital stock	0.00	-1.59
Export volume index	-2.76	-0.83
Import volume index	0.07	-0.77
Consumer price index	0.71	-0.34
Real devaluation	-0.73	0.48
Real wage rate	0.00	-1.44
Price of exports	0.29	0.11
Terms of trade	0.29	0.11
Emissions reductions (Mt)	70.13	183.13
Emissions reduction (%)	-11.94	-31.19
Carbon revenue ($ billions)	6.39	3.73

Source: A3E-G model projections.

In the short-run, other than household consumption, the domestic absorption is determined by the balance of trade. In this case, the balance of trade has slightly deteriorated. The overall effect on the trade balance can be further verified by observing the export and import volume indices. Accordingly, export and import volumes have reduced by 2.76 percent and 0.07 percent respectively. Furthermore, the domestic currency has appreciated against the foreign currency by 0.73 percent in real terms, which may have further induced the reduction in exports. As a result, Australia’s competitiveness in the international market has been affected by the carbon price. However, the impacts are less severe in the long-run. In this case, the trade balance is determined outside the model, thus, imports tend to move with the level of exports in order to maintain the trade deficit at the 2005 level. Both export and import volumes have declined by 0.83 and 0.77 respectively. In particular, the required change in the real exchange rate to maintain the trade deficit is seen as currency depreciation.

The main intention of introducing a carbon price in the economy is to achieve a required level of emissions abatement. In the short-run, the amount of emissions reduction in the economy is estimated at 11.34 percent (or 70.03 Mt) with a revenue generation of $6.39 billion. In the long-run more emissions are abated (183.13 Mt), thus, the government would collect less revenue from the remaining emissions in the economy ($3.73 billion). The high emission abatements are possible in the long-run because the total capital stock and aggregate investment are endogenously determined implying that producers have more capacity to substitute energy with capital.

Industry effects

The detailed analysis of industry effects reveal that the carbon price reduces output in some industries, while it increases output in other industries. Mostly affected industries are high carbon emitting energy related industries. Table 2 gives the percentage change of output and emissions reduction of industries under both the short-run and the long-run. The carbon price generally increases the cost of production of industries producing higher carbon emissions relative to industries producing lower carbon emissions. Accordingly, output changes after a carbon price shock can be explained largely using the percentage reduction of emissions relative to baseline of those industries.

The carbon price increases the prices of directly targeted energy goods such as brown coal, black coal, oil, gas, petroleum products and commercial electricity. On the other hand, a carbon price indirectly affects the prices of goods that utilise energy goods as factors of production. For instance, the commercial electricity price increases with the carbon price (Table 1) mainly as an indirect effect brought about by increases in the cost of production of high carbon bearing fossil energy sources. The increase in prices of commercial electricity exerts further indirect impacts on electricity intensive production sectors. These kinds of combined direct and indirect effects lead to high carbon emissions and energy intensive sectors to contract. As shown in Table 2, significant industry output losses are projected in the brown coal, electricity generating brown coal, electricity generating black coal and commercial electricity sectors. Basically, these sectors (except the commercial electricity sector) have significantly reduced their carbon emissions.

Output contractions in the electricity generating sectors exert a direct impact on the output of the commercial electricity sector. In the short-run, the output reduction in the brown coal and black coal electricity generating sectors contribute to reduce commercial electricity sector's output by 7.49 percent. This is because the contribution to electricity output is much larger with coal powered generating plants as compared to other sources[2].

Among the other energy sectors, the brown coal sector records the highest output loss. This could be due to two reasons. Firstly, the direct impact (emissions reduction) increases the cost of production of the brown coal sector and, as a result, output contracts. Secondly, indirect impacts (reduced input demand) of the electricity generating brown coal and electricity generating black coal sectors have contracted output in the brown coal sector. This is because the brown coal sector is a major input supplier to coal powered electricity generation in the economy.

The other energy sectors, namely black coal, oil, gas and petroleum outputs have contracted mainly as a response to the direct impacts in the short-run. This is confirmed by looking at emissions reduction in those sectors. However, overall output losses in those sectors have eased slightly due to indirect impacts. In the case of the

[2] Renewable energy sources contribute 6% whereas coal powered sources contribute 78% to the electricity generating (ABARE, 2005)

oil and gas sectors, the increased input demand from the electricity generating oil and electricity generating gas sectors reduces the negative impacts on the oil and gas sectors. Since major input demanding sectors from the petroleum sector, namely agriculture and road transport sectors have been exempted from the carbon price shock, the petroleum sector experiences only a slight output reduction. Next, the output of the black coal sector decreases slightly as compared to output of the brown coal sector. This could be due mainly to relocating inputs (labour and capital) towards the black coal sector which is less emissions intensive compared to the brown coal sector.

Overall, sectoral outputs of the other remaining sectors have contracted in the short-run. For instance, the output from the iron and steel sector reduces by 4 percent. All other export oriented sectors, namely non metallic products (aluminium) and all other metal products sectors have also reduced their outputs. This could be due to two reasons: one is due to increased electricity prices in the economy; another reason is that emissions associated with these sectors are comparatively high and output related emissions are also priced under the model. In contrast, a slight growth in output is seen in the construction services industry. Because construction services are relatively capital intensive, the improved marginal productivity of capital in the short-run tends to increase the level of output in that sector. Quite by contrast, the sectors exempted from the direct carbon price shock, namely agriculture and road transport services also have reduced outputs in the short-run. This is because these sectors cannot be totally excluded from an external shock due to existence of general equilibrium effects in the economy.

In the long-run, most of the emissions intensive sectors have contracted more than that observed in the short-run. Both electricity generating black coal and electricity generating brown coal contract by 82 percent and 73 percent respectively. Heavy output contraction in electricity generating black coal is mainly due to high emissions reduction of the sector and partly due to contraction in the output of the black coal sector by 10.8 percent. The output of the brown coal sector reduced by 70 percent which is mainly due to its own emissions reduction (71 percent), and partly due to reduced input demand from electricity generating brown coal and black coal sectors. Furthermore, outputs from the electricity generating gas and gas sectors have contracted by 36 percent and 22 percent respectively. A 100 percent expansion can be seen in the electricity generating oil sector. As a result, the corresponding input supplying oil sector has only contracted by 2 percent. The electricity generating renewable energy sector has expanded by 829 percent mainly as a result of substituting lower emissions technologies for higher emissions technologies. The overall impact on the output of the commercial electricity supply sector is -3.3 percent which has significantly improved compared to what was seen in the short-run. This is mainly because of larger expansion observed in the electricity generating renewable energy (829 percent) and electricity generating oil (100 percent) sectors.

Output changes in other sectors show mixed results in the long-run. Similar to the short-run, significant output losses can be seen in the iron and steel sector and all other metal products sector in the long-run. These outputs have declined by 7.6 percent and 6.8 percent respectively. Interestingly, some less emissions intensive manufacturing sectors show positive expansion in the gross output, especially in the food, beverages and tobacco sector (0.21 percent), textile, clothing and footwear sector (0.51 percent), wood, paper and printing sector (0.24 percent) and all other manufacturing sector (0.58 percent). This is partly because of the comparatively smaller increase in electricity prices in the long-run. Furthermore, when factors are released from emissions intensive sectors they can be absorbed by less emissions intensive sectors. As a result, outputs of the less emission intensive sectors tend to expand. On the positive side, these sectors grow with remarkable reductions in sectoral emissions. Results also show that both the agriculture and road transport services sectors expand by 0.97 percent and 1.1 percent respectively with a slight increase in emissions.

Interestingly, the long-run effects have become favourable for sectors which have relatively fewer emissions as well as sectors that are exempted from the policy. Overall, the carbon price under the long-run has significant effects on reducing emissions associated with high emissions intensive sectors while improving the growth of less emissions intensive sectors in the economy.

Table 2 Industry output and emissions reduction (percentage change)

	Industry	Output		Emissions	
		Short-run	Long-run	Short-run	Long-run
1	Agriculture	-0.53	0.97	-0.49	0.93
2	Black coal	-0.56	-10.86	-0.43	-10.96
3	Brown coal	-24.64	-70.20	-19.30	-71.48
4	Oil	-0.11	-1.59	-1.83	-3.29
5	Gas	-0.40	-21.94	-1.91	-23.50
6	Other mining	-0.30	-2.38	-45.18	-48.69
7	Food, beverages and tobacco	-1.03	0.21	-9.75	-13.27
8	Textile, clothing and footwear	-0.97	0.51	-6.07	-11.70
9	Wood, paper and printing	-0.85	0.24	-39.76	-41.94
10	Automotive petrol	-0.53	-1.25	-13.35	-13.75
11	Kerosene	-0.87	-1.74	-25.81	-26.45
12	Liquid gas petroleum	-1.13	-2.67	-25.63	-26.61
13	Other petrol and coal products	0.31	-0.95	-21.25	-26.56
14	All other chemical products	-2.48	-5.59	-10.73	-15.55
15	Non metallic products	-1.46	-0.36	-7.00	-11.97
16	Cement and concrete	-1.23	-1.77	-24.66	-25.78
17	Iron and steel	-3.90	-7.69	-5.68	-11.08
18	All other metal products	-2.37	-6.80	-38.35	-43.50
19	All other manufacturing	-1.12	0.58	2.37	-3.33
20	Electricity generating - black coal	-9.05	-82.10	-30.61	-85.06
21	Electricity generating - brown coal	-17.99	-73.02	-24.48	-80.04
22	Electricity generating - oil	6.88	100.05	0.57	7.96
23	Electricity generating - gas	3.09	-36.33	0.28	-39.57
24	Electricity generating - renewable	11.48	829.47	0.00	0.00
25	Commercial electricity	-7.49	-3.31	0.00	0.00
26	Gas supply	-0.74	1.43	-0.54	1.06

27	Water and sewerage services	-0.49	-0.25	-0.44	-0.40
28	Construction services	0.03	-1.27	-11.46	-13.49
29	Trade services	-0.58	0.41	-2.89	-3.58
30	Accommodation and cafe	-1.43	-0.52	-1.53	-1.14
31	Road transport services	-0.84	1.11	-0.76	1.01
32	Other transport services	-1.19	-1.91	-0.75	-1.93
33	Business services	-0.35	0.00	2.09	-0.76
34	Public services	-0.44	-0.23	-7.55	-11.58
35	Other services	-0.32	-0.13	0.00	0.00

Source: A3E-G model projections.

Household effects

This section presents the carbon price impact at different household income groups. The model is used to capture income and expenditure patterns of ten household groups. The household income is basically determined as changes in wage income (disaggregated into 9 occupational groups), capital rent, land rent, government transfers and other transfers. The wage income is solely received by the households, which determine a major part of household income. Table 4 presents the projection of household employment by nine occupational groups in the economy.

The short-run results indicate the overall reduction in derived demand for occupational labour categories due to slack labour market assumption. This closure assumes capital mobility between sectors. Accordingly, a reduction in output of many sectors in the economy is closely related to reduction in employment. Furthermore, as the labour income is received by the households, the reduction in derived demand for occupational labour will basically have an effect on household income at different degrees.

The long-run situation is quite different. Because full employment and allow capital mobility between sectors are assumed under this closure, results show that employment effects have been favourable for many employment groups except on trade persons and related workers category and intermediate production and transport workers category.

Table 4 Percentage change of household labour employment by occupational categories

	Occupational category	Short-run	Long-run
1	Managers and administrators	-0.97	0.13
2	Professionals	-0.71	0.14
3	Associate professionals	-0.81	0.15
4	Trades persons and related workers	-0.89	-0.67
5	Advanced clerical and service workers	-0.79	0.13
6	Intermediate clerical, sales and services workers	-0.85	0.15
7	Intermediate production and transport workers	-1.37	-0.52
8	Elementary clerical, sales and service workers	-0.79	0.43
9	Labourers and related workers	-0.98	0.01

Source: A3E-G model projections

With regard to household consumption, a carbon price alters relative prices of commodities as industries incorporate the carbon price into their production costs. These changes affect the composition of household consumption of goods and services in the economy. For instance, the increased prices of carbon intensive commodities will have a disproportionate impact on those households, which consume more carbon intensive commodities. Accordingly, commodities that are required for subsistence requirements are purchased regardless of their price increase. The remaining consumption - the ‘luxury’ or ‘supernumerary’ expenditure - is altered with relative price changes.

Table 5 shows the percentage change in household real consumption under various carbon price scenarios. The real household consumption of each income group is negatively affected under both short-run and long-run with the magnitude of the impact varies between two closures. It is also quite clear that short-run assumption generates proportionate consumption reductions in the income groups of deciles 3 to 10. However, projected household consumption impacts are progressive under the long-run and the degree of change varies from -0.004 (decile 1) to -0.714 percent (decile 10).

Another important issue of a carbon price in the economy is to evaluate how household real income varies between income groups. As shown in Table 5, income distribution effects range from a proportional to mildly progressive tax incidence under the short-run. However, the effects are not significant on deciles 1 and 2. These two groups receive a significant proportion of government transfers which constitute their major source of income[3]. As a result, introduction of a carbon price may not necessarily reduce their household post tax income. The rest of the income groups share the burden quite proportionately to their relative income, with middle income groups (deciles 5, 6, 7, and 8) fairing the worst. This is because in the short-run, household incomes are mainly affected by the changes in labour supply rather than changes in capital rent. Accordingly, this projection confirms that middle income households receive wage income as a major part of their total income and that wage income is affected by the carbon price policy. The post tax income effect on the last two income deciles (deciles 9 and 10) are relatively less than the average middle income group effect.

In contrast, the long-run impacts of the carbon price policy lead to a progressive tax incidence with the highest income groups (deciles 9 and 10) fairing the worst. The degree of change varies from -0.10 percent to -1.36 percent. This is mainly because the income distribution stems primarily from capital income under the long-run. Capital income constitutes a larger proportion of post-tax income of rich household groups. Moreover, the post-tax income changes of the rest (deciles 1 to 8) are somewhat less burdensome as compared to the short-run.

[3] More than 75% of the total incomes constitute government transfers for these two groups combined.

Table 5 Percentage changes in household real consumption and real income

Household income deciles	Real consumption		Real income	
	Short-run	Long-run	Short-run	Long-run
1st	-0.002	-0.004	-0.14	-0.10
2nd	-0.001	-0.010	-0.18	-0.14
3rd	-0.030	-0.034	-0.62	-0.34
4th	-0.051	-0.051	-0.55	-0.32
5th	-0.107	-0.084	-0.76	-0.42
6th	-0.128	-0.097	-0.73	-0.38
7th	-0.162	-0.194	-0.75	-0.69
8th	-0.186	-0.219	-0.72	-0.66
9th	-0.211	-0.499	-0.64	-1.28
10th	-0.328	-0.714	-0.68	-1.36

Source: A3E-G model projections, 1st – 10th range poorest to richest.

5. Concluding remarks

The impacts of a carbon price in the Australian economy are evaluated using an A3E-G model calibrated to an ESAM database. The carbon price used for this simulation is entirely based on the Australian government decision to implement a carbon price of $A23 from July 2012. Both the short-run and long-run economic conditions are considered to estimate impacts of $A23carbon price on the macro economy, industries and household groups in Australia. The carbon price is likely to have an increased cost on the economy while generating a considerable revenue and emissions reduction to the economy. The negative impacts on households can be minimised by employing a compensation mechanism to recycle the revenue collected from the carbon price. This will be an area for future research using the model developed in this study.

References

[1] ABS (Australian Bureau of Statistics). "Australian national accounts: Input output table, 2004-05." Catelogue No, 5209.0. Australian Government Publishing Service, Canberra, 2008a.

[2] ABS. "Australian system of national accounts, 2005." Catelogue No. 5204.0, Australian Government Publishing Service,Canberra, 2008b.

[3] Australian Government. "Strong growth, low Pollution: Modelling a carbon price". Commonwealth of Australia, Canberra, 2011.

[4] Codsi, G. and Pearson, K. "GEMPACK: A General Purpose Software for Applied General Equilibrium and Other Economic Modellers." Computer Science in Economics and Management,Vol.1,1988, pp.189-20.

[5] DCCEE (Department of Climate Change and Energy Efficiency). "National greenhouse gas inventory (NGGI)." Australian Govenrment, Canberra, 2005.

[6] Devarajan, S., Go, D. S., Robinson, S., and Thierfelder, K. "Tax policy to reduce carbon emissions in a distorted economy: Illustrations from a South Africa CGE model." The B.E. Journal of Economic Analysis and Policy, Vol.11, No.1,2011, pp.1-22.

[7] Dixon, P. B., Parmenter, B. R., Sutton, J., and Vincent, D. P. "ORANI: A multisectoral model of the Australian economy." Amsterdam, North-Holland, 1997.

[8] IPCC (Intergovernmental Panel on Climate Change). "Climate change 2007: Impacts, adaptation, and vulnerability.", Ed., M. Parry, O. Canziani, J. Palutikof, Can Der Linden and C. Hanson Cambridge, Cambridge University Press, 2007.

[9] Pang, F., Meagher, G. A., and Lim, G. C."An aggregated social accounting matrix for the Australian economy: Data sources and methods". Growth, Distribution and Social Accounting Matrices, Korean National Statistical Office, Daejeon, South Korea, 2007.

[10] Round, J. "Constructing SAMs for development policy analysis: Lessons learned and challenges ahead." Economic Systems Research, Vol.15 2003,: pp.161-183.

[11] Telli, C., Voyvoda, E., and Yeldan, E. "Economics of environmental policy in Turkey: A general equilibrium investigation of the economic evaluation of sectoral emission reduction policies of climate change." Journal of Policy Modeling, Vol.30 2008, pp.321-340.

[12] UNFCCC. "Kyoto Protocol to the united nations framework convention on climate change." http://unfccc.int/key_documents/kyoto_protocol/items/6445.php, 1998.

[13] Yusuf, A. A., and Resosudarmo, B. P. "On the distributional effect of carbon tax in developing countries: The case of Indonesia." Working Paper in Economics and Development Studies, Department of Economics, Padjadjaran Universtiy, 2007.

iafor