



# Australia's Carbon Tax: An Economic Evaluation

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# Executive Summary

Australia has implemented a carbon tax, and it is failing to deliver any of its promised benefits. Its failures have made the tax a highly politicized issue, and may provide lessons for other nations. The tax, which is currently set at \$24.15<sup>1</sup> is the central component of the Australian Government’s climate change policy. The tax applies directly to around 370 Australian businesses<sup>2</sup> and was originally designed as a precursor to a “cap and trade” scheme, with the transition to a flexible price originally (and currently) scheduled to take place on July 1, 2015.

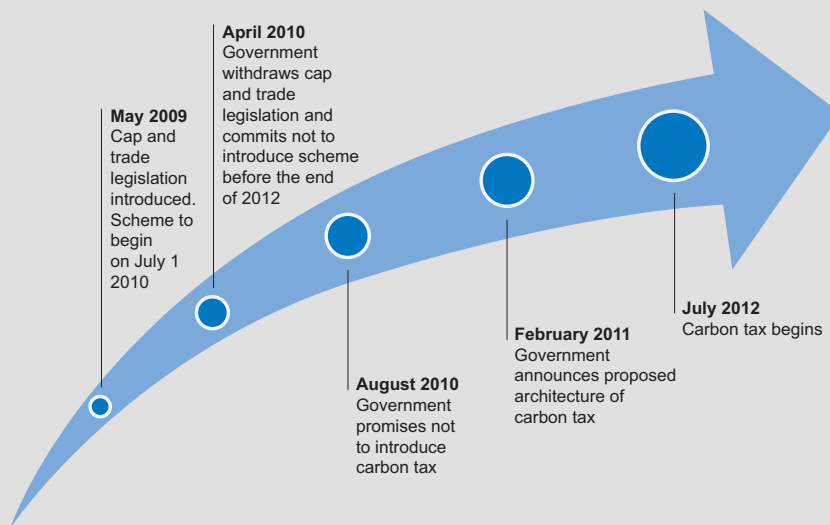
This report, commissioned by the Institute for Energy Research, evaluates Australia’s carbon tax experience and draws lessons for policymakers in the United States and other jurisdictions, who may be considering following the Australian example and implementing their own carbon taxes or cap and trade schemes. The analysis establishes a number of key points, which are summarised below.

**Establishing a Robust, Sustainable and Credible Carbon Tax is Politically Difficult. Policy Uncertainty and Time Inconsistency are Likely to be the Rule Rather than the Exception**

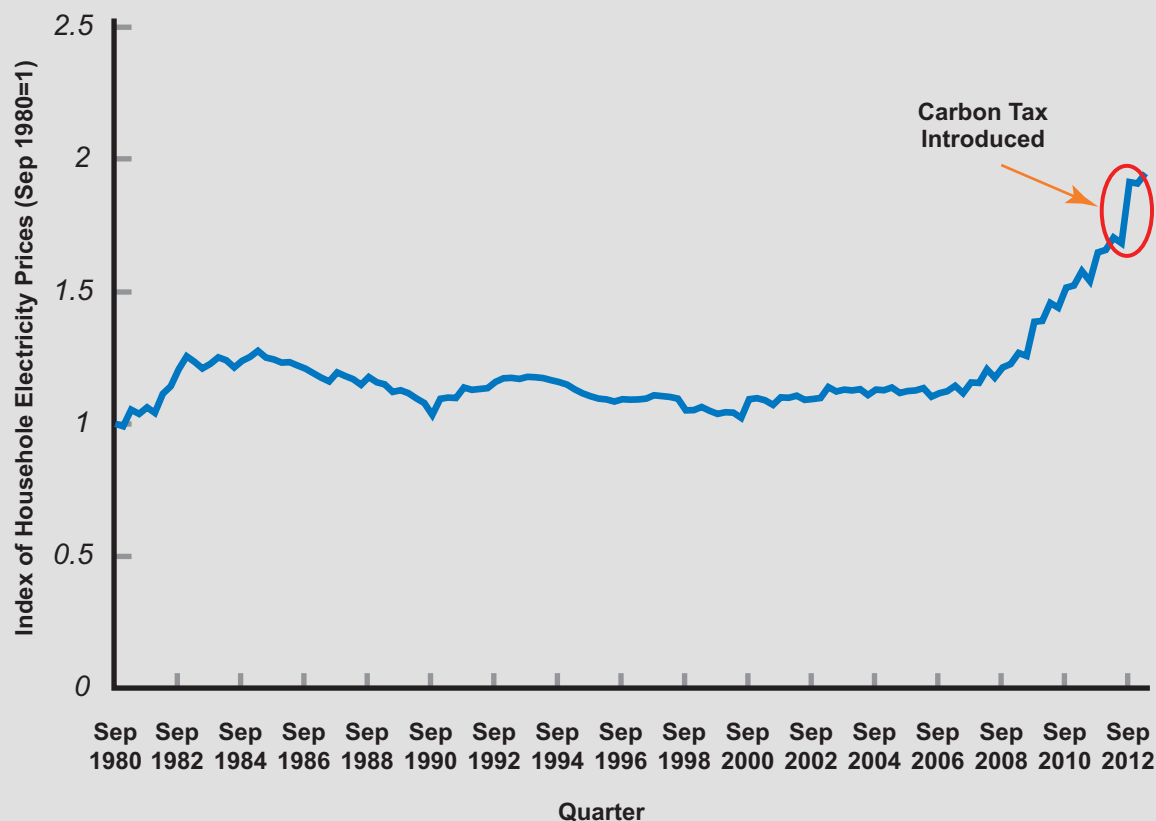
Figure E1 below summarises the legislative evolution of Australia’s carbon tax and shows that the policy was plagued by uncertainty well before it was formally introduced. Prior the 2010 election, neither major

political party in Australia supported a carbon tax - yet less than a year later, legislation to give effect to the tax was introduced into Parliament. *In addition, the tax was subjected to a number of significant changes almost immediately after it came into effect, reducing certainty for businesses and directly negating one of the original justifications for the tax.* For example, originally the proposed scheme was to have a fixed price for the first three years, followed by a floating price which would be subject to floor and ceiling prices. However, on August 28, 2012, less than two months after the scheme began, the Government announced that there would no longer be a floor price. That such significant changes were made to the scheme so soon after it began suggests that the original design contained significant flaws.

**FIGURE E1:  
SUMMARY OF THE LEGISLATIVE HISTORY OF THE CARBON TAX**



**FIGURE E2: INFLATION-ADJUSTED HOUSEHOLD ELECTRICITY PRICES, 1980 TO 2013**



Despite the carbon tax passing both the House of Representatives and the Senate and becoming law, political and popular support for the policy has been weak. Recently the Australian Government has proposed further major changes to the tax, announcing its desire to move earlier towards a cap and trade scheme, with the new transition taking place on July 1, 2014. However, legislation to give effect to this proposed change has not yet been introduced into Parliament; and in any case, it is unclear whether such legislation would actually be passed.<sup>3</sup>

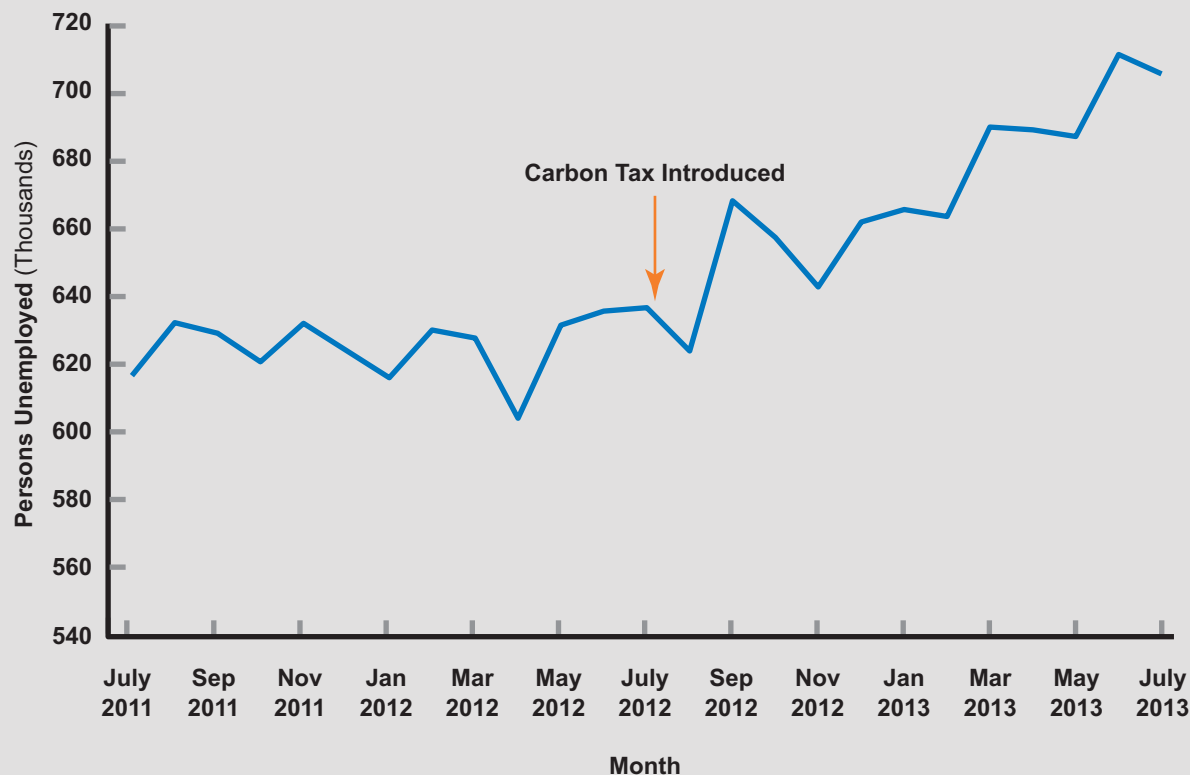
As a result, there is still a great deal of uncertainty surrounding the future status of the carbon tax. Depending on the result of the forthcoming election, the tax may either remain in place and transition to cap and trade in 2015, or it may move to a cap and trade scheme in 2014, or it may be abolished completely.

**In Assessing the Case for a Carbon Tax or Cap and Trade Scheme, the Incremental Net Benefits of All Feasible Policy Options Were Not Estimated.**

One reason for the lack of robustness of the carbon tax policy is that its development followed a flawed policy process. The role of climate change policy is not to assess the possible damage of climate change, but rather to focus on the incremental net benefits of possible policy options. A central tenet of good economic policymaking is that a full cost benefit analysis (CBA) should be undertaken, weighing up the gains and losses across a wide range of policy alternatives so that political decision-makers can be better informed of the economic effects of various options. Sensitivity analysis should be undertaken in order to determine the extent to which the results of such analysis depend on modelling assumptions and other inputs. If sensitivity analysis shows that a proposed policy's estimated net benefits vary wildly



**FIGURE E3: UNEMPLOYMENT BEFORE AND AFTER THE INTRODUCTION OF THE CARBON TAX**



with assumptions, the policy should be treated with a great deal of care and probably rejected on the grounds that it is unlikely to result in net benefits.

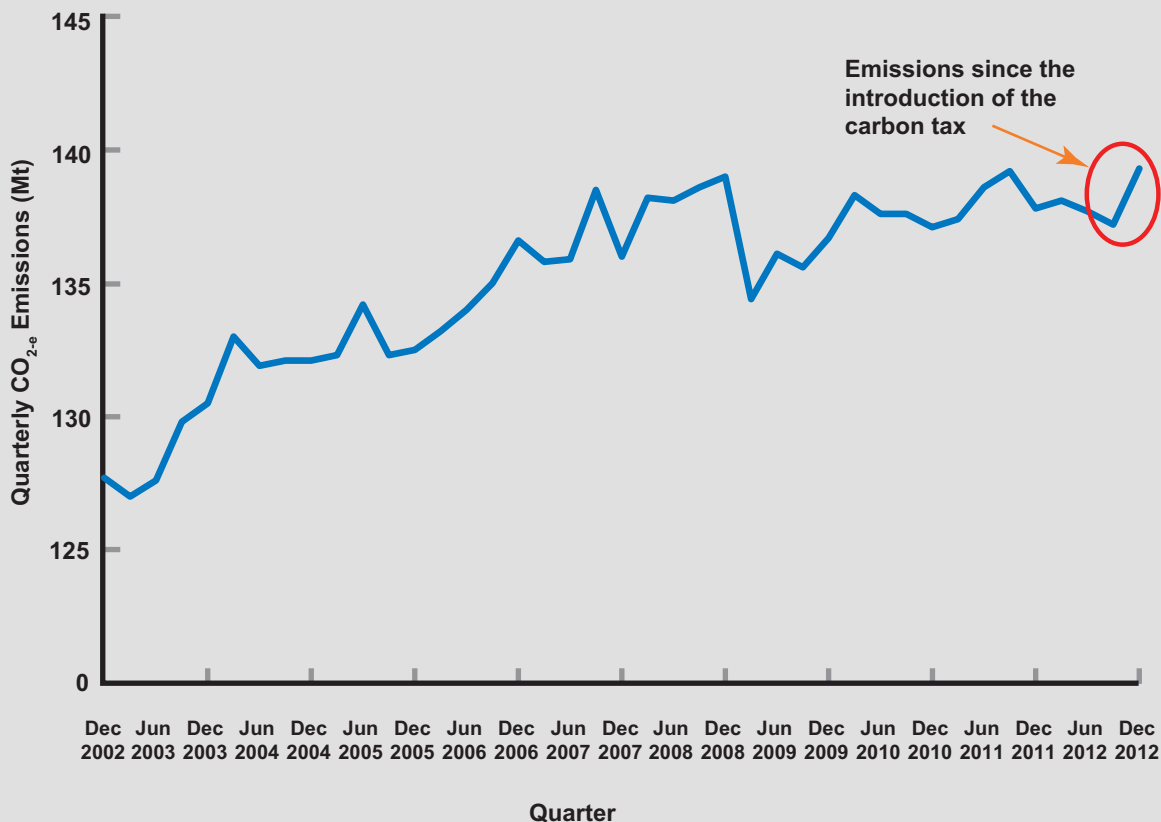
Whilst a number of Government-commissioned reports attempted to examine the economic costs of carbon taxes and emissions trading schemes, the incremental net benefits of the policy were never assessed. In other words, costs and benefits were never compared. Instead, Government-sponsored reports purported to measure benefits by examining the possible future damage that may be caused by climate change in Australia. But estimating these costs is not the same as estimating the benefits of various policies. In particular, there was never an assessment of the incremental net benefits to Australia of limiting emissions, versus other measures such as adaptation. The Australian debate has always been framed as limiting emissions on the one hand, versus doing nothing on the other.

In addition, the Government's quantitative modelling of the costs made a number of highly unrealistic assumptions and lacked transparency (Ergas and Robson, 2012). This made it impossible for neutral third parties to replicate and evaluate the results, or modify the assumptions to test the robustness of the results.

**The Cumulative Economic Costs of Carbon Taxes or Cap and Trade Schemes are Likely to be Substantial Over the Long Term, with Lower Discount Rates Resulting in Higher Cumulative Costs in Present Value Terms**

Under the carbon tax, most of the abatement that Australia will take credit for over the period to 2050 will be undertaken overseas, with Australian businesses paying their foreign counterparts to reduce emissions. Nevertheless, the tax will have significant economic costs. So far the main economic effect of the tax has been to increase energy prices (particularly

**FIGURE E4: AUSTRALIA'S TOTAL CO<sub>2</sub>-E EMISSIONS, SEASONALLY ADJUSTED WEATHER NORMALISED, 2002-2013**



electricity costs) for households and businesses (see Figure E2). According to the Australian Industry Group (AIG), energy cost increases have averaged 14.5 per cent for businesses as a result of the carbon tax, whilst TD Securities and the Melbourne Institute found that due to the introduction of the carbon tax, the price of electricity for households rose by 14.9 per cent. The increase in household electricity prices after the carbon tax was introduced was the highest quarterly increase on record.

The Government's own modelling (which, as the report discusses, are likely to have underestimated the costs of the tax) indicates that Australia's Gross Domestic Product (GDP) will be lower than it otherwise would be for every year that the tax is in place. Depending on the discount rate used, the present value of these costs could be as high as 83 per cent of current Australian GDP, or \$1.25 trillion. The carbon tax has been

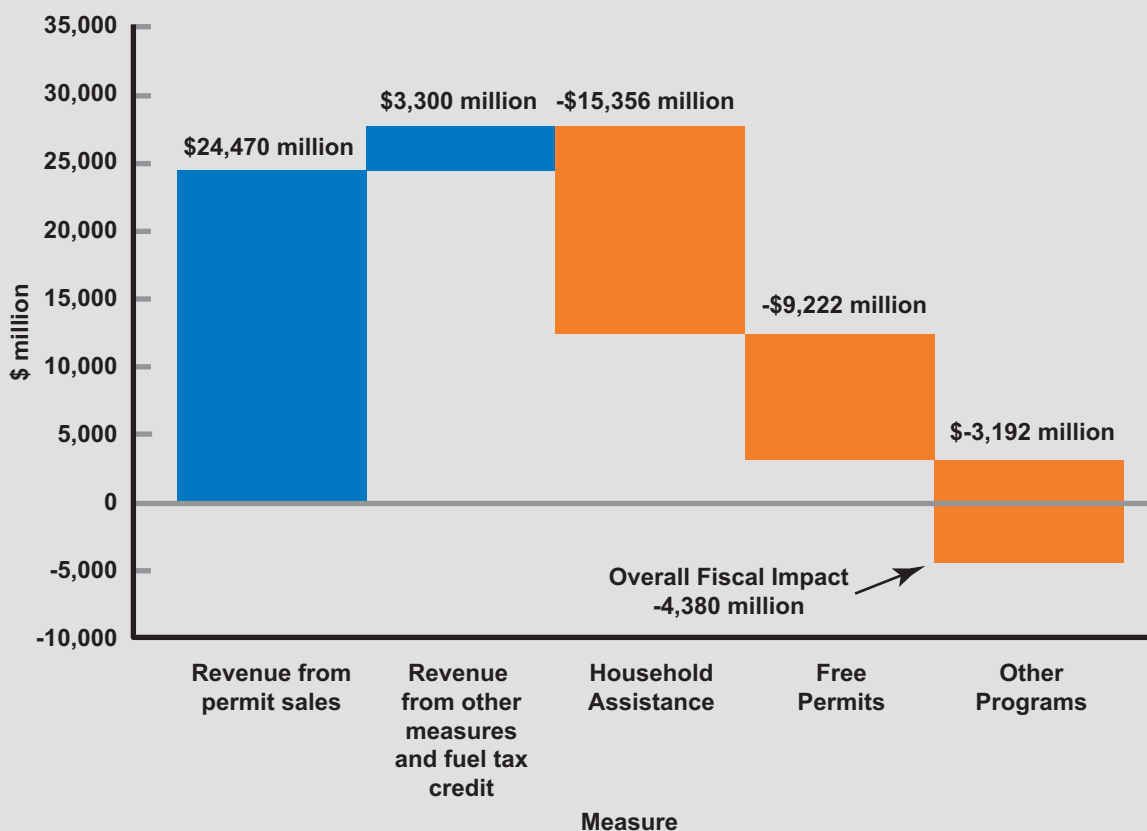
directly linked to a number of business closures and job losses, with overall unemployment rising significantly since the tax was introduced (see Figure E3).

Furthermore, government data shows that the tax has not reduced the level of Australia's domestically produced CO<sub>2</sub>-e emissions (Figure E4). This is not surprising, since under the carbon tax Australia's domestic emissions are not expected to fall below current levels until 2045.

**Carbon Leakage is Likely and will Create Economic Costs with no Offsetting Environmental Benefit**

Overall, Australia's exports are relatively emissions intensive. Hence a carbon tax is likely to increase the cost of exports, whose prices are largely determined on world markets. There is little opportunity for Australian export industries to pass on the increases in costs that are due to the carbon tax. In other

**FIGURE E5: EXPECTED CUMULATIVE FISCAL IMPACT OF THE CARBON TAX AND ASSOCIATED POLICIES, 2011-12 TO 2014-15**



words, the effect of the carbon tax on Australia’s emissions-intensive, trade-exposed industries is similar to a tax on exports or a tax on import-competing industries. Providing free permits to these industries does not alter marginal incentives. Domestic emissions in these industries may fall after a carbon tax is imposed, but that cannot be counted as an environmental gain if the ultimate effect is that the businesses shut down and emissions simply rise overseas. The net effect will be a pure deadweight cost to the Australian economy.

**Fiscal Impacts are Likely to be Uncertain, with both Carbon Taxes and Cap and Trade Schemes Adding to Existing Revenue Volatility**

Due to the structure of the carbon tax and accompanying policies, a sizeable fiscal gap has opened up between the revenues generated by the tax on the one hand, and the increases in government

spending and tax cuts that accompanied the scheme on the other. A significant proportion of compensation payments were “locked in”, whilst revenue from the tax is likely to be lower than originally anticipated. Hence the introduction of the tax, together with other policies, is likely to worsen Australia’s budget bottom line going forward, leading to higher deficits and higher public debt than would otherwise have been the case.

**Attention Needs to be Paid to the Effects and Costs of “Complementary” Policies, Which Are Likely to Result in Efficiency Losses Rather than Efficiency Gains, Compounding any Negative Effects of a Carbon Tax or Cap and Trade Scheme**

Table E1 below shows that the carbon tax, together with other green schemes, now account for a significant portion of a typical Australian household’s electricity bills. Proponents of carbon taxes have

**TABLE E1: ESTIMATED CONTRIBUTION OF THE INTRODUCTION OF THE CARBON TAX AND OTHER GREEN SCHEMES TO A TYPICAL ANNUAL HOUSEHOLD ELECTRICITY BILL, QLD AND NSW**

	QLD (2012-13)	NSW (2013-14)
RENEWABLE ENERGY TARGET	\$102	\$107
SOLAR BONUS SCHEME/OTHER SCHEMES	\$67	\$53
CARBON TAX	\$190	\$172
TYPICAL HOUSEHOLD BILL	\$1900	\$2073
GREEN SCHEMES/TOTAL	19 PER CENT	16 PER CENT

pointed to several kinds of efficiency gains that may accompany such taxes. It is often claimed, for example, that imposing a carbon tax allows policy makers to eliminate other, more costly “complementary” measures that are designed to reduce emissions, such as green subsidies (eg for solar and wind power), renewable energy targets, and so on.

However, these efficiency gains are unlikely to materialise in Australia’s case: the complementary measures have remained in Australia after the carbon tax was put in place. To make matters worse, new complementary measures have been introduced which will likely increase economic costs. Hence any hypothetical efficiency gains that may have occurred as a result of eliminating other programs remain just that: hypothetical.

**Overall, Australia’s exports are relatively emissions intensive. Hence a carbon tax is likely to increase the cost of exports, whose prices are largely determined on world markets.**

### **The “Double Dividend” is Elusive in Theory and Difficult to Achieve in Practice**

Carbon tax proponents also argue that carbon tax revenue can be “recycled” and used to reduce marginal income tax rates, thus providing a “double dividend.” The report also shows how the double dividend hypothesis is a dubious proposition in theory, due to the interaction between the carbon tax and the existing tax system (particularly personal income taxes and corporate taxes). In addition, as part of the household compensation package for the carbon tax, the Australian Government lowered some average income tax rates but actually *increased* marginal tax rates for around 2 million taxpayers. This increase in marginal tax rates is exactly the opposite policy of what a Government would do if it were trying to capture a “double dividend” from environmental taxation. In practice, therefore, there has been no double dividend from Australia’s carbon tax.

### **Conclusion**

Poor policy processes tend to lead to poor policy outcomes. Australia’s carbon tax experience provides a number of important lessons in how not to go about implementing sensible climate change policy. Although a number of Government reports examined the possible costs of the carbon tax, none of them assessed the incremental net benefits of the policy. For a variety of reasons, it is unlikely that Australia’s carbon tax will achieve “abatement at least cost.” The most significant complementary climate change policies have remained in place after the introduction of the tax, and a range of new, costly measures were introduced to accompany the policy. These factors have weakened—perhaps fatally—the economic case for Australia’s carbon tax.

# I. Introduction

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Australia's carbon tax, which came into effect on July 1, 2012 and is currently set at \$24.15, covers a broad range of industry sectors and categories of carbon dioxide equivalent (CO<sub>2</sub>-e) emissions. The tax is a fixed price emissions permit system, and is legislated to move to a full "cap and trade" or flexible emissions price scheme in 2015, with Australian firms permitted to buy permits from the European Union. The stated purpose of the tax is to reduce Australia's CO<sub>2</sub>-e emissions below projected "business as usual" levels. Slightly less than half of the expected CO<sub>2</sub>-e abatement in the period to 2050 is expected to occur as a result of domestic reductions in emissions, with the most abatement being sourced from purchases of overseas permits.

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**Despite the carbon tax passing the House of Representatives and the Senate and becoming law, political and popular support for the policy has been weak.**

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Despite the carbon tax passing the House of Representatives and the Senate and becoming law, political and popular support for the policy has been weak. Recently the Australian Government has proposed to move earlier towards an internationally linked cap and trade scheme, in July 2014. However, legislation to give effect to this proposed change has not yet been introduced into Parliament. In any case, it is unclear whether such legislation—should it be introduced—would even pass.<sup>4</sup>

As a result, there is a great deal of uncertainty surrounding the future status of the tax. Depending on the outcome of the forthcoming Australian election (which will be held on September 7), the tax may either (i) remain in place and transition to cap and trade in 2015 (as originally planned); or (ii) it may move earlier to a cap and trade scheme in 2014; or (iii) it may be abolished altogether.

This report evaluates the carbon tax in terms of policy process, policy design, and economic outcomes. The report is structured as follows. Section 2 outlines the policy history behind the carbon tax, and some of the legislative background to the current scheme, as well as reviewing some of the basic economic arguments that have been made to justify the introduction of the tax. Section 3 outlines the key economic features of the scheme. Section 4 examines the economic costs of the tax, and explains why it is unlikely that the Australian Government's policy will "achieve abatement at least cost." Section 5 examines the economic and fiscal effects of the carbon tax. Section 6 concludes by outlining the main policy lessons from the Australian experience.

## 2. History of the Carbon Tax

### 2.1. The Shergold Report (2007)

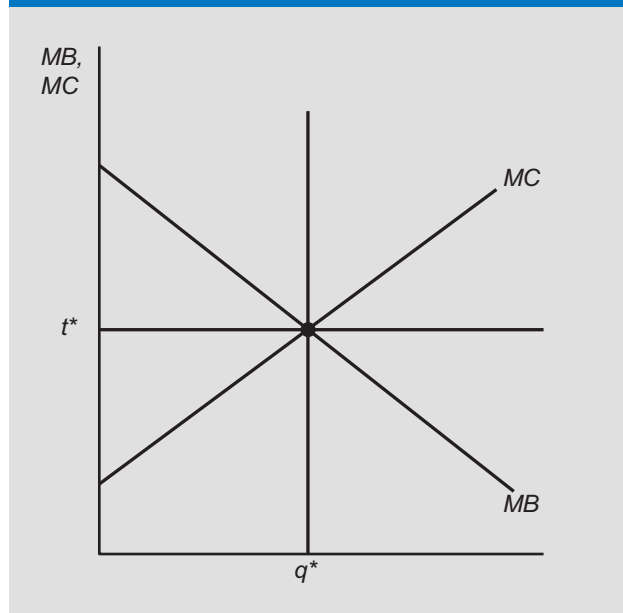
The political history of Australia's carbon tax began with the *Prime Ministerial Task Group on Emissions Trading* (more popularly known as the Shergold Report after its main author), which was released in mid 2007.<sup>5</sup> This Task Group advised “on the nature and design of a workable global emissions trading system in which Australia would be able to participate.” In response to the Shergold report, then Prime Minister John Howard announced on July 17 that a “cap and trade” system would be introduced in Australia. The scheme was planned to be operational possibly in 2011, and no later than 2012.<sup>6</sup>

The Shergold Report appealed to some standard analysis and results from basic welfare economics to justify its recommendation to introduce a cap and trade scheme, arguing that emissions generate external costs and that the market supplies too large a volume of emissions relative to the efficient level. Consider, for example, Figure 2.1 below, which plots the aggregate marginal costs and benefits of abatement in the case where there is complete certainty. Marginal costs here are the aggregate incremental social costs of reducing emissions, including lost output, lower living standards, the cost

of developing new technologies, the cost of geo- and bio-sequestration, and so on. Marginal benefits are the marginal social benefits that might come about as a result of the effect that a lower stock of CO<sub>2</sub>-e in the atmosphere has on global temperatures.

In this diagram  $q^*$  is the socially optimal quantity of abatement—it maximises net social benefits. The standard analysis assumes that in the absence of regulation no abatement would be produced. In such circumstances conventional economic theory argues that under a simple cap and trade scheme, the Government can issue an aggregate number of emissions permits at the desired level of the cap, and then allow firms to trade them so that the total costs of abatement can be minimised.

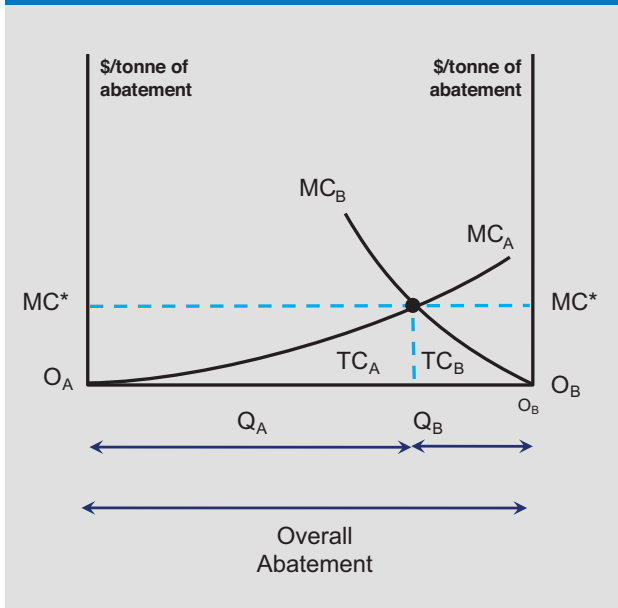
FIGURE 2.1:  
MARGINAL COSTS AND  
BENEFITS OF CO<sub>2</sub>-E ABATEMENT



The basic idea is to create an artificial set of legal rights and obligations and allow those rights to be traded. To illustrate this idea, consider Figure 2.2 below, which plots the marginal cost of abatement for two firms, A and B. In the absence of regulation, it is assumed that firms produce no abatement. Now suppose that the Government sets a target of  $Q_A+Q_B$  tonnes of abatement. It issues emissions permits equal to the difference between the business as usual quantity of emissions and the desired abatement. Suppose that firm B is issued with a sufficiently high amount of emissions permits that it undertakes no abatement, whilst firm A is allocated no emissions permits. In the absence of any trade, B would undertake no abatement, whilst firm A would be forced to reduce its emissions by  $Q_A+Q_B$ . Notice that at this point, the marginal cost of abatement would be higher for A than for B.

Now suppose that A and B can trade these permits. At the point  $O_B$ , the cost of abatement of the last unit

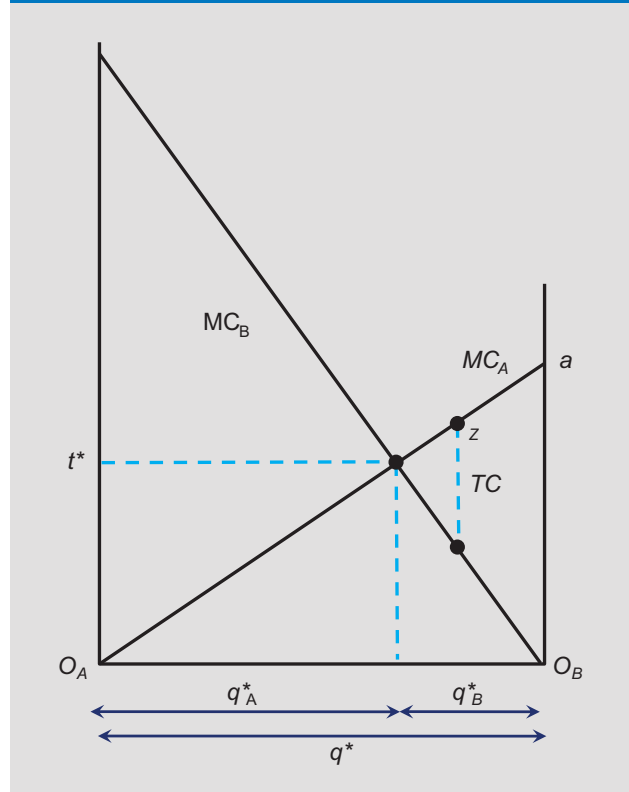
**FIGURE 2.2:  
A CAP AND TRADE SCHEME**



of emissions in industry B is less than the same cost in industry A. Thus B could offer to reduce emissions on A's behalf, in return for A no longer having to do so. This is accomplished by B selling a permit to A at a price less than  $MC_A$  at the point  $O_B$ . Firm A would willingly pay B to do this, and B would willingly accept such a payment in return for abating one tonne of emissions. In other words, at this point there are gains from trade to be exploited. In the absence of transaction costs, permit trades take place until the allocation  $Q_A Q_B$  is reached. At that point, the equilibrium permit price will be  $MC^*$ .

Note that a potential problem with a cap and trade scheme in practice may be the existence of high transactions costs in the permit market, which could exist due to the cost of arranging and negotiating trades, the costs of verifying permits and monitoring abatement activity, and the costs of enforcing the law. For example, consider Figure 2.3 below. Suppose that the initial allocation of permits is at point z. If transactions costs are equal to  $TC$  or higher, then no trade will take place, because the price that B is willing to accept plus transactions costs is equal to the price that A is willing to pay at that point. No gains from trade can be exploited because of the existence of transactions costs, and a cap and trade scheme fails to minimise the costs of abatement. If a

**FIGURE 2.3:  
TRANSACTION COSTS  
IN A CAP AND TRADE SCHEME**



firm has market power in the permit market then costs will also fail to be minimised, for similar reasons.

The possibility that high transaction costs or market may emerge as issues in a future Australian permit market have never been seriously considered by Australian policymakers. Instead, the Shergold Report argued that free trade in permits would minimise the total costs of abatement, but without asking what the appropriate level of abatement actually was. The Report also argued that a cap and trade scheme was preferable to a carbon tax, because cap and trade focuses "on the ultimate environmental objective—namely, reducing emissions to a point that mitigates the effects of climate change" and that there would be more opportunities to link with other markets under a cap and trade scheme.<sup>7</sup>

## 2.2. The Garnaut Report (2008) and the Carbon Pollution Reduction Scheme (CPRS) (2009)

Prior to the election of the new Labor Government in late 2007 (whose policy platform included the introduction of a cap and trade scheme), Professor Ross Garnaut of the University of Melbourne was commissioned by the then Leader of the Opposition (and current Prime Minister), Mr Kevin Rudd, to report to Australia's Federal and State Governments on "the possible ameliorating effects of international policy reform on climate change, and the costs and benefits of various international and Australian policy interventions on Australian economic activity."<sup>8</sup> Professor Garnaut's report argued that "a well-designed emissions trading scheme has important advantages over other forms of policy intervention." However, the report also argued that a carbon tax would be "better than a heavily compromised emissions trading scheme."<sup>9</sup> The Garnaut Review proposed a policy similar to the one that was eventually adopted: a cap and trade scheme with a short transition phase in which emissions permits would be sold by the Government at a fixed price, rather than being freely auctioned.

In July 2008 the Australian Government released a green paper<sup>10</sup> on a proposed "Carbon Pollution Reduction Scheme" (CPRS), which outlined the major issues surrounding the establishment of a cap and trade system in Australia. The Government responded in December 2008 with a white paper entitled "Australia's Low Pollution Future" (ALPF).<sup>11</sup> This report committed the Australian Government to an unconditional reduction in CO<sub>2</sub>-e emissions of at least 5 per cent below 2000 levels by 2020, as well as a long-term emissions reduction target of 60 per cent below 2000 levels by 2050. It also proposed a cap and trade scheme for Australia, to begin on July 1, 2010, and was accompanied by a summary of the results of economic modeling by the Treasury Department of some of the costs of such a scheme.<sup>12</sup>

Following this series of reports, the Government introduced the Carbon Pollution Reduction Scheme (CPRS) Bill (2009) on May 14 2009. The CPRS proposal was for an initial fixed auction price (which is effectively a carbon tax) of \$10 per tonne beginning in July 2011, transitioning to a full cap and trade scheme from July 2012. The CPRS passed the House of Representatives on June 4, but failed to pass the Senate. A second CPRS Bill passed through the

House of Representatives on November 16, 2009, but again failed to pass the Senate. Finally, a third CPRS Bill was introduced on February 2, 2010 and again passed the House of Representatives. However, on April 26, 2010 Prime Minister Rudd announced that the Government would delay the introduction of any scheme until the end of 2012, and the carbon tax moved off the Government's legislative agenda. The 2010 Bill then lapsed in the Senate due to the calling of the 2010 Australian general election.

During the 2010 election campaign the Government promised that should it win the election it would not introduce a carbon tax in its next three year term.<sup>13</sup> Instead, it proposed a number of alternative policies including a "Citizens' Assembly" which would spend 12 months examining the evidence on climate change, the case for action and the consequences of putting a price on CO<sub>2</sub>-e emissions.<sup>14</sup> However, the Government soon reneged on this promise. Following the 2010 election the Australian Labor Party formed a minority government with the Greens and some independents, and the Government established a Multi-Party Climate Change Committee to investigate "options for implementing a carbon price and to help build consensus on how Australia will tackle climate change."<sup>15</sup> The legislative and regulatory framework of the current tax, together with its design features, emerged from this committee.

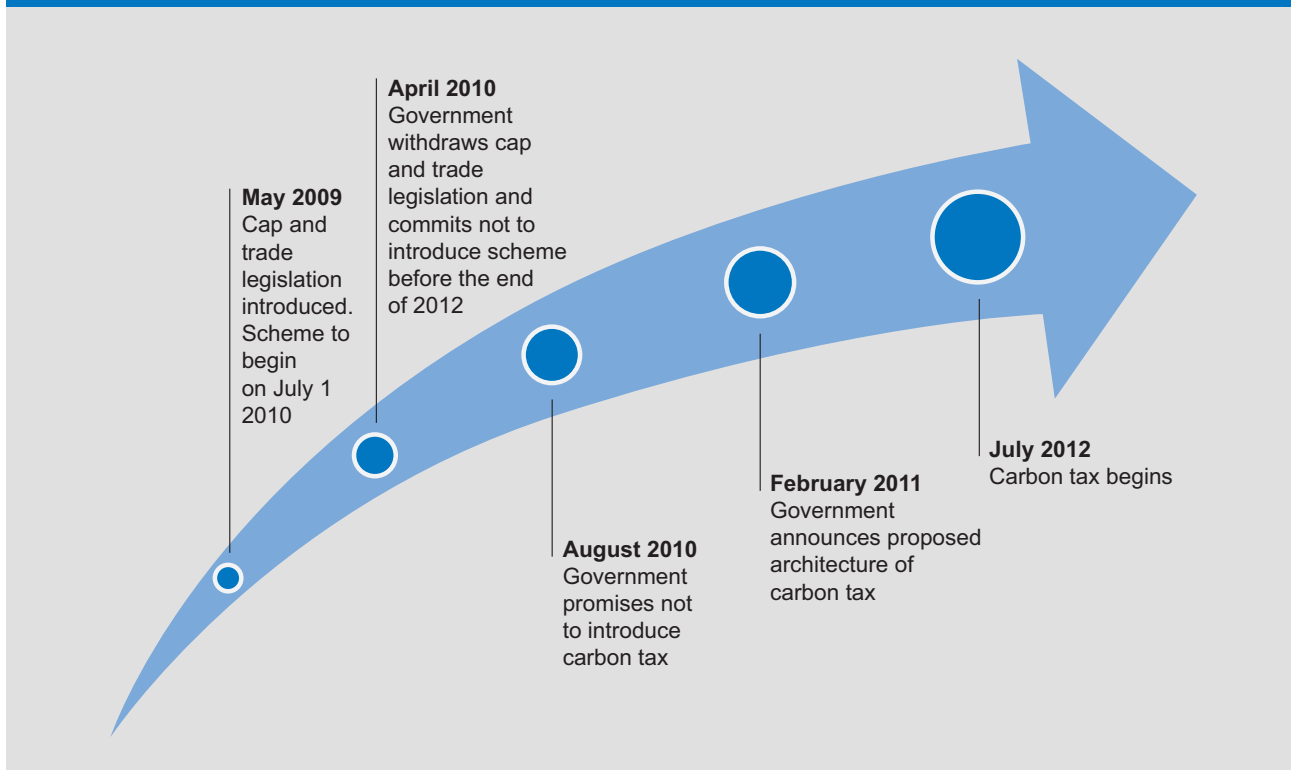
Figure 2.4 summarises the legislative history of the CPRS scheme and how it evolved to take the form of the current tax.

The Australian public opposed the carbon tax at the time of its introduction. For example, a Morgan Poll on July 19, 2011 found that:<sup>16</sup>

- A majority of Australians (62%) agreed that "The carbon tax will have no significant impact on reducing the total world-wide volume of carbon dioxide put into the atmosphere" (34% disagreed).
- An overwhelming majority of Australians (75%) disagreed that "The \$23 a tonne carbon price should be higher" while only 15% agreed that it should be higher.
- A majority of Australians agreed that "We should not have carbon tax until China and the USA have a similar tax."



FIGURE 2.4:  
SUMMARY OF THE LEGISLATIVE HISTORY OF THE CARBON TAX



- A plurality of Australians (49 per cent) disagreed with the statement that “The carbon tax is a good first step towards a market-based price on carbon.”

### 2.3. Carbon Taxes versus Cap and Trade Schemes: The Standard Treatment in the Literature

As in earlier reports, the Government has appealed to some basic economic principles to argue its case for the carbon tax. Consider again Figure 2.2. If the Government has perfect information, a carbon tax of  $t^*$  per tonne (which allows the market to determine the quantity of emissions) can in principle be used to achieve exactly the same outcome as a cap and trade scheme in which permits are auctioned (and the market determines the price of a ton of emissions). At the point  $O_B$ , for example, firm B it is not abating at all, and pays a tax of  $t^*$  on all units of emissions. But if B had abated one tonne of emissions, its tax bill would be reduced by the tax cost of one tonne. Since the marginal cost of abatement is less than the tax for the first tonne, it has an economic incentive to abate this first tonne. Such an abatement incentive remains

up until the point at which B reduces emissions by  $q_B$ . The same argument applies to industry A. At a tax or carbon price of  $t^*$ , industry A has an incentive to abate exactly  $q_A$  tonnes.

However, although with perfect information a carbon tax can be equivalent to a cap and trade scheme, in reality of course policymakers do *not* have perfect information. Yet neither the Shergold Report nor subsequent reports discussed in any great detail why a cap and trade scheme might be preferable to a carbon tax (or vice versa), or whether either of these is preferable to direct “command and control” mechanisms. Moreover, policymakers didn’t attempt to show that their recommended “solution” was better than the status quo, because they failed to conduct an accurate assessment of the *marginal* benefits and costs of their proposals relative to a plausible baseline in which Australian firms and households adapted to possible future climate change.

To see the importance of the (implicit) perfect information assumption, note that in Figure 2.2, if the

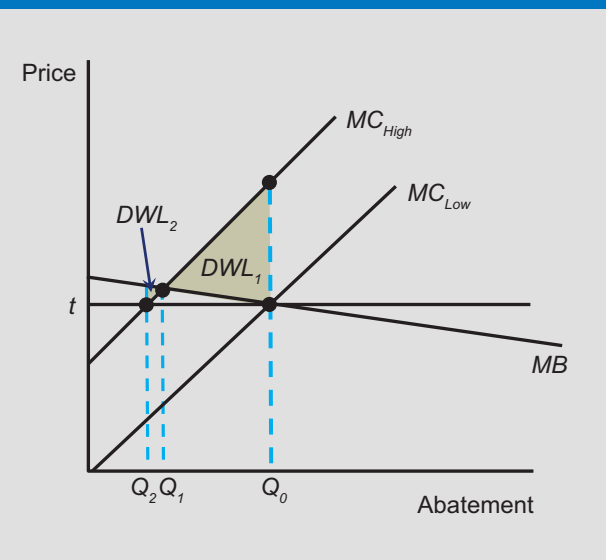
government has complete information and knows that  $q^*$  is efficient, direct command and control policies can achieve an identical outcome to a tax or a cap and trade scheme. If the government knew what the individual marginal cost curves looked like, it could simply force industry A to reduce its emissions by  $q_A$  units, and force industry B to reduce its emissions by  $q_B$  units. In other words, under conditions of complete policy certainty and perfect knowledge, an appropriately chosen carbon tax has the same outcome and welfare properties as both command and control and a cap and trade scheme.

The textbook analytical case for preferring a carbon tax or a cap and trade scheme over alternatives therefore rests on the superiority of those instruments in an environment in which policymakers have imperfect information. However, in such an environment the optimal policy choice is far from clear—information about the marginal benefits of abatement is needed to make a full determination. In a static setting, a cap and trade scheme may indeed minimise the costs of abatement for a give target of emissions reduction, but those costs may still exceed the benefits of achieving that target. Only a full cost benefit analysis can determine which policy is appropriate. Unfortunately, such an analysis has never been completed for Australia.

A standard result in the literature states that in the absence of international permit trading, if the marginal cost of abatement curve is very steep and the marginal benefit of abatement curve is relatively flat, then a carbon tax or fixed price scheme is preferred on the grounds that it has a lower expected deadweight loss. The intuition behind this result is as follows. Consider Figure 2.5, which is based on McKibbin and Wilcoxon (2002) and which plots the marginal social costs and marginal social benefits of abatement. Suppose that marginal benefits are known but that marginal costs are unknown but are believed to be  $MC_{Low}$ . Under this belief, the efficient quantity of abatement is  $Q_0$ . Suppose that the government has two choices: a cap and trade system which either auctions  $Q_0$  emissions permits (or allocates them freely to firms); or a carbon tax of  $t$ .

If costs actually turn out to be  $MC_{Low}$ , then both policies are equivalent and are efficient. However, if marginal costs actually turn out to be high ( $MC_{High}$ ) then the efficient quantity *ex post* turns out to be  $Q_1$ . But the cap and trade system—which fixes aggregate

**FIGURE 2.5:  
EFFICIENCY LOSSES FROM A  
CARBON TAX AND A CAP AND  
TRADE SCHEME WHEN MARGINAL  
COSTS ARE UNEXPECTEDLY HIGH**



emissions at  $Q_0$ —results in a very high price and a large welfare loss triangle of  $DWL_1$ . The reason for this welfare loss is simple: if marginal costs of abatement turn out to be high then efficiency requires that less abatement actually takes place than what was initially planned—but that cannot occur under the cap and trade system in which the aggregate quantity is fixed.

On the other hand, a fixed emissions price or carbon tax performs much better in this scenario. If marginal abatement costs turn out to be high, then the tax allows less abatement to occur, which is what is required. In Figure 2.5 if the tax is set at  $t$  and marginal costs turn out to be  $MC_{High}$  instead of  $MC_{Low}$ , then the aggregate emissions abatement is equal to  $Q_2$ , which is lower than the efficient level. Despite this, the welfare loss is relatively small (it is equal to the small triangle marked  $DWL_2$ ) because large costs are avoided whilst only small benefits are foregone. Under a carbon tax it is very unlikely that a fixed target will be met—but not meeting a target is an advantage, not a disadvantage. The point is that under these conditions, the economic consequences of not meeting a target are relatively small, whereas the economic consequences of fixing a target and

meeting it no matter what the cost could be quite severe. If marginal costs are rising steeply and are uncertain, it makes little economic sense to try to hit a precise target. Indeed, the more precise the target, the more costly the scheme is likely to be.

If the marginal benefit curve is steep, then the best policy would be to implement a policy that mimics such a curve. An aggregate fixed abatement target basically looks like a vertical marginal benefit curve and so is a better instrument in this case. Under those circumstances, hitting a target is desirable on economic grounds, not just because hitting a target is a good idea in itself.

Hence, the standard results in the literature are that:

- A carbon tax or cap and trade scheme with a price ceiling is preferred in circumstances where the marginal benefit curve is relatively flat and the marginal cost curve is relatively steep.
- A cap and trade scheme is preferred in circumstances where the marginal benefit curve is relatively steep and the marginal cost curve is relatively flat.

The basic lesson of this analysis is that the policy tool which more closely resembles the actual social marginal benefit curve will tend to work the best. Knowledge of the shape of the marginal benefit of abatement curve is therefore crucial in being able to decide which instrument is optimal. Most of the literature argues that the marginal benefit curve is relatively flat, for the following reason. There are infinitely many ways in which current emissions can be reduced over time to achieve some given future target for annual emissions. Any current and future benefits of abatement are related to the *stock* of greenhouse gases, whereas the current and future economic costs of abatement are related to *flows* of emissions (or more precisely, how those flows are restricted). This means that as a general proposition, current marginal

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**Under a carbon tax it is very unlikely that a fixed target will be met—but not meeting a target is an advantage, not a disadvantage.**

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costs of abatement are likely to be sensitive to the current rate of emissions reductions, whilst current marginal benefits are likely to be relatively insensitive to current levels of reductions.

All of this means that missing a single annual emissions target has relatively low economic costs in future climate change damages (i.e. low foregone benefits). But the consequences of rigidly fixing a flow target that can then only be achieved by having a high marginal cost of abatement (and therefore a high price under a cap and trade scheme) are potentially quite severe. Therefore, a policy which focuses on the price (e.g. a tax, subsidy or cap and trade scheme with a price ceiling) is likely to be preferable to a policy that rigidly sticks to an aggregate quantity.

*It is important to note, however, that the standard textbook result depends on a critical assumption: that the tax or cap are chosen at their ex-ante efficient levels (i.e. where expected marginal benefits equal expected marginal costs). If the tax or cap differ from these levels, then the welfare ranking can be reversed when any comparison is made. Intuitively, if the tax is set above the point where expected marginal benefits equal expected marginal costs—which could happen, for example, if the tax is retained for raising revenue, as opposed to climate damage mitigation—then there will be an additional, systematic welfare loss that is not caused by imperfect information or uncertainty, and this could offset any additional expected gain that the tax brings about.*

As mentioned earlier, in Australia's case there has never been a full assessment of costs and benefits of a carbon tax or a cap and trade scheme, or indeed any demonstration that either policy is better than the status quo. In particular, there has been no assessment of the likely position or shape of the marginal benefit of abatement curve. Hence, even if policymakers had accepted the standard result in the literature regarding the ranking of the two policy instruments, they lacked the information that would have enabled them to make a judgement about which policy was more desirable, or if either policy in practice (with the attendant rent seeking and other real-world considerations such as the "tax interaction effect," discussed later in this paper) would be better than an alternative approach relying on adaptation.

## 3. Policy Framework and Key Parameters

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### 3.1. Development of the Tax

The Government announced its “Clean Energy Future” (CEF) plan on July 10, 2011. The CEF policy consists of a complex package of 18 different pieces of legislation. Despite popular opposition to the tax, the CEF legislation was introduced into the Australian Parliament on September 13, 2011. The bills passed the House of Representatives (with amendments) on October 12, 2011, and passed the Senate on November 8, 2011. The package became law soon after, receiving Royal Assent on November 18, 2011.

The legislation sets the initial level of the carbon tax, which commenced on July 1, 2012, at \$23 per tonne CO<sub>2</sub>-e. The tax increased to \$24.15 on July 1, 2013, which is nearly four times the current level of the EU permit price.<sup>17</sup> The tax is legislated to rise again to \$25.40 on July 1, 2014. Under the initial policy design, the tax was always designed to transition to a flexible price or cap and trade scheme in July 2015, with permit prices fluctuating with market conditions.<sup>18</sup>

During the fixed price period, permits cannot be traded or banked for future use, but banking is permitted during the flexible price period. The Government expects the permit price to more than double by the end of the next decade, reaching \$57.61 (in 2013 dollars) by 2030. The use of international permits to meet liabilities is not permitted in the fixed price period. During the flexible price period firms may use international permits, subject to certain qualitative and quantitative restrictions. Importantly, until 2020, liable parties must meet at least 50 per cent of their annual liability with domestic permits. This restriction is due to be reviewed by the Climate Change Authority in 2016. The economic effect of the 50 per cent cap on overseas permits during the cap and trade phase is analysed in section 6 below.

In addition to establishing the initial level and coverage of the carbon tax, the CEF legislation establishes two new regulatory agencies:

- The Clean Energy Regulator (CER), whose responsibilities include overseeing the administration of the carbon tax, monitoring compliance and assessing the emissions of individual firms, enforcing payments of the tax, and determining eligibility for free permits, as well as overseeing auctions of permits during the flexible price phase.

- The Climate Change Authority (CCA), whose primary role is to provide advice and recommendations to the Government on important aspects of the carbon pricing mechanism, including future emissions caps. The Clean Energy legislation contains a “poison pill” arrangement in the form of punitive default emissions caps. These default caps are automatically activated if Parliament fails to pass regulations specifying the cap.<sup>19</sup> The CCA was also established to provide advice on the role of the price floor and price ceiling beyond the first three years of the flexible price phase (see section 3.4 below). However, the price floor was abandoned less than two months after the carbon tax became operational.

### 3.2. Coverage: Who Pays?

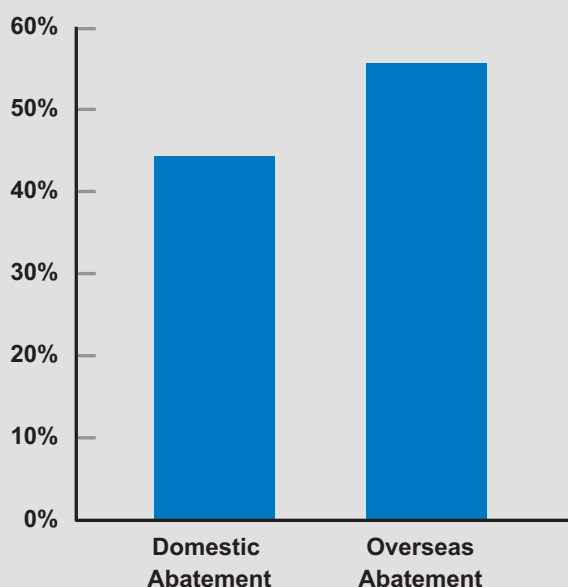
Australia’s carbon tax applies to emissions of carbon dioxide, methane, nitrous oxide and perfluorocarbons from aluminium smelting. A threshold of 25,000 tonnes of CO<sub>2</sub>-e applies for determining whether a production facility is covered by the tax. Liable firms which emit but which do not surrender a permit must pay an emissions charge. The emissions charge in the flexible price period will be double the average price of permits for that year. In terms of sectoral coverage, the Australian scheme is very comprehensive, covering emissions from stationary energy, industrial processes, fugitive emissions (other than from decommissioned coal mines) and emissions from non-legacy waste. Agricultural and

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**Although the carbon tax only directly affects around 370 businesses, the economic incidence is far broader than the narrow legal incidence.**

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**FIGURE 3.1:  
SOURCES OF CUMULATIVE  
ABATEMENT RELATIVE TO  
BUSINESS AS USUAL  
PROJECTIONS, 2013-2050**



SOURCE: SGLP, CHART 5.2

forestry emissions, as well as emissions from the combustion of biofuels and biomass (including CO<sub>2</sub>-e emissions from combustion of methane from landfill facilities) are not covered by the scheme.

Household transportation (i.e. fuel for personal vehicle use) is not directly covered by the scheme.<sup>20</sup> However, as part of the CEF package, the Government imposed an effective carbon tax in relation to off-road business use of diesel fuel by reducing the existing diesel fuel tax credit.<sup>21</sup> The carbon tax will be extended to the fuel used in trucks on July 1, 2014.

Although the carbon tax only directly affects around 370 businesses, the economic incidence is far broader than the narrow legal incidence. As a general rule, the economic incidence of any tax depends on the elasticities of demand and supply in the affected markets, with most of the economic incidence falling on the less elastic side of the market (usually consumers in the case of the carbon tax). If the tax affects the

production of exported goods where prices are determined by conditions in world markets (such as coal-mining), then the incidence of the tax will fall entirely on domestic producers. The carbon tax will therefore adversely affect consumer prices, real wages, investment, and GDP growth. These broader economic effects are examined in section 5 below.

### 3.3. Abatement Target and Sources of Abatement

The CEF plan proposed a carbon tax for three years and aimed for a reduction in emissions of at least 5 per cent compared with 2000 levels by 2020, and a reduction of 80 per cent below 2000 levels by 2050. It is important to note that these emissions reductions targets do not refer purely to domestic reductions or abatement which actually take place within Australia's borders. Under the Government's policy, Australia will only reach its overall target if Australian firms can purchase permits from overseas—in other words, if Australian firms pay businesses in other countries to further reduce their emissions. Under the policy, cumulative abatement relative to business as usual will be 16.7 Gt CO<sub>2</sub>-e by 2050. However, 9.3 Gt or 55.7 per cent of this total abatement is sourced from overseas jurisdictions, rather than domestically (see Figure 3.1). In other words, a significant part of the CEF policy involves Australian taxpayers paying other countries to reduce their emissions. As a result, along the price path that was originally projected by the Government, the purchase of foreign permits will involve a cumulative transfer of around \$75 billion from Australian taxpayers to the rest of the world to 2050.

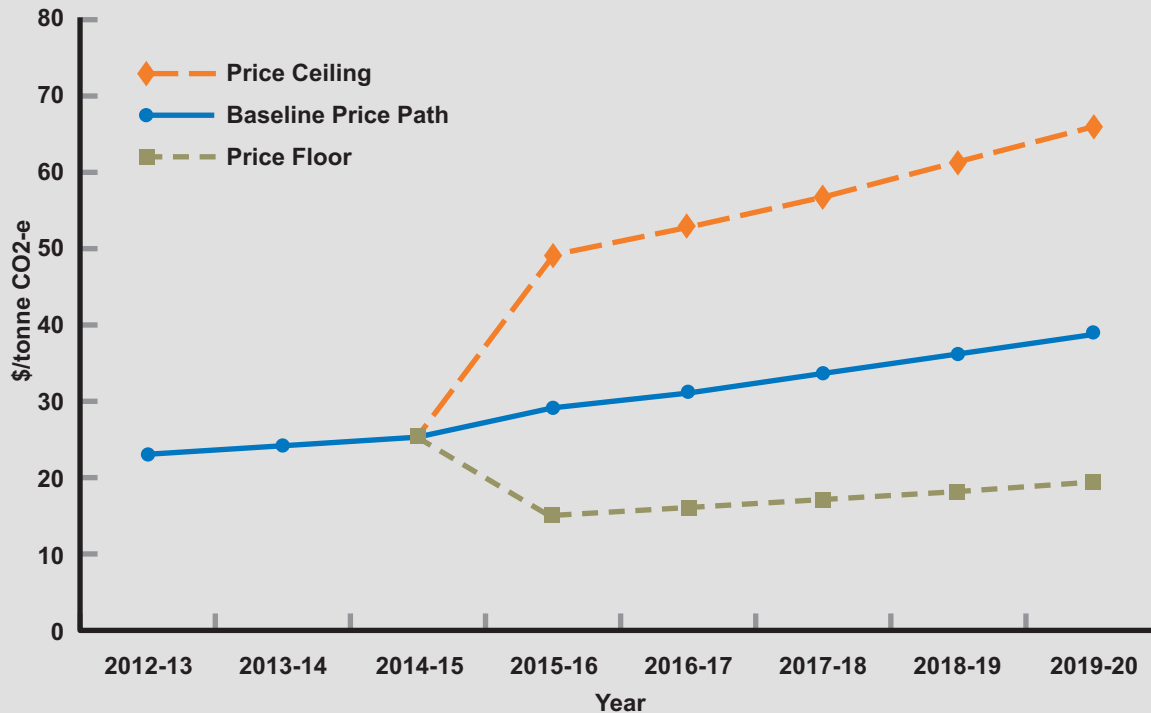
### 3.4. The Price Floor and Price Ceiling

For the first three years of the flexible price period, the Government's original policy added two important institutional features to the planned cap and trade mechanism:

- A price ceiling of \$20 above the expected international price, rising annually by 5 per cent in real terms. Domestic permit prices were not allowed to rise above this price ceiling; and
- A price floor of \$15 rising annually by 4 per cent in real terms. Domestic permit prices were not permitted to fall below this price floor.

The originally anticipated price path, together with the expected floor and ceiling prices, are shown in Figure

**FIGURE 3.2:  
BASELINE PERMIT PRICES, PRICE CEILING PATH  
AND PRICE FLOOR PATH UNDER THE ORIGINAL CEF POLICY**



SOURCE: AUSTRALIAN GOVERNMENT, SECURING A CLEAN ENERGY FUTURE, PAGE 27

3.2. The Government’s original intention was that the price floor and ceiling were to be reviewed by the Climate Change Authority in 2017.

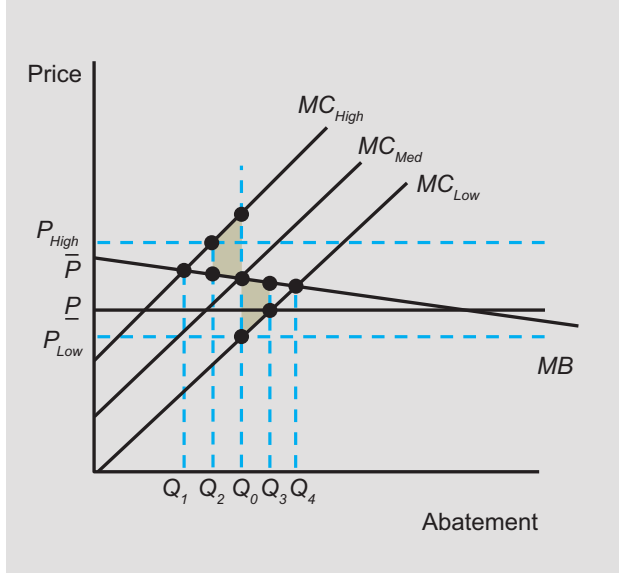
In principle, the introduction of a price cap and floor can improve the expected outcome under a cap and trade scheme. Consider Figure 3.3 which again plots marginal social costs and marginal social benefits of abatement. In this figure the marginal cost of abatement is uncertain. The Government introduces a cap and trade scheme to equate expected marginal benefits with expected marginal costs, and this target is fixed at  $Q_0$ . There is a price floor of  $\underline{P}$  and a price ceiling of  $\bar{P}$ . Under this system, if either the price ceiling or price floor bind, then firms abate up to the point where marginal costs equal the price. If costs turn out to be lower than expected at  $MC_{Low}$ , then  $Q_4$  is efficient. But without a price floor there will still only be abatement of  $Q_0$ , and there is a welfare loss. If the price floor binds, then abatement of  $Q_3$  is

produced and there is a welfare gain of the lower shaded area, relative to the case where there is no price floor.

Similarly, if costs turn out to be higher than expected, then  $Q_1$  is efficient and under a standard cap and trade there would be a deadweight loss. However if there is a binding price ceiling in place, then less abatement ( $Q_2$ ) is produced, and there is a welfare gain of the upper shaded area relative to the case where there is no price ceiling.

The Government’s position on the floor price has never been clear. In 2011 the Government stated that “the floor is designed to reduce the risk of sharp downward movements in the price, which could undermine long-term investment in clean technologies.”<sup>22</sup> However, on August 28, 2012, less than two months after the carbon tax had taken effect, the Government announced that there would not be a

**FIGURE 3.3:  
WELFARE EFFECTS OF A PRICE  
FLOOR AND PRICE CEILING**



price floor after 2015-16, and that there would instead be direct linking with the EU cap and trade scheme. The price ceiling remains in place but it is proposed to end before mid-2018. When the Government announced that it was not proceeding with the floor price and would instead link with the EU scheme, it stated that this would provide “investors with long term certainty on the price of carbon pollution.” In other words, establishing a floor price was supposed to lead to less risk, but *not* establishing a floor price was supposed to provide long term certainty.

### 3.5. Other Policies

#### 3.5.1. Complementary Emissions Reduction Policies

There are a number of other policies at both the Federal and State level which accompany the carbon tax. Most of these policies are intended to achieve the same or similar policy goals as the carbon tax (i.e. reductions in CO<sub>2</sub>-e emissions below business as usual levels). In addition to the large number of subsidies to alternative energy sources (such as solar and wind) that have remained in place after the tax was introduced, the most important “complementary” policies are Australia’s Renewable Energy Target (RET), the Clean Energy Finance Corporation (CEFC), and the Australian Renewable Energy Agency

(ARENA). All of these complementary policies show that the introduction of Australia’s carbon tax was *not* accompanied by the phase-out of inefficient, command-and-control policies, but in fact ushered in *more* of them.

The RET was implemented in August 2009 well before the carbon tax was introduced, and is an extension of the previous Mandatory Renewable Energy Target (MRET), which began under the previous government in 2001. The RET requires that by 2020, 20 per cent of Australia’s electricity must come from renewable sources. As of December 2012, 11.36 per cent of Australia’s annual electricity output in the National Electricity Market<sup>23</sup> is sourced from hydroelectric power and other renewables.

The CEFC is a wholly government-owned entity that will siphon \$10 billion taxpayer funds into renewable energy projects, energy efficiency schemes, and new technologies. The purpose of the CEFC is to provide debt and equity financing to projects which would otherwise not be sufficiently commercial to borrow on their own.

ARENA, which has funding of around \$3 billion, provides financial assistance for “research, development, demonstration, deployment and commercialisation of renewable energy and related technologies”, as well as “storage and sharing of knowledge and information about renewable energy technologies.”<sup>24</sup>

The textbook analysis can be used to show that in the presence of a renewable energy target, a carbon tax or a cap and trade scheme will not lead to abatement at least overall cost. Consider Figure 2.3 again, and suppose that industry A is the renewable energy industry, which due to the presence of a renewable energy target must produce at least  $z$  tonnes of abatement. Then the outcome under a cap and trade scheme will be that the renewable energy industry will produce abatement exactly equal to  $z$ , and marginal costs of abatement fail to equalise across sectors, meaning that the overall cost of abatement is not minimised. Thus, although a textbook case for an “optimal” carbon tax or cap and trade scheme may be made, at least in the case of Australia, policymakers failed to act according to the textbook. The economic effect of these other policy instruments is discussed further in section 4.2 below.

**TABLE 3.1: ALLOCATION OF FREE PERMITS TO EMISSIONS INTENSIVE TRADE EXPOSED INDUSTRIES**

EMISSIONS INTENSITY	FREE PERMITS (% OF ALLOCATIVE BASELINE)
≥2,000 TONNES OF CO <sub>2</sub> -E/MILLION DOLLARS OF REVENUE <u>OR</u> ≥6,000 TONNES OF CO <sub>2</sub> E/MILLION DOLLARS OF VALUE ADDED	94.5
1,000-1,999 TONNES CO <sub>2</sub> E/MILLION DOLLARS OF REVENUE <u>OR</u> 3,000- 5,999 TONNES OF CO <sub>2</sub> E/MILLION DOLLARS OF VALUE ADDED	66

### 3.5.2. Household Compensation

In addition to these complementary measures, the Australian Government made a number of changes to Australia’s personal income tax system in an attempt to compensate households for increases in the cost of living caused by the carbon tax. The Government also increased payments, including pensions and family tax benefits. Although this compensation scheme involved lowering marginal tax rates for some taxpayers, to claw back revenue the Government had to increase marginal rates for around 2 million taxpayers. Furthermore, income tax cuts that were originally scheduled for 2015-16 were subsequently rescinded by the Government. Again, one of the chief arguments in favour of a carbon tax—that its revenues will be used to flatten and simplify the income tax system—did not come to fruition in the case of Australia’s carbon tax. The economics of these income tax changes is discussed further in section 4.2.2 below.

### 3.5.3. Free Permits

The other major component of the carbon tax is the Government’s “Jobs and Competitiveness” program, which allocates free carbon permits to businesses involved in emissions-intensive, trade-exposed industries (EITIs) such as aluminium production, steel manufacturing, pulp and paper manufacturing, glass making, cement production and petroleum refining.

Under this program, the allocation of free permits is determined as follows:

- **Step 1: Determine whether an entity is trade exposed and emissions intensive**

Under the carbon tax, the extent to which an industry is “trade-exposed” is determined by whether exports or imports as a share of the value of domestic production was greater than 10 per cent in either 2004-05, 2005-06, 2006-07 or 2007-08, or if there is a “demonstrated lack of capacity to pass-through costs due to the potential for international competition.” “Emissions intensity” is determined by whether the industry-wide weighted average emissions intensity of an activity is above a threshold of either 1,000 tonnes CO<sub>2</sub>-e per million dollars of revenue or 3,000 tonnes CO<sub>2</sub>-e per million dollars of value added.

- **Step 2: Determine an “allocative baseline” for each firm.**

Allocative baselines are determined by regulation, and take into account historic emissions and production information regarding emissions and production levels in 2006-07 and 2007-08. Baselines will not be updated over time as emissions intensities change.

- **Step 3: Determine the share of the baseline each firm will receive as free permits.**

Under the carbon tax, free permits are allocated according to Table 3.1.

These initial rates will be reduced by 1.3 per cent a year, and are not adjusted for future emissions levels. The economic effect of free permits, effective carbon prices and carbon leakage is discussed in section 5.3 below.



## 4. The Economic Costs of Australia's Carbon Tax

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### 4.1. The Carbon Tax and Australia's Exports

The incremental costs to Australia per tonne of CO<sub>2</sub>-e abatement will likely exceed those of many other advanced economies. One of the contributing factors to this higher cost burden is the fact that exports account for a relatively high share of Australian's GDP, and that these exports are relatively emissions intensive.

To see how the emissions intensity of exports is likely to affect overall costs, note that under standard production-based approaches to measuring emissions reductions, CO<sub>2</sub>-e emissions that are produced within a country (rather than consumed within a country) are counted as part of that country's emissions target under international agreements. Hence, emissions that are created in the process of producing exports are attributed to the exporting country, rather than the importing country.

The consequences for the costs of emissions reductions and trade are straightforward. Countries tend to export goods in which they have a comparative advantage. This means that countries export goods which can be produced at lower opportunity cost, and import goods which they can only produce at relatively high opportunity cost. If a country's exports have a relatively high intensity of emissions, this means that the country has a comparative advantage in production of goods which are relatively carbon intensive.

It follows that in such a country, the opportunity cost of producing low emissions goods must be relatively high. Furthermore, reducing domestic emissions requires reducing production of goods that are currently exported, and switching production to less CO<sub>2</sub>-e emissions intensive goods. The costs of such a switch are likely to be greater for Australia compared to countries which enjoy a comparative advantage in the production of goods which are less emissions intensive.

There have been a number of recent empirical studies of the carbon intensity of production, consumption, exports and imports. The literature has used two basic methodologies:

- **Emissions averaging approach:** This approach takes the emissions intensity of each economy

overall, then examines the exports of each country and assumes that emissions intensity of exports is the same as the rest of the economy. Similarly, the studies examine the country-breakdown of imports from other countries and compute the emissions intensity of those imports.

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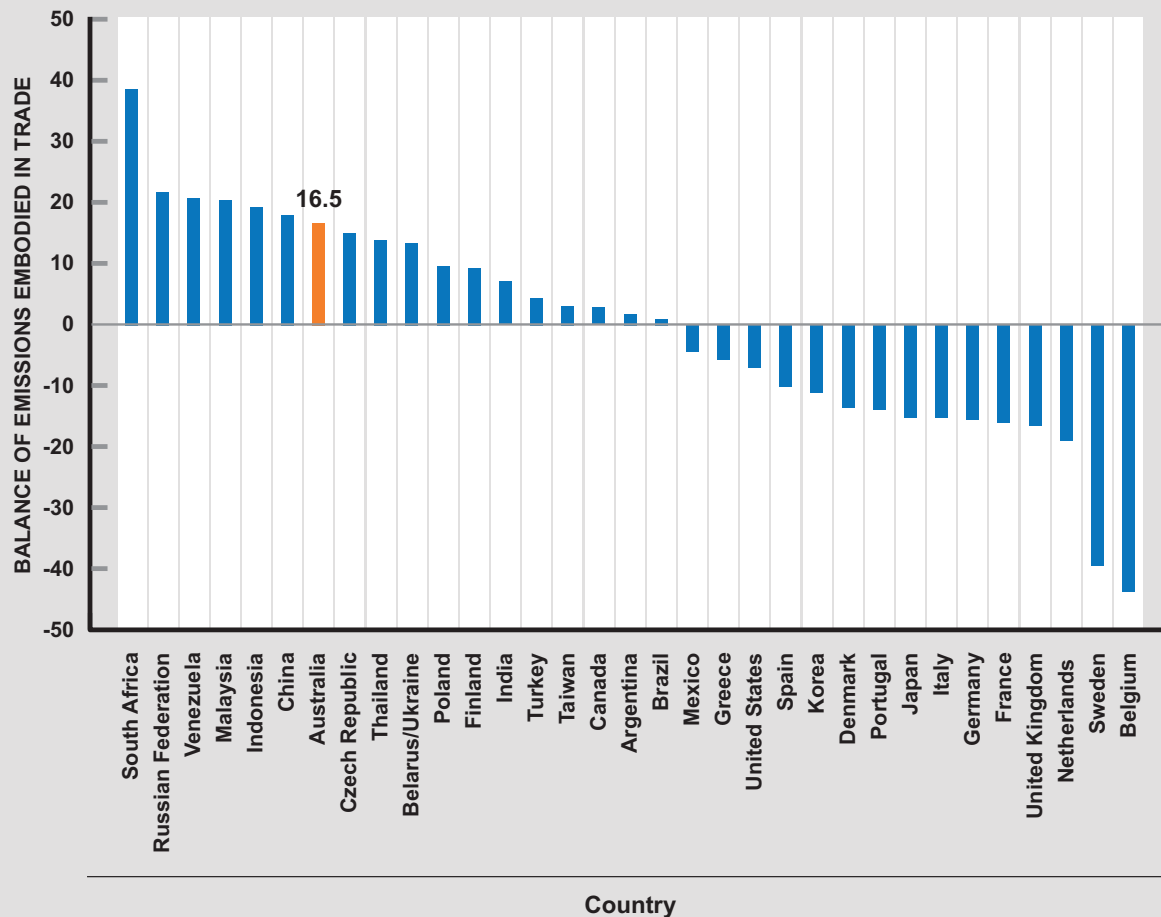
**The consequences for the costs of emissions reductions and trade are straightforward. Countries tend to export goods in which they have a comparative advantage.**

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- **Input-Output Analysis (IOA) approach:** This approach uses input-output analysis at the sectoral level. Input-output analysis is a way of tracking the inputs used by various sectors in the production of final goods, using fixed input coefficients. The IOA approach uses this method to directly compute the inputs used in the production of exports, and then applies an assumed emissions intensity coefficient to those inputs. This estimate is then used to obtain estimates of the emission intensity of exports (EEE), which is computed by dividing the emissions embodied in a country's exports by total emissions produced. The same is done for imports, to obtain the emissions embodied in imports (EEI), which is computed by dividing the emissions embodied in a country's imports by total emissions produced. Finally, the balance of emissions embodied in trade (BEET) is defined as difference between the EEE and the EEI.

Both approaches have advantages and disadvantages. The emissions averaging approach is relatively straightforward, but implicitly assumes that a

FIGURE 4.1:  
PETERS AND HERTWICH (2008) ESTIMATES OF  
THE BALANCE OF EMISSIONS IN TRADE



SOURCE: PETERS AND HERTWICH (2008), PAGE 1404.

country's exports have the same emissions intensity as the rest of the economy, which is not the case in general. The IOA approach is more rigorous and detailed, and does not make the restrictive assumption of the emissions averaging approach. However, it is a less transparent method, and is less straightforward to compute estimates using this approach.

Estimates of the emissions intensity of exports and imports using the emissions averaging approach have been published for some countries, but not for Australia. On the other hand, there are some recent estimates in the literature of the emissions intensity of

exports and imports using the IOA approach. Figure 4.1 below, for example, reports estimates of the BEET computed by Peters and Hertwich (2008) for a range of countries. A positive BEET indicates that a country's exports are relatively more intensive than its imports. In the Peters and Hertwich study, Australia's BEET is measured as:

$$\text{BEET} = \text{EEE} - \text{EEI} = 31.4 - 14.9 = 16.5$$

Peters and Hertwich find that Australia has the highest BEET in the OECD (the next highest OECD country is Poland, with a BEET of 9.4).

Peters and Hertwich (2008) use version 6 of the GTAP modelling database to derive their estimates. Davis and Caldeira (2010) use similar methods and an updated version of the GTAP database to derive estimates for a larger group of countries, including Australia. They find a BEET of 2.1 for Australia, ranking Australia fifth in the OECD behind Poland (9.7), Estonia (8.9), Canada (4.3) and Slovakia (3.2), but well ahead of larger OECD economies such as the US (-12.1), the UK (-45.6), Germany (-28.3), Japan (-21.6) and France (-43.4).

It is often claimed that Australia’s carbon tax will “achieve abatement at least cost.” The argument for the superiority of a cap and trade scheme or carbon tax over more direct abatement mechanisms in a static setting relies on the theoretical analysis presented earlier. However, there has been no direct evidence to demonstrate that this is the case. In reality, there are a number of reasons why it is unlikely that Australia’s carbon tax will achieve this objective. The remainder of this section examines these reasons.

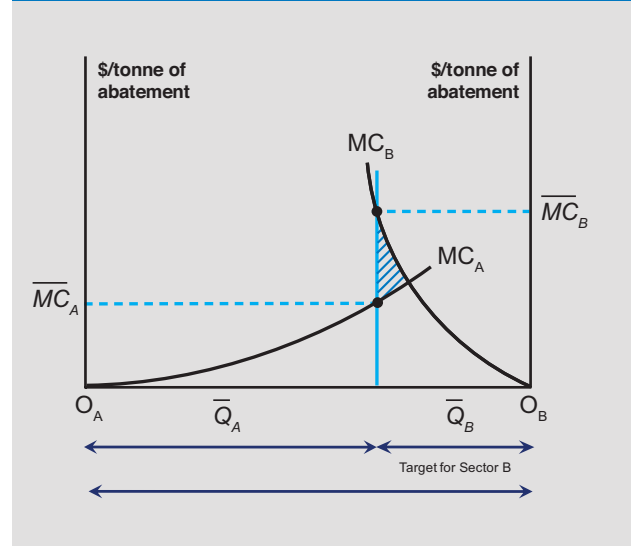
## 4.2. The Interaction Between the Carbon Tax and Other Policies

### 4.2.1. Complementary Emissions Reduction Policies

As discussed in section 2.1 above, the main argument for a carbon tax or cap and trade scheme is that such instruments in principle allow the marginal costs of abatement to be equalised across firms and across sectors, which means that overall abatement is achieved at least cost. Under a carbon tax, equality of marginal costs of abatement is achieved by levying the same tax on each tonne of emissions, no matter where it is produced. Under a cap and trade scheme, equality of marginal costs is achieved by permitting free trade in permits.

The presence of complementary measures such as wind and solar subsidies, the RET, and the Clean Energy Finance Corporation means that achieving such equality of marginal costs is unlikely, if not impossible. Consider, for example, the RET which was discussed in section 3.5.1 above. To understand the costs of this scheme, consider Figure 4.2, where abatement is plotted on the horizontal axis and can be produced in two sectors, A and B. To reach the emissions target,  $Q_A + Q_B$  tonnes of abatement are required. Sector B is the renewable energy sector. Under an undistorted cap and trade scheme, permits

**FIGURE 4.2:  
THE COSTS OF A MANDATORY  
RENEWABLE ENERGY TARGET**

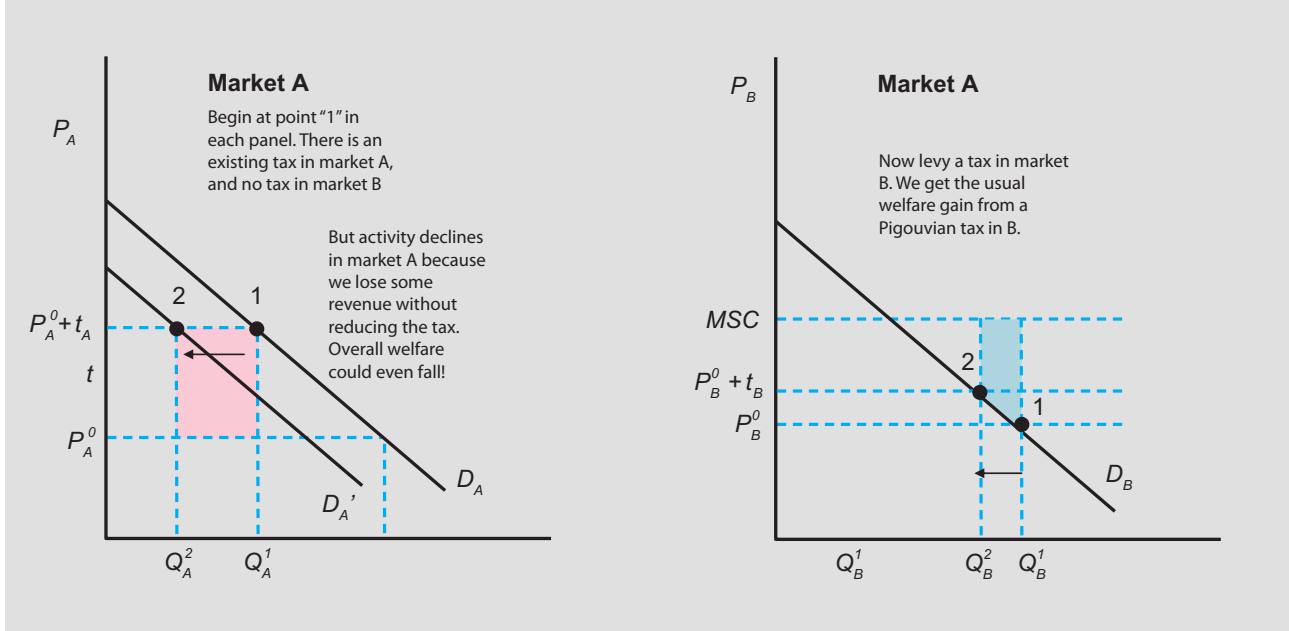


would be traded and the renewable energy sector would produce at the point where marginal abatement costs are equalised. Under a mandatory renewable energy target, however, sector B must produce  $Q_B$  tonnes of abatement. The marginal costs of achieving the last unit of abatement in B exceed the marginal costs of achieving the last unit in A. Hence the marginal costs of abatement are not equalised and abatement is not achieved at least cost. There is a welfare loss equal to the shaded triangle in the diagram. The only way such a scheme could achieve a different outcome is if it either (i) achieved more than  $Q_A + Q_B$  units of abatement, in which case the permit price would be zero (and indeed there would be no need for a cap and trade scheme) or (ii) if transaction costs or some kind of market failure in the permit market prevented trade in permits from achieving the efficient outcome (in which case a cap and trade scheme may also not be desirable).<sup>25</sup>

### 4.2.2. The Effects of Household Assistance and Income Tax Changes

Another common argument for introducing a carbon tax (or a cap and trade scheme in which permits are auctioned by the government) is that tax or permit revenues can be used to reduce existing distortionary taxes, such as personal income taxes. The “double dividend hypothesis” refers to the idea that there may

**FIGURE 4.3:  
THE “TAX INTERACTION EFFECT”: THE WELFARE EFFECTS  
OF A PIGOUVIAN TAX WHEN THERE IS A PRE-EXISTING  
DISTORTION IN A RELATED MARKET**



actually be *two* benefits from environmental taxation: the usual welfare gain that a Pigouvian tax brings about by reducing external costs, and an additional gain which comes about from the reduction in the welfare losses associated with existing taxes. However, it is unlikely that there is a double dividend in the case of Australia’s carbon tax for two reasons: a theoretical reason, and an empirical reason.

To understand why this is the case, we consider Figure 4.3, which models a simple situation in which there are two related markets, A and B, and assumed that A and B are complements. There is an existing distortionary tax of  $t_A$  in market A, and consumption in market B causes a negative externality. Initial consumption and production levels in each market are  $Q_A^1$  and  $Q_B^1$ .

Now introduce a Pigouvian tax in market B. Since the goods are complements, introducing this tax leads to a reduction in the consumption of both goods. Consumption and production fall to  $Q_A^2$  and  $Q_B^2$ , and the tax in B creates a benefit equal to the shaded area in B. However, it also exacerbates the negative welfare effects of the existing tax in market A, leading

to a fall in welfare in that market equal to the shaded rectangle in market A. This is usually referred to in the literature as the “tax interaction effect” and it can partially (or even completely) offset any welfare gain in market B.

A reduction in the tax in market A will simply reduce this exacerbating effect, and so there is no sense in which there are “two” gains from introducing the Pigouvian tax.

The analysis also shows that if there are existing distortions in other markets and the goods are complements, then the optimal Pigouvian tax should be set at a level that is *lower* than the marginal external harm. More formally, letting  $\Delta W_B$  be the change in welfare as a result of imposing the Pigouvian tax  $t_B$ ,  $MSC_0$  be the marginal social cost of activity B, and letting  $p_B^0$  be the initial price in B, we have that the change in welfare in market B is:

$$\Delta W_B = [MSC - (p_B^0 + t_B)] \times -\frac{\partial Q_B}{\partial t_B}$$

where  $\frac{\partial Q_B}{\partial t_B}$  is the slope of the demand curve for good B.

On the other hand, the change in welfare in market A is the change in revenue that occurs in that market, which is not offset by any gain in market A:

$$\Delta W_A = t_A \frac{\partial Q_A}{\partial t_B}$$

where  $\frac{\partial Q_A}{\partial t_B}$  is the shift in the demand for A when the price of B rises.

The optimal (welfare maximising) Pigouvian tax is the one where the marginal welfare gain in market B just equals the marginal welfare loss in market A:

$$\left[ MSC - (p_B^0 + t_B) \right] \times -\frac{\partial Q_B}{\partial t_B} = -t_A \frac{\partial Q_A}{\partial t_B}$$

Rearranging this expression gives:

$$t_B = \underbrace{MSC - p_B^0}_{\text{External harm}} - \underbrace{\frac{t_A \frac{\partial Q_A}{\partial t_B}}{\frac{\partial Q_B}{\partial t_B}}}_{\text{Additional term}}$$

This expression tells us that:

- If there are no distortions in other markets, then the usual Pigouvian rule applies (set tax = marginal external harm);
- If there are existing distortions in other markets and the goods are complements, then the optimal Pigouvian tax should be set at a level that is lower than the marginal external harm; and
- If there are existing distortions in other markets and the goods are substitutes, then the optimal Pigouvian tax should be set at a level that is higher than the marginal external harm.

For Australia's carbon tax the case of complements is the most empirically relevant one—the income tax is the most significant pre-existing tax in the Australian tax system, and activities that the carbon tax effects (such as electricity, fuel, and so on) are

complementary to labour. Hence the likely effect of the carbon tax is that it will decrease labour supply, exacerbating the distortionary effects of the existing income tax system.

Whatever one thinks about the theory of the double dividend hypothesis, actually implementing the idea in practice requires marginal income tax rates to be reduced. As part of the carbon tax policy, the Australian Government made a number of changes to the personal income tax system to compensate for increases in electricity prices and other household costs. However, as section 5.1 below shows, since the carbon tax will reduce GDP below the level it otherwise would have been in every year that it is in place, full compensation for all taxpayers is not possible. Hence average income tax rates remained unchanged for a large number of taxpayers.

Table 4.1 below summarises the changes to statutory and effective marginal tax rates for Australian taxpayers as a result of the changes.<sup>26</sup> As a result of the changes, effective marginal tax rates (EMTRs) fell for those on incomes between \$16,001 and \$20,542 (around 560,000 taxpayers), but increased for those on incomes between \$20,543 and \$30,000, as well as those on incomes between \$37,001 and \$67,000 (a total of around 2.2 million taxpayers). In other words, regardless of the textbook theory, in actual practice whilst average income tax rates for many Australians declined, more Australians saw their marginal income tax rates go up, rather than down, by a ratio of almost 4-to-1.

As Williams (2011) explains, this increase in marginal rates was needed as part of the compensation package because of the revenue cost of the Government's decision to increase the tax free

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**Since the efficiency costs of taxation increase with the square of the tax rate, these changes are likely to have led to significant overall efficiency costs, even taking into account the fact that marginal rates were reduced for some taxpayers.**

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**TABLE 4.1: NEW STATUTORY INCOME TAX RATES, OLD EMTRS AND NEW EMTRS**

INCOME LEVEL	OLD EMTR	NEW STATUTORY RATE	NEW EMTR	CHANGE IN EMTR	APPROXIMATE NUMBER OF TAXPAYERS (MILLION)
\$0-\$16,000	0	0	0	NO CHANGE	0.28
<b>\$16,001-\$18,201</b>	<b>0.15</b>	<b>0</b>	<b>0</b>	<b>FALL BY 0.15</b>	<b>0.28</b>
<b>\$18,201- \$20,542</b>	<b>0.15</b>	<b>0.19</b>	<b>0</b>	<b>FALL BY 0.15</b>	<b>0.28</b>
<b>\$20,543-\$30,000</b>	<b>0.15</b>	<b>0.19</b>	<b>0.19</b>	<b>RISE BY 0.04</b>	<b>1.38</b>
\$30,001- \$37,000	0.19	0.19	0.19	NO CHANGE	1.19
\$37,001- \$67,001	0.34	0.325	0.34	NO CHANGE	3.58
<b>\$67,001- \$80,000</b>	<b>0.3</b>	<b>0.325</b>	<b>0.325</b>	<b>RISE BY 0.025</b>	<b>0.83</b>
\$80,001- \$180,000	0.37	0.37	0.37	NO CHANGE	1.19
>\$180,001	0.45	0.45	0.45	NO CHANGE	0.18

SOURCE: WILLIAMS (2011).

threshold, which reduced marginal rates for some low income earners. To claw back some of the foregone revenue, marginal rates for those on higher incomes had to be increased. Under the carbon tax policy, marginal income rates were increased for those already facing reasonably high tax rates. Since the efficiency costs of taxation increase with the square of the tax rate, these changes are likely to have led to significant overall efficiency costs, even taking into account the fact that marginal rates were reduced for some taxpayers.

*The crucial point is that that this increase in effective marginal tax rates is the exact opposite of what the double dividend theory recommends.* In other words, instead of using the tax system to offset some of the negative welfare effects caused by the interaction between the carbon tax and the personal income tax system, the most likely effect of the Australian Government's income tax changes is that they have actually made things worse and exacerbated the negative effects of those interactions. Moreover, none of these additional costs were taken into account in the Government's modelling of the effects of the tax.

### 4.3. International Linking and Restrictions on International Trade

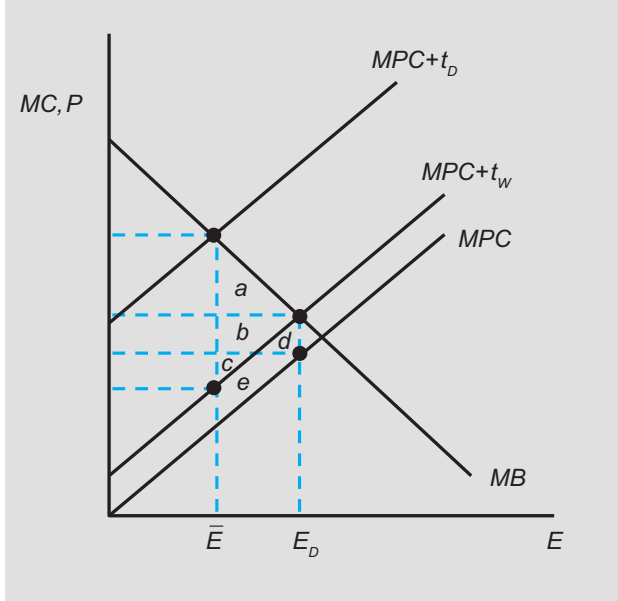
#### 4.3.1. The Gains from International Trade in Permits

The Australian Government has recently proposed moving to a flexible price "cap and trade" scheme a year earlier than originally intended, in 2014. In principle, this may help to achieve abatement at less cost. To see this, consider Figure 4.4 below, which analyses the economic effects of opening up the economy to trade in permits.

The figure plots the marginal private benefits and costs of emissions. Before trade, the domestic tax is  $t_D$  and domestic emissions are  $E$ . Now the economy is permitted to trade permits with the rest of the world, at the world price of  $t_W < t_D$ . The overall emissions target is still  $E$ , but at the world price of  $t_W$  domestic emissions now increase to  $E_D$ . Domestic firms purchase  $E_D - E$  from the rest of the world.

Note that the external costs of emissions are irrelevant here, due to the assumption that the target is fixed and so global emissions are the same before and after the economy opens up to trade. The economic effect

**FIGURE 4.4:  
INTERNATIONAL TRADE IN  
EMISSIONS PERMITS**

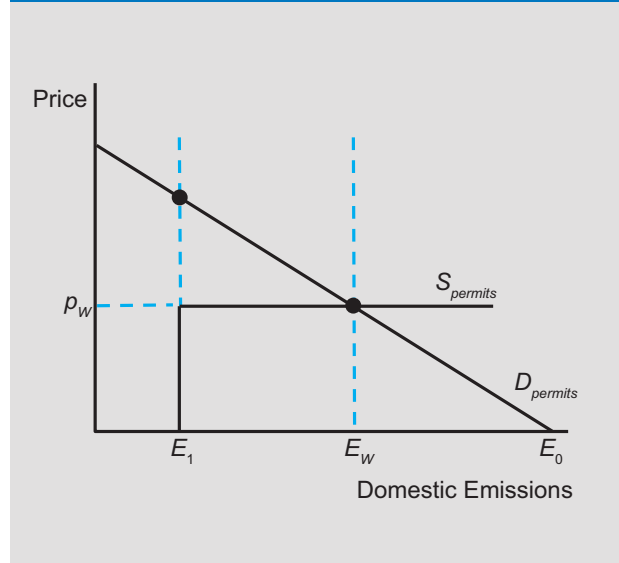


is therefore similar to lowering an ordinary tax, taking into account the fact that part of the revenue is now transferred to foreign firms. The domestic economy gains the area  $a + b + c + d + e$ , which is the usual welfare gain from lowering a tax. There is a transfer to the rest of the world of  $b + d$ . Hence the overall welfare effect is a gain of  $a + c + e$ . Note that by similar triangles,  $b + c = c + e$ , and so the welfare gain is simply 
$$a + b + c = \frac{1}{2}(E_D - \bar{E})(t_D - t_W)$$
, which is

one half multiplied by the difference between the domestic and foreign price, multiplied by the number of foreign permits purchased. Australia's carbon tax in 2014 is scheduled to be \$25.40. In the Government's modelling, there are 15 million tonnes of overseas abatement in 2014. At an EU price of \$6, using the above estimate we obtain a welfare gain from an early move to a link with the EU of \$145.5 million, or less than 0.01 per cent of Australia's expected GDP in that year.

Any estimate of the gains from allowing international trade in permits depends on the assumption that the European Union keeps the same number of permits in circulation. If instead the EU meets the increase in demand for permits by increasing supply, then the welfare gain for Australia would be much lower

**FIGURE 4.5:  
DOMESTIC EMISSIONS  
AND ABATEMENT WITH FREE  
TRADE IN PERMITS**



because there would be less global abatement. If that is the most likely scenario, the optimal policy is simply to lower the carbon tax to the current EU price and not bother linking. Domestic firms emit the same amount as they would under the link to the EU, and global emissions would rise by the same amount as they would if the EU issued more permits. But the Australian government would earn additional revenue.

#### 4.3.2. Constraints on Overseas Permit Purchases

Although there may be gains to Australia from linking to the European scheme, there are a number of reasons why such gains are likely to be smaller than those identified in the previous section. The primary reason is that under the Government's policy, liable entities must meet at least 50 per cent of their annual liability with domestic carbon units. This section examines the effect of this constraint.

To understand the effects of this restriction, we simplify Figure 4.4 in Figure 4.5 by assuming that the marginal private cost of emissions are zero. In this diagram,  $D_{permits}$  is the Australian demand for emissions permits and is derived from the marginal cost of abatement curve. Throughout we assume that the world permit price is  $p_W$  and that this is lower than

the domestic autarky price.

Suppose that Australia's overall emissions target is  $E_1$ . At a world price of  $p_W$ , domestic firms want to emit  $E_W$  i.e. they demand  $E_W$  permits. The government issues  $E_1$  permits, and Australian firms pay overseas firms to reduce their emissions at the world price of  $p_W$ . There is an income transfer from Australia to overseas, equal to  $p_W(E_W - E_1)$ . Australia's domestic abatement is  $E_0 - E_W$ . Foreign abatement is  $E_W - E_1$ . The cost to Australia is the cost of abatement plus the cost of purchasing foreign permits.

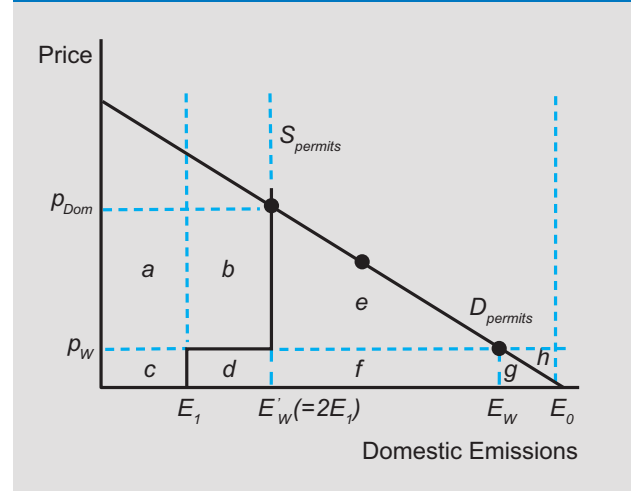
Notice that in the above situation, more than 50 per cent of aggregate emission liabilities are met by purchasing foreign permits ( $E_W$  is more than twice  $E_1$ ). But this is not permitted under Australia's scheme before 2020. Under the CEF policy, liable entities must meet at least 50 per cent of their annual liability with domestic carbon units. The aggregate effect of this constraint is shown in Figure 4.6 below. In this scenario, the Australian government again issues  $E_1$  permits. But domestic firms are now allowed to purchase at most  $E_W' - E_1$  permits from overseas, with  $E_W' = 2E_1$ . The remaining permits must be purchased domestically. This is akin to placing a quota on foreign imports. The restriction means that the supply curve is not flat at the world price, but takes the shape indicated in Figure 4.6.

Domestic firms now emit far less,  $2E_1$  than they would have if there was no restriction on the use of overseas permits. To meet their obligations, they purchase  $E_1$  at a world price of  $p_W$ , and must purchase a further  $E_1$  from domestic sources. The marginal value of a permit at the point  $2E_1$  is  $p_{Dom}$ . If domestic permits are tradeable within Australia, then the price of these permits will be bid up until they reach  $p_{Dom}$  which, when the constraint on foreign permit purchases binds, must exceed the world price of  $p_W$ .

Appendix B shows that the markup of the domestic permit price over the world price will be equal to  $1 - \frac{1}{\varepsilon} \left( 1 - \frac{E_1}{\theta E_W} \right) > 1$ , where  $\varepsilon < 0$  is the elasticity

of domestic demand for permits evaluated at the level of the target,  $E_W$  is the level of domestic emissions at the world price under free trade, and  $\theta$  is the share of annual liabilities that entities must meet with domestic carbon units ( $\theta = 1/2$  under the Australian Government's policy). The elasticity of demand for permits reflects

**FIGURE 4.6:  
DOMESTIC EMISSIONS AND  
ABATEMENT UNDER AUSTRALIA'S  
CEF POLICY TO 2020**



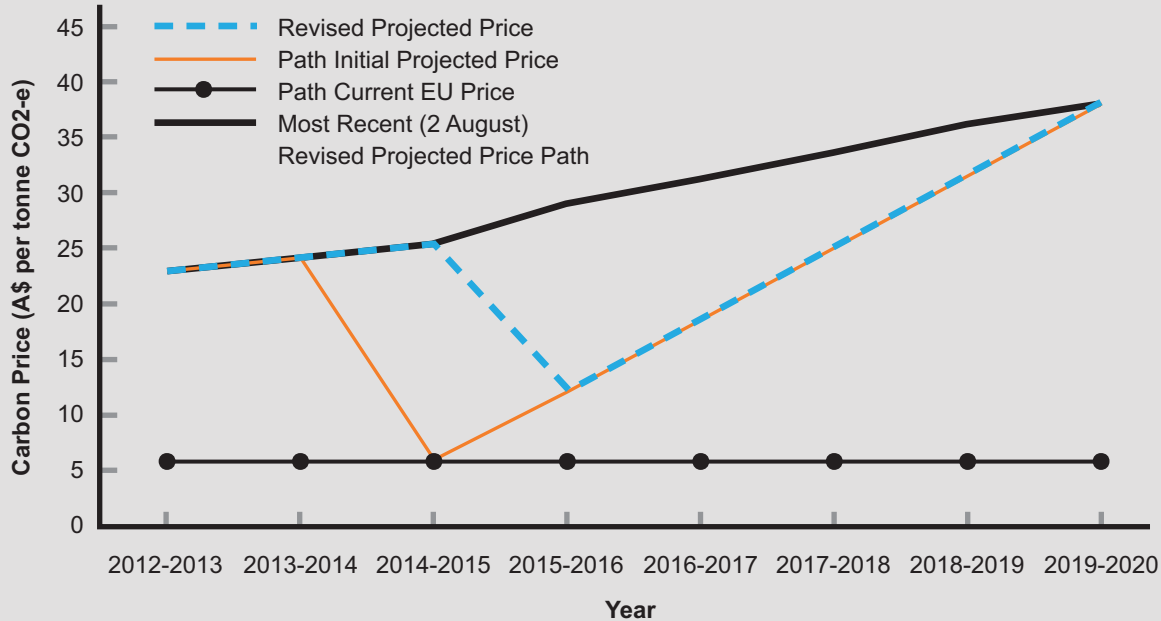
how rapidly marginal costs of abatement rise as abatement increases. The price of a domestically issued must therefore be equal to  $p_{Dom}$ . Domestic abatement is now equal to  $E_0 - E_W' > E_0 - E_W$ . However, compared to a situation in which there are no restrictions on international permit purchases, there is an additional cost of "e" in Figure 4.6. The total cost to Australia is  $e+f+g$ , which is the cost of abating  $(E_0 - E_W')$  plus a payment of "d" to the rest of the world. Global emissions fall by  $E_0 - E_1$ , which is identical to the outcome that would be achieved in the absence of restrictions on international permit purchases. In other words, abatement in the Australian scheme is not achieved at least cost.

In fact, there may be an even less costly abatement option. Consider what would happen if the Australian Government directly purchased  $E_0 - E_1$  permits from the rest of the world at the world price of  $p_W$ , and simply withdraws these permits from circulation (or destroyed them). This has a cost to Australia of  $d+f+g+h$ , which is simply the income transfer to the rest of the world from buying permits. Global emissions again fall by  $E_0 - E_1$ , so there are no other costs or benefits to consider, apart from the costs of raising the revenue needed to purchase the required permits.

In theory, even if the taxes used to raise this revenue were non-distortionary, this option would be more costly than allowing domestic firms to reduce their



FIGURE 4.7:  
CARBON PRICE PROJECTIONS, 2012-13 TO 2019-20



SOURCE: AUSTRALIAN GOVERNMENT BUDGET PAPERS PRE-ELECTION ECONOMIC AND FISCAL OUTLOOK; POINT CARBON.

emissions by  $E_0-E_W$  and then having them purchase overseas  $E_W-E_1$  permits (the difference in costs of the two policies is the area “h” in the diagram). However, in practice that may not be the case. Indeed, using the Government’s estimate of GDP losses from the current carbon tax over the period to 2020 (which are explored in more detail in section 5.1 below), it is possible to show that even if the marginal cost of public funds<sup>27</sup> is as high as 1.4, it would be cheaper for Australia to abandon its carbon tax and instead directly purchase emissions permits from the rest of the world and then withdrew those permits from circulation (i.e. destroy them).<sup>28</sup> Since permits are withdrawn from the EU market, global emissions would fall by exactly the same amount as they would under Australia’s current scheme - the only difference is that Europe would be doing all of the abating rather than the effort being shared between Europe and Australia. This analysis Australia’s carbon tax does not even pass a cost-effectiveness test, let alone a more stringent cost-benefit test.

#### 4.4. Dynamic (In)efficiency

Another important reason why Australia’s carbon tax is

unlikely to achieve abatement at least cost is due to intertemporal considerations: if a carbon tax is set at an inappropriate level over time, then it can fail to achieve abatement at least cost in a dynamic setting. The Australian Government’s carbon tax modelling initially assumed that the permit price would rise at the real rate of interest, in accordance with a simple version of the Hotelling (1931) rule, which is derived in Appendix C. Intuitively, along an optimal abatement path the present value of the marginal cost of abatement should be constant, otherwise abatement could be reallocated across time and a cost saving could be made. Since competition in the permit market should force price down to marginal cost, this means that prices should grow at the real interest rate.

**But despite earlier modelling which assumed otherwise, recently revised permit price projections in the Government Budget documents (shown in Figure 4.7) shows that Australia’s carbon price is not expected to rise at the real rate of interest. Hence, according to the simple Hotelling rule, it cannot be the case that the carbon tax is minimising the cost of achieving a given fixed abatement target. In other words, there is no evidence that the carbon tax will “achieve abatement at least cost” over time.**

## 5. Economic and Fiscal Effects

### 5.1. Gross Domestic Product (GDP) Losses

Because the carbon tax has only been in place for just over 12 months, it is difficult to determine with any great deal of precision the effect that it has had on macroeconomic outcomes such as GDP and unemployment. Although there is mounting anecdotal evidence regarding the economic losses caused by the tax (see section 5.3 below), and although the Australian Government has recently revised down its official forecasts of economic growth over the near term, there is not enough data to undertake a formal statistical analysis of the tax's macroeconomic effects.

A number of earlier analyses of the tax suggest that it is likely to create significant economic costs. For example, McKibbin et al (2010) use the G-Cubed model to estimate the macroeconomic effects of the commitments made under the Copenhagen Accord of late 2009. The results, which are summarised in Table 5.1 below, show that the annual costs to GDP for Australia under the Copenhagen Accord will be 6.3 per cent by 2020, which is much higher than the costs incurred by major economies included in the study, even though Australia's Copenhagen commitment is relatively modest by comparison.

The bulk of the costs of Australia's carbon tax are expected to be incurred over the medium to long term rather than in the short term. Modelling of the economic effects of the carbon tax by the Australian

Government suggests that the carbon tax will permanently reduce GDP below what it otherwise would have been in every year that it is in place, with these costs growing over time. Although the reductions in annual growth appear to be relatively small when viewed in isolation, the value of the sum of these costs expressed in today's dollars is likely to be significant.

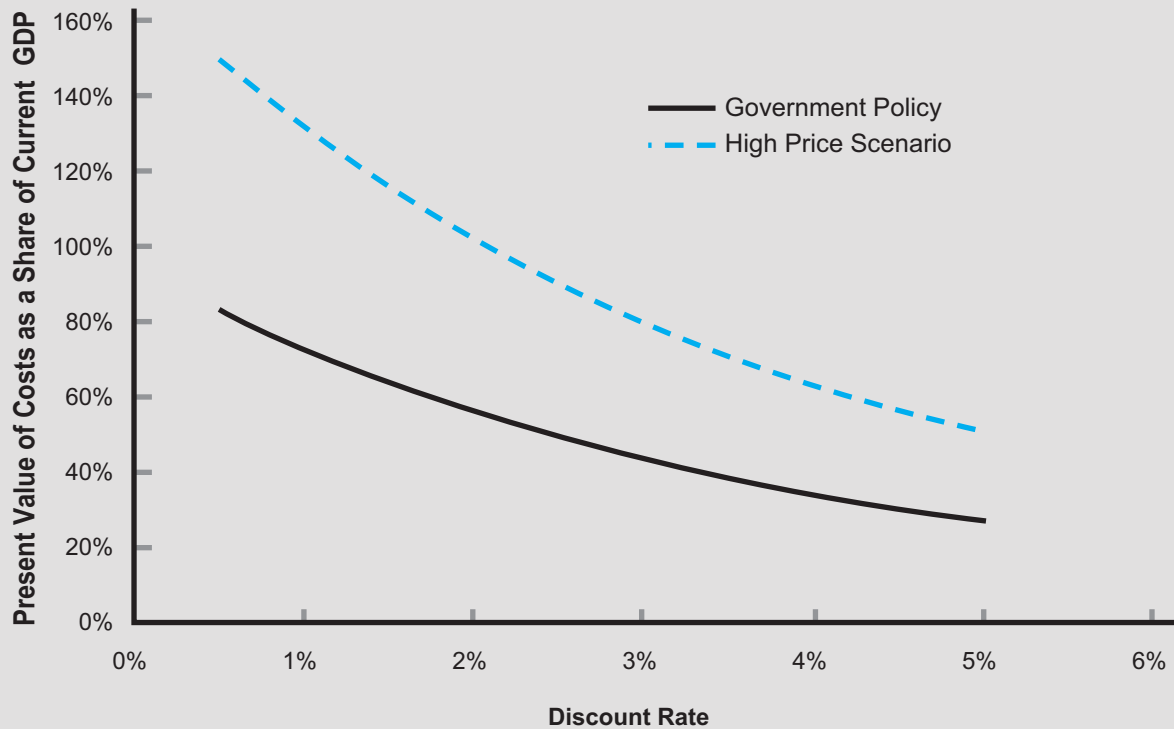
These Government modelling exercises, which have been examined in detail elsewhere,<sup>29</sup> make a number of unrealistic assumptions and as a result are likely to underestimate the costs of Australia's carbon tax. The main reasons for this are as follows. First, the baseline against which costs are measured assume that the rest of the world takes similar action to Australia. This is unrealistic for a number of reasons,

**TABLE 5.1: ESTIMATED GDP COSTS OF POLICY COMMITMENTS UNDER THE COPENHAGEN**

COUNTRY/REGION	POLICY COMMITMENT	GDP LOSS IN 2020
UNITED STATES	-15% ON 2000 LEVELS BY 2020	-2.7%
JAPAN	-37% ON 2000 LEVELS BY 2020	-5.1%
AUSTRALIA	<b>-5% ON 2000 LEVELS BY 2020</b>	<b>-6.3%</b>
EUROPE	-24% ON 2000 LEVELS BY 2020	-4.9%
CHINA	+350% ON 2000 LEVELS BY 2020	-3.7%
OPEC	+105% ON 2000 LEVELS BY 2020	-5.9%
WORLD	+70% ON 2001 LEVELS BY 2020	-3.2%

SOURCE: MCKIBBIN ET AL (2010)

**FIGURE 5.1:  
PRESENT VALUE OF PROJECTED ECONOMIC COSTS  
OF AUSTRALIA'S CARBON TAX TO 2050**



SOURCE: STRONG GROWTH, LOW POLLUTION; AUTHOR'S OWN CALCULATIONS.

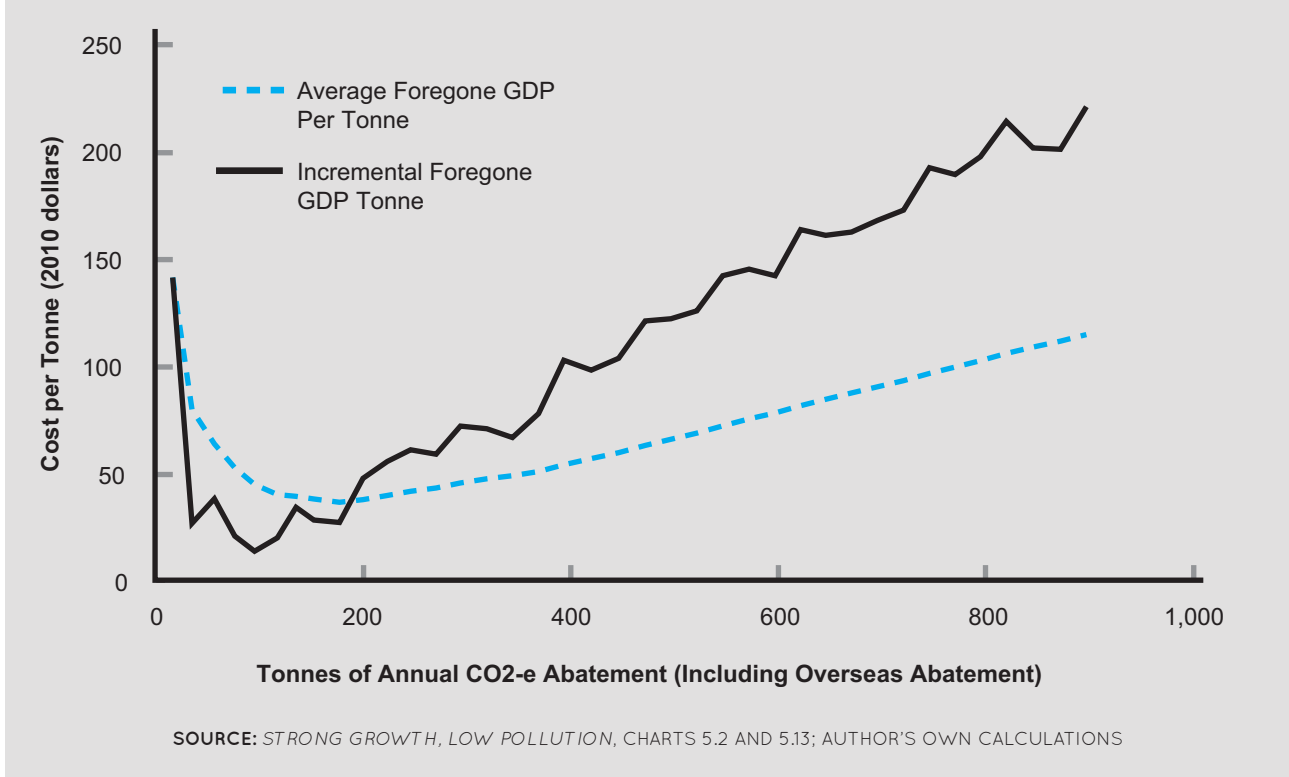
not the least of which is that no other country currently has an economy-wide carbon tax as high as Australia's. Second, the modelling also assumes away a number of costs, such as those associated with the distortions caused by the income tax changes accompanying the scheme (which are analysed in section 4.2.2 above), as well as the costs associated with carbon leakage, which are analysed in section 5.3 below.

Nevertheless, the Australian Government's modelling output can be used to indicate the rough magnitude of the GDP costs of introducing the carbon tax. The models estimate GDP over time with and without the carbon tax, in various policy scenarios out to the year 2050. Two scenarios are particularly relevant: the government's policy, and a "high price" scenario. The government policy scenario assumes a global target of 550 CO<sub>2</sub>-e parts per million, with an Australian emission target of a 5 per cent cut on 2000 levels by

2020 and an 80 per cent cut by 2050. It also assumes a nominal domestic starting price of A\$23 in 2012-13, rising at a real rate of 5 per cent per year, before moving to a flexible world price of \$29 in 2015-16. The high price scenario, on the other hand, assumes a global target of 450 ppm, with an Australian emission target of a 25 per cent cut on 2000 levels by 2020 and an 80 per cent cut by 2050. The starting price is assumed to be \$30 in 2012-13, again rising at a real rate of 5 per cent, to be around \$61 in 2015-16.

In each scenario GDP is estimated to be lower than it otherwise would have been. As is standard in cost-benefit analysis, the costs of the policy in each scenario can be computed as the discounted present value of the sum of the foregone GDP each year in the future.<sup>30</sup> The results of these calculations are shown in Figure 5.1 for various discount rates, which are used to convert the value of a dollar tomorrow to the value of a dollar today so that consistent comparisons can

**FIGURE 5.2:  
AVERAGE AND INCREMENTAL COSTS OF ABATEMENT,  
RELATIVE TO BUSINESS AS USUAL EMISSIONS**



be made. The figure plots the discounted present value of costs relative to Australia’s current GDP, using a range of discount rates between 0.5 per cent and 5 per cent.

There is a debate in the economics literature about the appropriate discount rate to use in cost-benefit analysis. On the one hand, Stern (2004) and Garnaut (2008) use relatively low discount rates, i.e. that the value of a dollar tomorrow is very close to its value today. On the other hand, Nordhaus (2007) uses a higher discount rate.<sup>31</sup> As Figure 5.1 shows, since the costs of the carbon tax increase over time, choosing a lower discount rate translates into higher present value of costs.

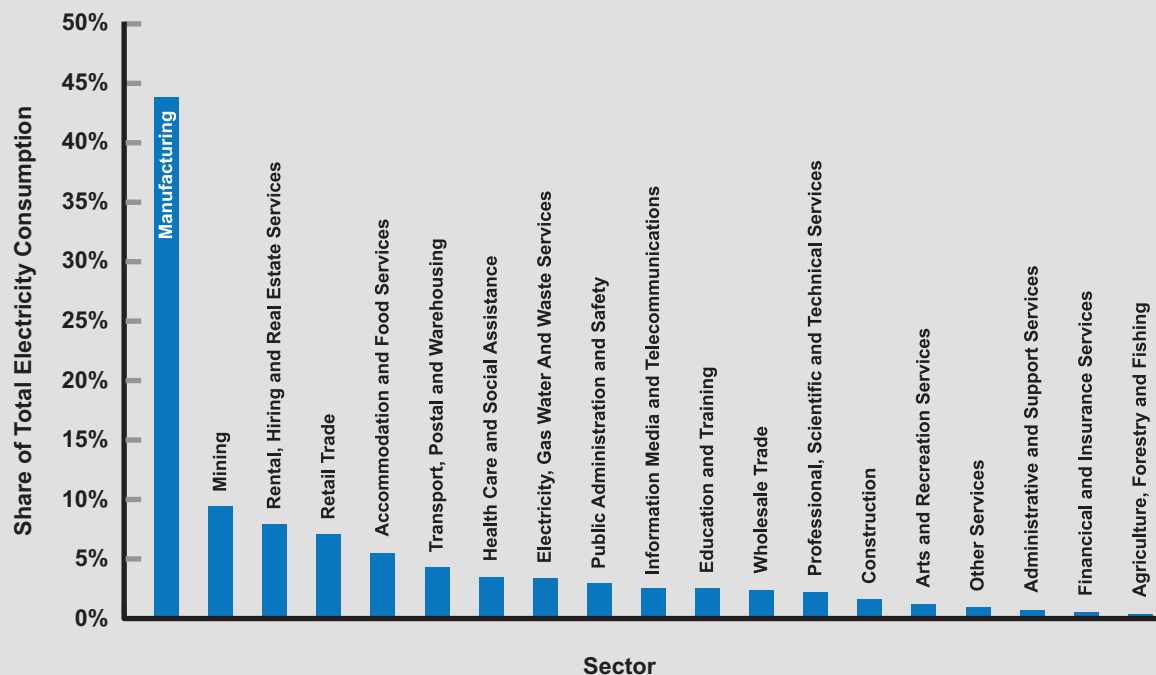
The results show that depending on the discount rate used, the present value of the costs in the government policy scenario could be anywhere between 27 per cent and 83 per cent of current Australian GDP<sup>32</sup>, or between \$405 billion and \$1.25 trillion in the

government policy scenario. For example, using a discount rate of 1.4 per cent (used by Professor Garnaut on page 270 of his final report), we can conclude that in present value terms, the cost of the carbon tax is 65.4 per cent of current GDP in the government policy scenario (\$981 billion), and 118.5 per cent of current GDP (1.78 trillion) in the high price scenario.

### 5.2. GDP Costs per Tonne of Abatement

It is also possible to use the Government’s modelling results to estimate the marginal and average GDP cost per tonne of abatement. For example, under the carbon tax, Australia is projected to achieve a cumulative reduction (inclusive of the purchase of overseas permits, relative to business as usual) of 681Mt CO<sub>2</sub>-e. But the cumulative GDP cost to 2020 of achieving this abatement, relative to business as usual, is \$33 billion in 2010 dollars. In other words, between 2013 and 2020 there is an average GDP loss

**FIGURE 5.3:  
SECTORAL SHARES OF TOTAL BUSINESS ELECTRICITY USE, 2011-12**



SOURCE: ABS.

of \$48 dollars for each tonne of abatement (more than half of which is sourced from overseas), with costs as high as \$142 per tonne in 2013. In other words, the economic cost of the carbon tax in terms of lost GDP per tonne far exceeds the headline carbon price.<sup>33</sup>

Figure 5.2 plots the average and incremental costs (in terms of foregone GDP) of annual abatement, and shows that incremental costs rise rapidly as abatement rises.

It is important to note that the GDP costs of the carbon tax examined in the previous section are inclusive of the compensation paid to households, which was examined in section 3.5.2. In other words, the compensation measures affect the distribution of losses, but do not reduce the overall GDP losses (in fact, as we argue above in section 4.2.2, the compensation measures are likely to exacerbate the GDP losses).

As Appendix D shows, a pure matter of national income accounting, the income that is foregone as a result of the carbon tax must come broadly from either labour income or business profits. Historically the relative shares of income flowing to labour and capital in Australia have been around 60 per cent and 40 per cent respectively. This suggests that the carbon tax will lead to a larger proportional reduction in income to capital than to labour income.

### 5.3. Business Costs, Profitability and Carbon Leakage

The main way in which business profits are likely to be directly affected under the carbon tax is via increases in energy input costs. As Figure 5.3 shows, the manufacturing sector in Australia is the main user of electricity, followed by mining. The adverse effects of the carbon tax are therefore most likely to be directly experienced by electricity-intensive manufacturing activities (such as refining, cement, aluminium, iron

and steel production) as well as certain types of energy-intensive mining activities (particularly coal mining, but also oil and gas mining).

Survey evidence suggests that many Australian businesses have been unable to pass on energy cost increases, which, according to the Australian Industry Group (AIG), have averaged 14.5 per cent for businesses as a result of the carbon tax. The AIG has also published the results of two business surveys demonstrating how the carbon tax has affected input costs and profits.<sup>34</sup> The survey found that of the three quarters of businesses that were able to estimate how much of their increased costs they were able to pass on to their customers, 70 per cent said they had not been able to pass on any energy cost increases. In other words, in these instances the economic incidence of the carbon tax fell on producers.

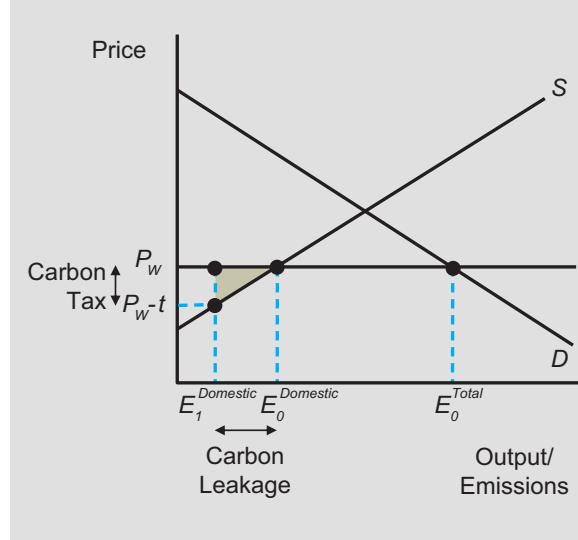
The most likely reason for the lack of pass-through of the carbon tax for these firms is that they are either producing goods for export or are competing directly against goods imported from overseas, and so face a fixed world price for their output. In such cases the carbon tax is likely to lead to carbon leakage rather than a reduction in global emissions.

Figure 5.4 provides a diagrammatic analysis of carbon leakage in a domestic import-competing industry. In the diagram, output and emissions are assumed to be produced in constant proportions, and domestic firms produce in an industry in which there is a fixed world price of  $P_W$ . At this price, domestic output and emissions are equal to  $E_0$ . Imports are initially  $E_0 - E_0$ .

Now suppose that Australia introduces a carbon tax. Since domestic producers are price takers on the world market, they cannot pass on any of the tax and so bear the entire economic incidence, receiving for each unit of output. Domestic firms whose costs exceed this threshold are rendered unprofitable and are forced to exit the market.

Australia's domestic output and emissions now fall to  $E_1$ . There is carbon leakage of  $E_0 - E_1$  as the rest of the world produces more output and emissions. Global emissions do not change, but Australia's imports now increase to  $E_0 - E_1$ . Since there is no change in global emissions, there is no economic or environmental benefit and the tax is simply a tax on import competing firms. There is a

**FIGURE 5.4:  
CARBON LEAKAGE IN AN  
IMPORT-COMPETING INDUSTRY**



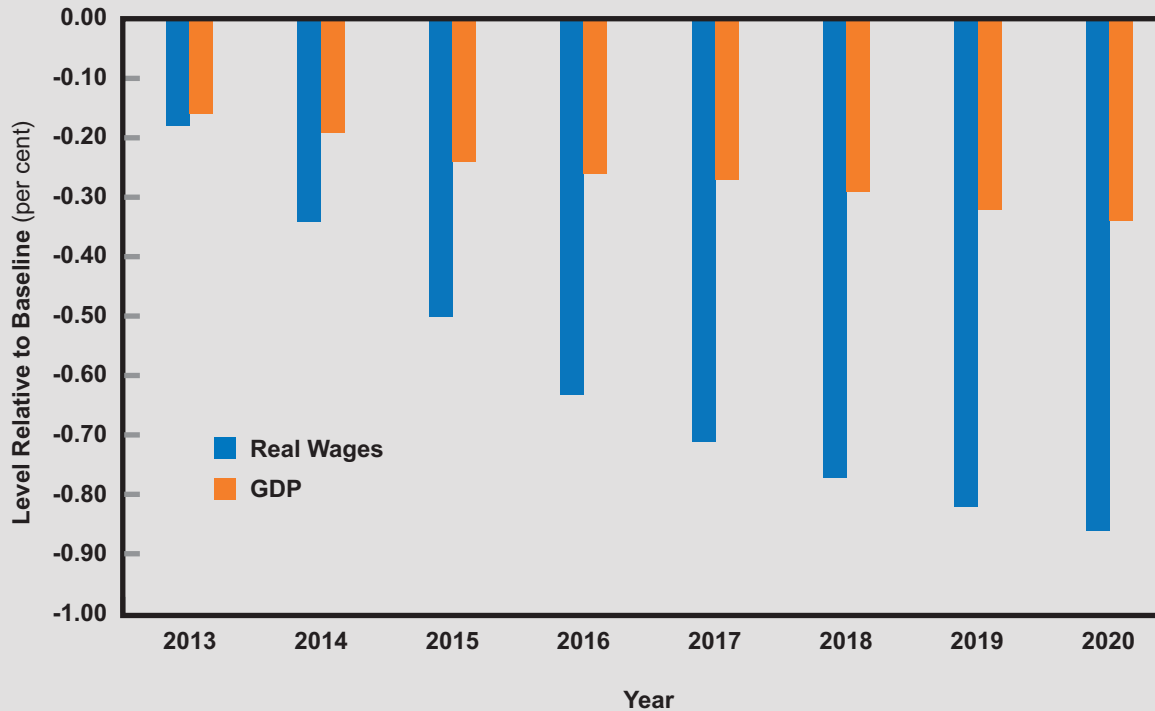
welfare loss equal to the shaded triangle in the diagram, with the incidence of the loss falling entirely on domestic producers. The AIG survey evidence summarised above suggests that the situation described in Figure 5.4 is likely to be quite common. As discussed in section 3.5.2 above, under the carbon tax's "Jobs and Competitiveness Program", certain emissions intensive trade exposed firms are issued with a declining amount of free permits. The Australian Government has argued that the "effective" carbon price for firms in emissions intensive trade exposed industries is only \$1.30, which is the permit price multiplied by the share of permits that these firms receive for free. If true, this would mean that firms have little incentive to reduce emissions. However, this ignores the fact that firms make decisions and respond to incentives at the margin.

Consider the following simple example of a profit maximising firm whose output varies directly with its emissions, so that its output ( $Y$ ) is equal to its emissions ( $E$ ). The firm faces an output price of  $P$  and its cost function is  $C(E)$ .

In the absence of a carbon tax, the firm's output is:

$$E^* = \arg \max_E PE - C(E)$$

FIGURE 5.5:  
ANNUAL REDUCTION IN REAL WAGES VERSUS ANNUAL REDUCTION  
IN GDP UNDER THE CARBON TAX, RELATIVE TO BASELINE, 2013-2020



SOURCE: SGLP

If the firm faces a carbon tax of  $t$ , its output is:

$$E^{**} = \arg \max_E PE - C(E) - tE$$

Clearly  $E^* < E^{**}$ . In the presence of the carbon tax, the firm will reduce its emissions and its profit will be lower. Now suppose that the firm receives  $E$  free permits. The firm's output is now:

$$\begin{aligned} E^{***} &= \arg \max_E PE - C(E) - t(E - \bar{E}) \\ &= \arg \max_E PE - C(E) - tE + t\bar{E} = E^{**} \end{aligned}$$

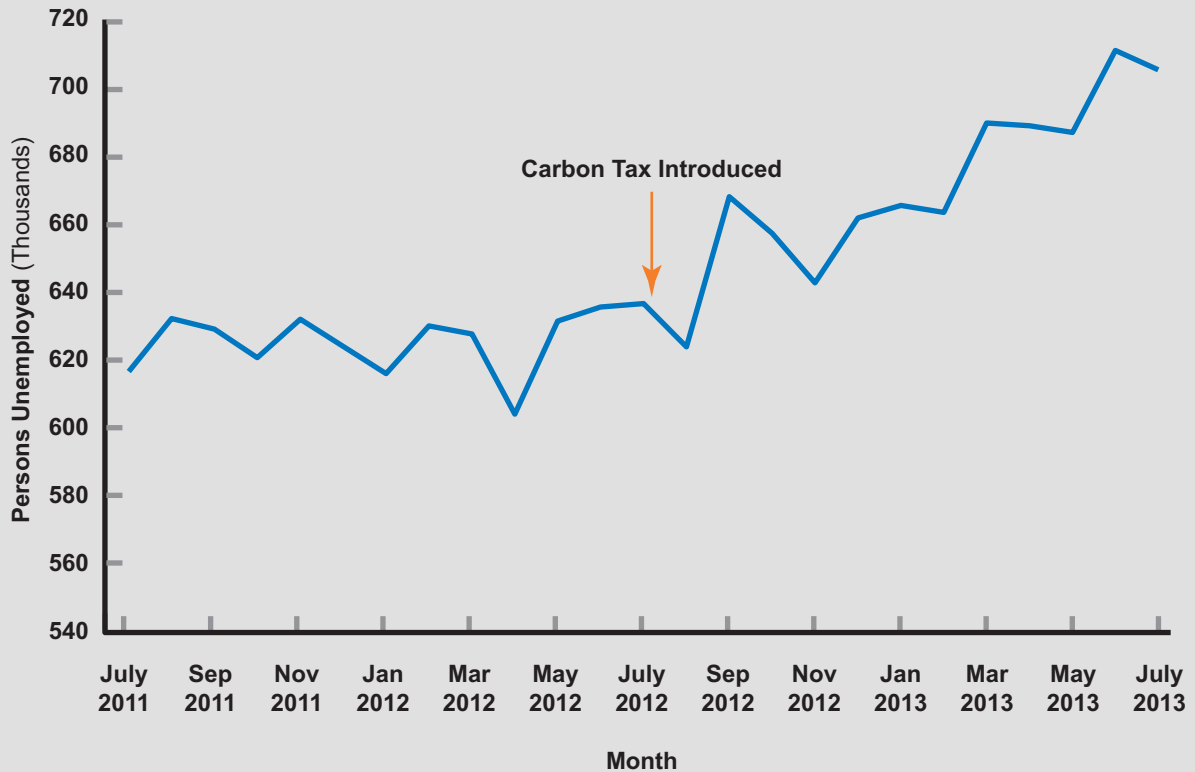
The firm reduces emissions by the same amount as it would have if it did not receive free permits. The firm clearly prefers to receive free permits as this means that its profits are higher than they would be in the absence of free permits. But at the margin the firm still faces an “effective” carbon tax of  $t$ . The main effect of allocating free permits to emissions intensive

trade exposed industries is that whilst marginal costs increase by the amount of the tax, allocating free permits means that *average costs* rise by less than the tax, and so average costs are lower than they otherwise would be in the absence of free permits. Hence, if there are no barriers to exit, fewer firms may exit the industry. However, as the number of free permits is reduced over time, this effect will diminish. And irrespective of whether firms receive free permits or not, the effect on global emissions is the same (i.e. there is no reduction).

#### 5.4. Real Wages and Unemployment

None of the official Government reports discussed in section 2 above examined in detail the likely effects of the carbon tax on job losses and unemployment. Instead, the computable general equilibrium models that were used in the modelling exercises typically assume that markets clear in the long run, so that any

FIGURE 5.6:  
UNEMPLOYMENT IN AUSTRALIA, JULY 2012 TO JULY 2013



SOURCE: ABS CAT. NO. 62XX, LABOUR FORCE, JULY 2013.

labour market effects of the carbon tax must ultimately show up as reductions in real wages. Figure 5.5 shows that in percentage terms, even with compensation in place, the Government expects the reduction in real wages relative to baseline to be much larger in relative terms than the overall reduction in GDP.

If labour market rigidities prevent real wages freely adjusting in the manner suggested by Figure 5.5, then the introduction of the carbon tax means that unemployment will be greater than would have otherwise been the case. As Figure 5.6 shows, since July 2012 the number of unemployed workers in Australia has risen by more than 10 per cent, from 636,564 to 705,421, with the unemployment rate rising from 5.2 per cent to 5.7 per cent over the same period.

There is mounting evidence that the carbon tax is

causing job losses in certain sectors, particularly in manufacturing. Examples of job losses directly attributable to the introduction of the carbon tax include the following:

- **22 May 2012:** Norsk Hydro announced the closure of its aluminium smelter at Kurri Kurri in New South Wales, resulting in the loss of jobs for around 350 fulltime workers and 150 contractors. The company had made at least one submission to the Government in 2009 highlighting that the carbon tax “would put existing operation[s] at risk and render an expansion unviable, stripping a potential \$4 billion dollar investment and 3000 jobs from the Australian economy.”
- **19 December 2012:** Tamworth-based Grain Products Australia announces the appointment of voluntary administrators amid concerns of impending insolvency, putting the future of 68



employees at risk. The company’s directors cite a 75 per cent rise in electricity costs over the preceding three years as pivotal to the decision—and include reference to the carbon tax, saying that there has been no relief provided by the Federal Government and that “it is very hard for manufacturing in Australia to survive with these sort of increases.” Allied Mills ultimately agreed to buy the business in early 2013.

- **18 January 2013:** Penrice Soda announces it will cease soda ash production at its Adelaide plant in June, accounting for the loss of 60 jobs. The company specifically cites the carbon tax, among other factors, as having had a major bearing on its decision.
- **18 February 2013:** Amcor announces that over 300 jobs will be lost at its operations across Melbourne and Brisbane. The company stated that “significant cost increases including energy” was one of the factors that “had a significant impact on our ability to remain competitive in the cartonboard market.”
- **11 March 2013:** CSR announced a restructure of its glass manufacturing business, Viridian, with the loss of 150 jobs overall at two sites—Ingleburn and Wetherill Park. Rob Sindel, the Managing Director, confirmed that the carbon tax had added around \$500,000 to the annual costs at its Ingleburn facility.

As the carbon tax increases and further affects economic incentives, it should be expected to lead to further reductions in business profitability, job losses, and ultimately closures of certain businesses. Indeed, the whole purpose of the carbon tax is to reduce and eventually eliminate certain types of economic activities, as well as the jobs that are created from these activities.

### 5.5. Consumer Prices

Part of the reduction in real wages relative to baseline (see Figure 5.5) brought about by the carbon tax occurs as a result of a more rapid increase in consumer prices than would otherwise be the case. The main direct effect on consumer prices has been through electricity prices, as well as natural gas prices. These price increases are expected to continue over time as the carbon tax rises. Indeed, the Government’s modelling suggests that by 2050

**TABLE 5.2:  
ESTIMATED EFFECT OF THE  
CARBON TAX ON WHOLESALE  
ELECTRICITY PRICES TO 2050**

YEAR	2013	2030	2040	2050
<b>ESTIMATED % INCREASE ABOVE BUSINESS AS USUAL</b>	43.18	61.76	90.54	104.05

SOURCE: STRONG GROWTH, LOW POLLUTION, CHART 5.27.

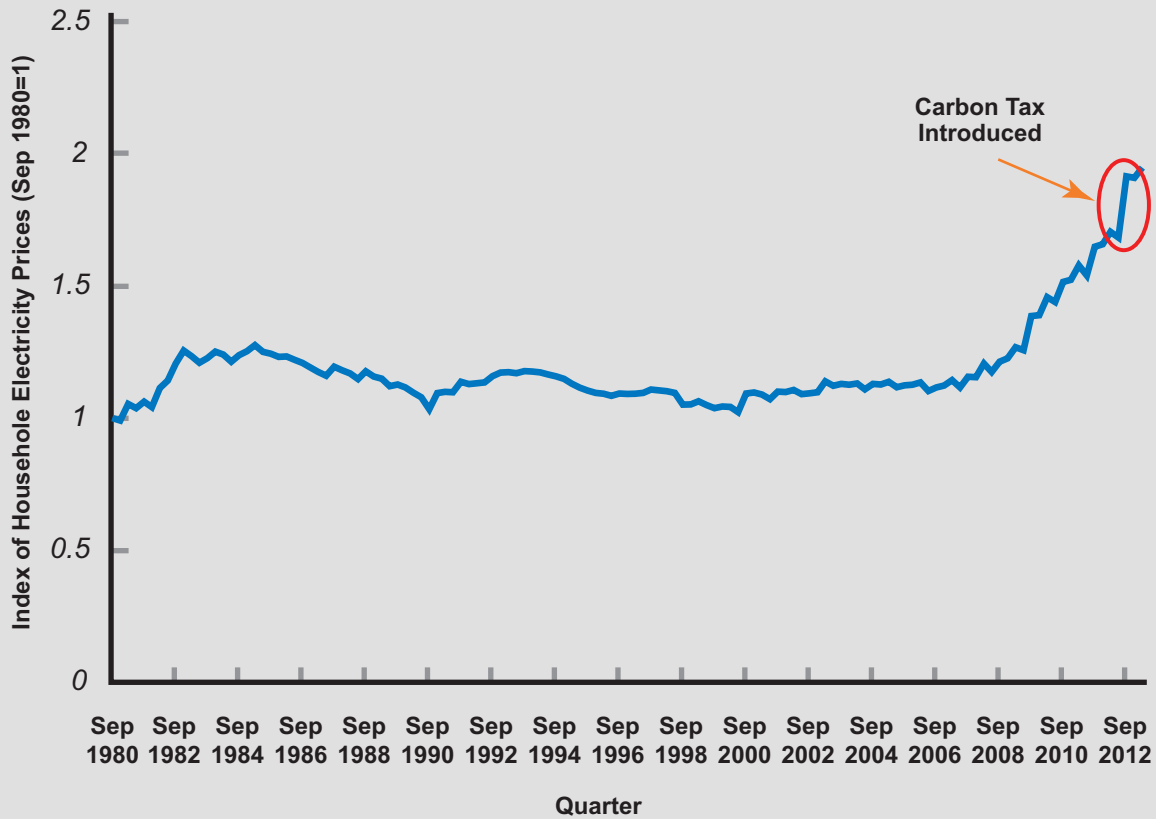
the carbon tax will cause inflation adjusted wholesale electricity prices to be double what they otherwise would be (see Table 5.2). This is expected to lead to an increase in retail electricity prices of around 32 per cent above business-as-usual levels by 2050.<sup>35</sup>

The Australian Government stated that the carbon tax would lead to “an average increase in household electricity prices of 10 per cent over the first five years of the scheme.” In most jurisdictions in Australia, retail electricity prices are subject to direct regulation. A number of estimates have indicated that the initial effect of the tax on electricity prices have already achieved the 10 per cent increase. The July 2012 release of the TD Securities Melbourne Institute Monthly Inflation Gauge stated that “due to the introduction of the carbon tax from 1 July, the price of electricity rose by 14.9 per cent.”<sup>36</sup> As Figure 5.7 below shows, the increase in household electricity prices after the carbon tax was introduced was the highest quarterly increase on record.

Table 5.3 shows that in the states of Queensland and New South Wales, the carbon tax, together with other “green” electricity schemes (including the RET discussed in section 3.5 above) now account for up to 19 per cent of a typical household electricity bill.

There has been some controversy in Australia over the issue of whether the carbon tax will reduce the quantity demanded of electricity when it is accompanied by cash payments to households or permanent tax cuts. As Appendix E shows, standard consumer theory can be used to analyse this

FIGURE 5.7:  
INFLATION-ADJUSTED HOUSEHOLD ELECTRICITY PRICES,  
1980 TO 2013



SOURCE: AUSTRALIAN BUREAU OF STATISTICS, CAT. NO. 6401.0 CONSUMER PRICE INDEX, AUSTRALIA, TABLE 7; AUTHOR'S CALCULATIONS.

question. The quantity of electricity demanded by an individual can actually *increase* under the carbon tax if there is enough overcompensation,<sup>37</sup> when the percentage increase in disposable income as a result of cash payments and other tax changes exceeds the difference between the expenditure share of the good and the price change multiplied by the ratio of the compensated elasticity to the income elasticity.

The main implication is that it is likely that the quantity of electricity demanded will fall in response to the carbon tax—but for some individuals the fall is likely to be less than would have occurred in the absence of compensation.

Whilst the direct effect of the carbon tax on electricity prices has been reasonably well documented, there

has been no attempt by Government agencies to directly estimate the actual effect of the tax on the *overall* price level since it has been in place. Before the tax was introduced, the Government estimated that the Consumer Price Index (CPI) would rise by 0.7 per cent more than it would have in the absence of the tax. However, the accuracy of this forecast has not been verified ex-post. Indeed, on July 25, 2012 the Australian Bureau of Statistics' (ABS) Consumer Price Index release stated that:

*“The ABS will not be able to quantify the impact of carbon pricing, compensation or other government incentives and will not be producing estimates of price change exclusive of the carbon price or measuring the impact of the carbon price.”*

**TABLE 5.3:  
ESTIMATED CONTRIBUTION OF THE  
INTRODUCTION OF THE CARBON TAX AND OTHER GREEN  
SCHEMES TO A TYPICAL ANNUAL HOUSEHOLD  
ELECTRICITY BILL, QLD AND NSW**

	QLD (2012-13)	NSW (2013-14)
RENEWABLE ENERGY TARGET	\$102	\$107
SOLAR BONUS SCHEME/OTHER SCHEMES	\$67	\$53
CARBON TAX	\$190	\$172
TYPICAL HOUSEHOLD BILL	\$1900	\$2073
GREEN SCHEMES/TOTAL	19 PER CENT	16 PER CENT

SOURCE: QLD - MINISTER FOR ENERGY AND WATER SUPPLY, MEDIA STATEMENT, 30 MAY 2013.<sup>36</sup>

NSW - INDEPENDENT PRICING AND REGULATORY TRIBUNAL, REVIEW OF REGULATED ELECTRICITY PRICES 2013-16, FINAL REPORT.<sup>39</sup>

The ABS also stated that:

*“The ABS is unable to measure the impact of the carbon price. It is therefore not known if the changes in prices are a one-off impact or continuing into future quarters.”*

In February 2009 the Reserve Bank of Australia said in relation to the carbon tax that it “*should be able to look through the initial increase in inflation*” when assessing the consequences for monetary policy. However, since no official estimates of the actual effects of the carbon tax on the Consumer Price Index exist, it is unclear how this has been achieved. Whilst inflation in Australia has remained low, the precise effect of the carbon tax on the overall price level remains unknown.

### 5.6. Fiscal Effects

After several years of budget surpluses between 1996 and 2007, Australia’s Federal Government has run budget deficits in each year since 2008, with net government debt increasing from negative \$45 billion to an expected \$219 billion in 2015-16. An important feature of Australia’s fiscal situation in recent years is that revenues from individual taxes, as well as aggregate revenues, have become more difficult to predict.

The carbon tax will have two broad effects on the Government’s budgetary position. On the one hand, the carbon tax is expected to directly raise a

substantial amount of revenue.<sup>40</sup> In addition, the excise rebate reduction—which is an equivalent carbon price applying to business transport emissions from liquid fuels (rail and shipping) and non-transport emissions from businesses using liquid fuels—will also result in higher revenue.

On the other side of the budget, the carbon tax policy involves additional spending and/or tax reductions to compensate some households, selected trade exposed industries, and billions of dollars in other outlays.<sup>41</sup> The carbon tax may also lead to a reduction in company tax revenue and personal income tax revenues below what they otherwise would have been, although this has not been quantified.

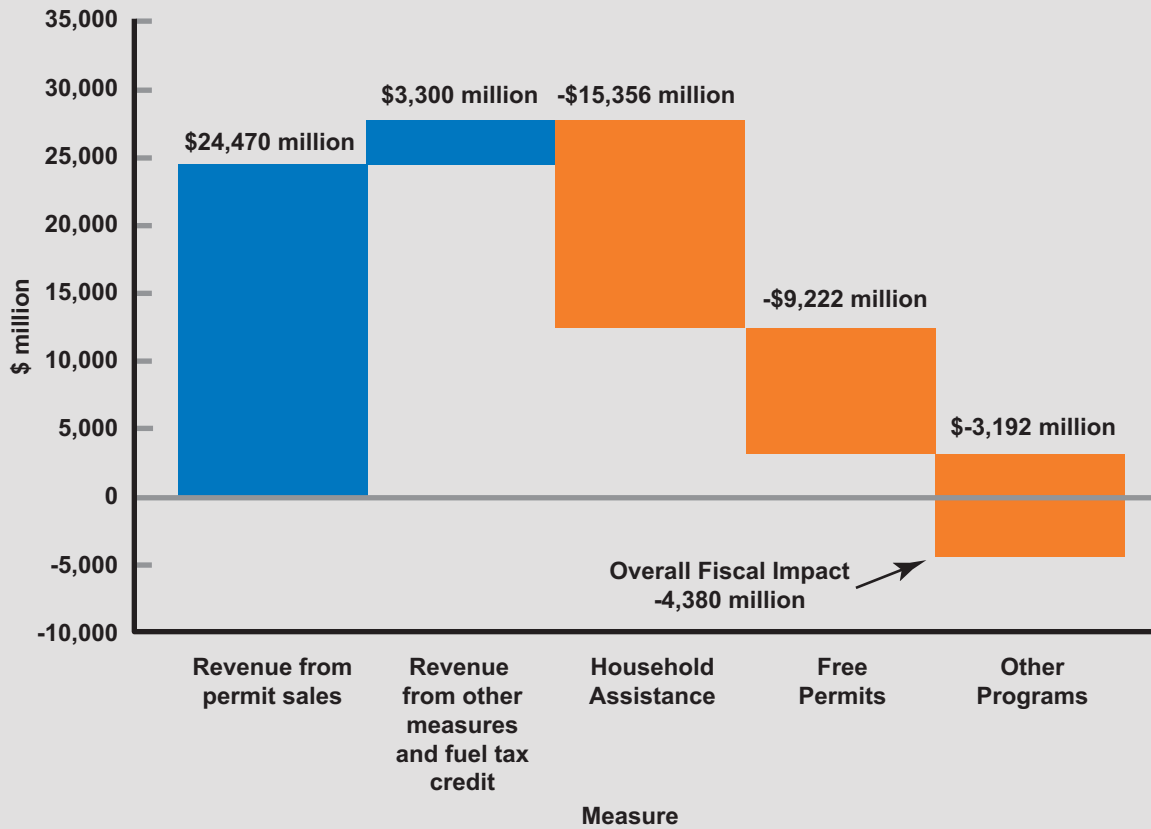
Despite raising a large amount of revenue, Figure 5.8 shows, in its initial years the carbon tax was expected to worsen Australia’s budget position, leading to higher deficits and higher public debt than would otherwise have been the case. The cumulative fiscal shortfall was initially expected to be \$4.4 billion over the period 2011-12 to 2014-15.

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**There is mounting evidence that the carbon tax is causing job losses in certain sectors, particularly in manufacturing.**

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**FIGURE 5.8:  
EXPECTED CUMULATIVE FISCAL IMPACT OF THE CARBON TAX  
AND ASSOCIATED POLICIES, 2011-12 TO 2014-15**



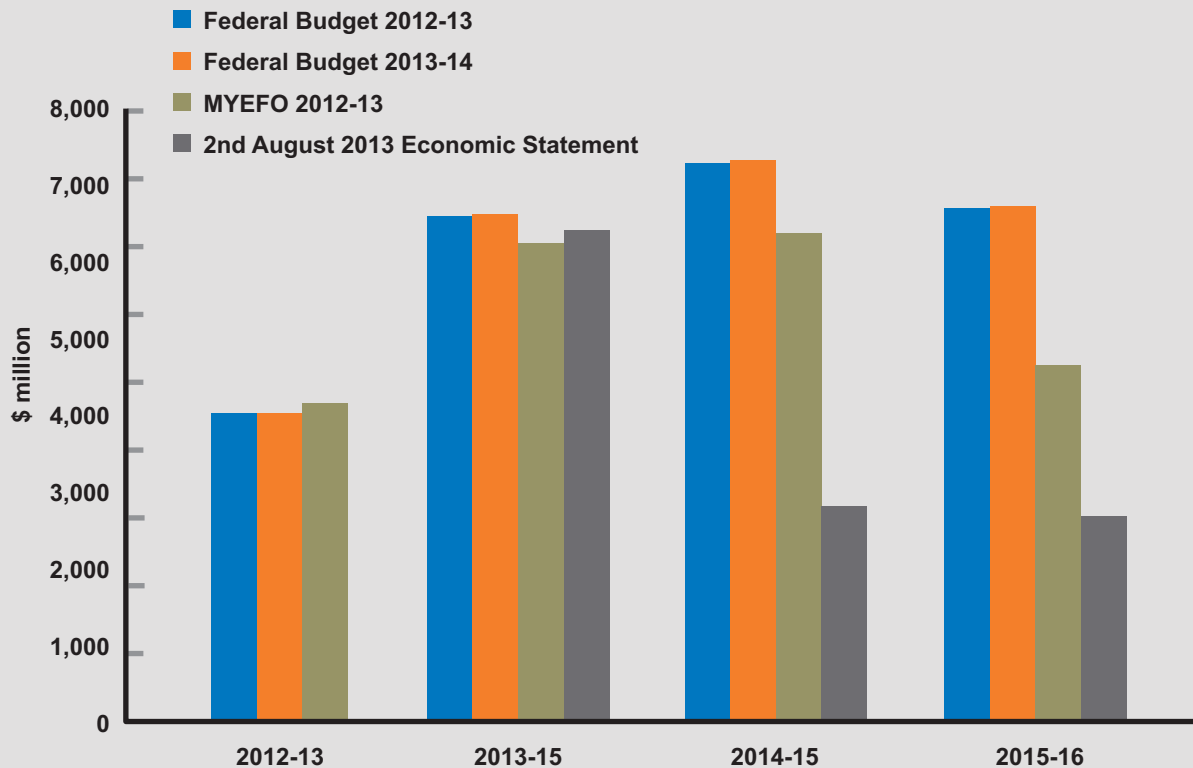
SOURCE: SECURING A CLEAN ENERGY FUTURE: THE AUSTRALIAN GOVERNMENT'S CLIMATE CHANGE PLAN, TABLE 1 PAGE 131, AND TABLE 1 PAGE 135.

Figure 5.8 illustrates one of the most significant problems with the design of the overall carbon tax policy: the mismatch between the tax's revenue inflows and the outflows from compensation measures. The changes to the personal income tax system were introduced well before the tax came into effect, and were effectively "locked in" (although additional tax cuts that were originally promised to come into effect in 2015-16 have since been rescinded). This means that a significant portion of the compensation for the carbon tax was based on assumptions about the uncertain future path of carbon prices. In practice, when the floating price period begins, the carbon tax rate will fluctuate substantially, as will the revenues that the tax raises.

In other words, the carbon tax has introduced an additional source of uncertainty into the Government's budget projections: carbon tax revenues are likely to be relatively volatile, whilst much of the outlays and compensating tax reductions are difficult to change. As Figure 5.9 shows, the most recent estimates of carbon tax revenue for 2014-15 and 2015-16 are now less than half the original revenue estimates. Should the most recent projections eventuate, there will be a growing negative gap between the revenues generated by the tax and the increases in government spending that have accompanied the scheme.<sup>42</sup>

In the floating period, changes in the carbon tax will affect both the revenue and expenditure side of the Federal Government's Budget. The Departments of Treasury and Finance have recently estimated a

FIGURE 5.9:  
INITIAL ESTIMATES AND REVISIONS OF CARBON TAX REVENUE,  
2012-13 TO 2016-17



SOURCE: AUSTRALIAN GOVERNMENT BUDGET PAPERS AND STATEMENTS, VARIOUS ISSUES.

simple rough “rule of thumb”, which states that a \$1 change in the carbon tax in any given year would be a change in the Budget bottom line (in underlying cash terms) balance of around \$160 million in 2014-15 or around \$220 million in either 2015-16 or 2016-17.<sup>43</sup>

## 5.7. Effect on CO<sub>2</sub>-e Emissions

### 5.7.1. Overall Emissions

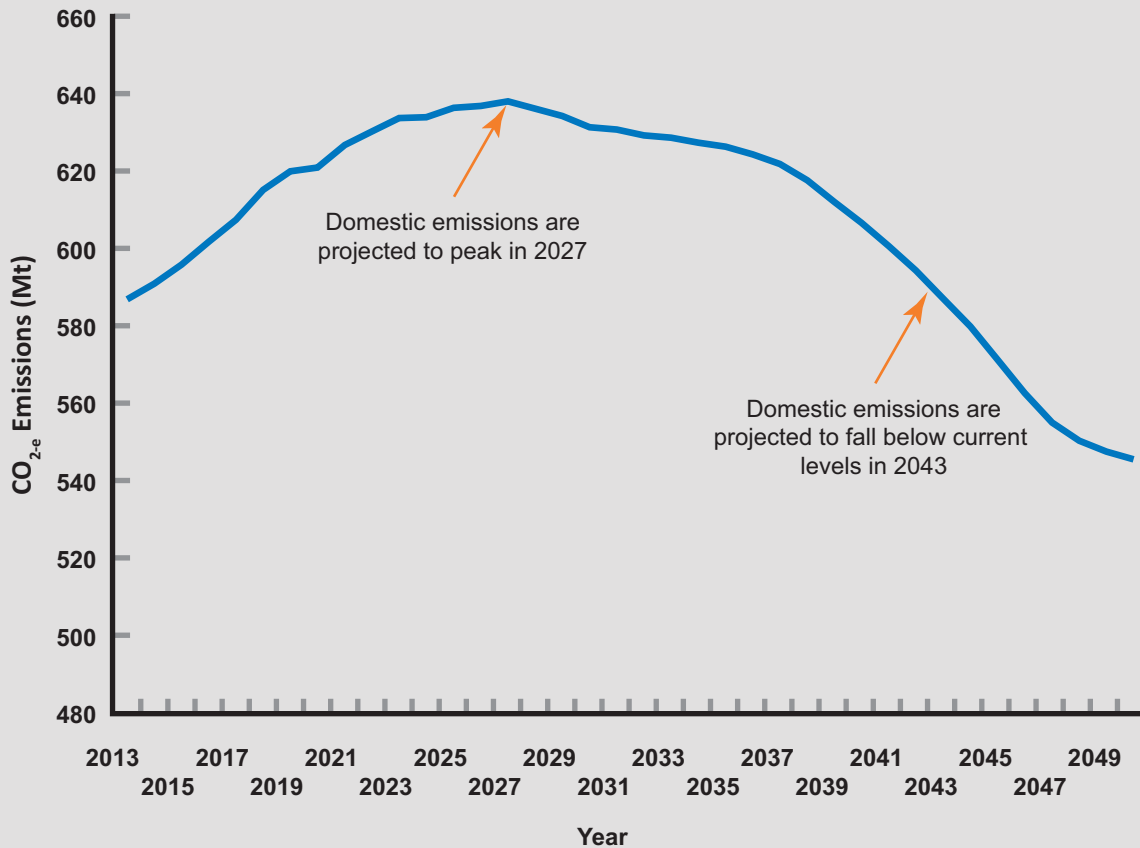
It is important to note that whilst emissions in the electricity sector were expected to fall almost immediately as a result of the carbon tax,<sup>44</sup> the purpose of the tax is not to reduce Australia’s *overall* emissions below current levels in the short to medium term. The main expected effect of the tax on domestic emissions levels is to reduce them below

projected “business as usual” levels, rather than reducing the *absolute level* of emissions. Indeed, the Government’s own modelling suggests that under the carbon tax Australia’s domestic emissions are not expected to stop increasing until 2027, and are not expected to fall below current levels until 2043 (see Figure 5.10).

### 5.7.2. Electricity Sector Emissions

As Figure 5.11 shows, electricity emissions in Australia have been falling since 2008-09, due to both supply side factors (mainly through the RET) and demand side factors (primarily increases in regulated retail prices for reasons unrelated to the carbon tax). Electricity demand fell by 5.5 per cent in response to a 35 per cent real increase in retail electricity prices over

FIGURE 5.10:  
GOVERNMENT PROJECTIONS OF AUSTRALIA'S DOMESTIC  
CO<sub>2-e</sub> EMISSIONS UNDER THE CARBON TAX, 2013-2050



SOURCE: STRONG GROWTH LOW POLLUTION, CHART 5.2

the period, with electricity emissions falling by nearly 12 per cent.

Despite this fall in emissions, data from the Australian Government indicates that brown and black coal still accounted for around 79 per cent of total electricity production in Australia's National Electricity Market in the year to December 2011, before the carbon tax was introduced.

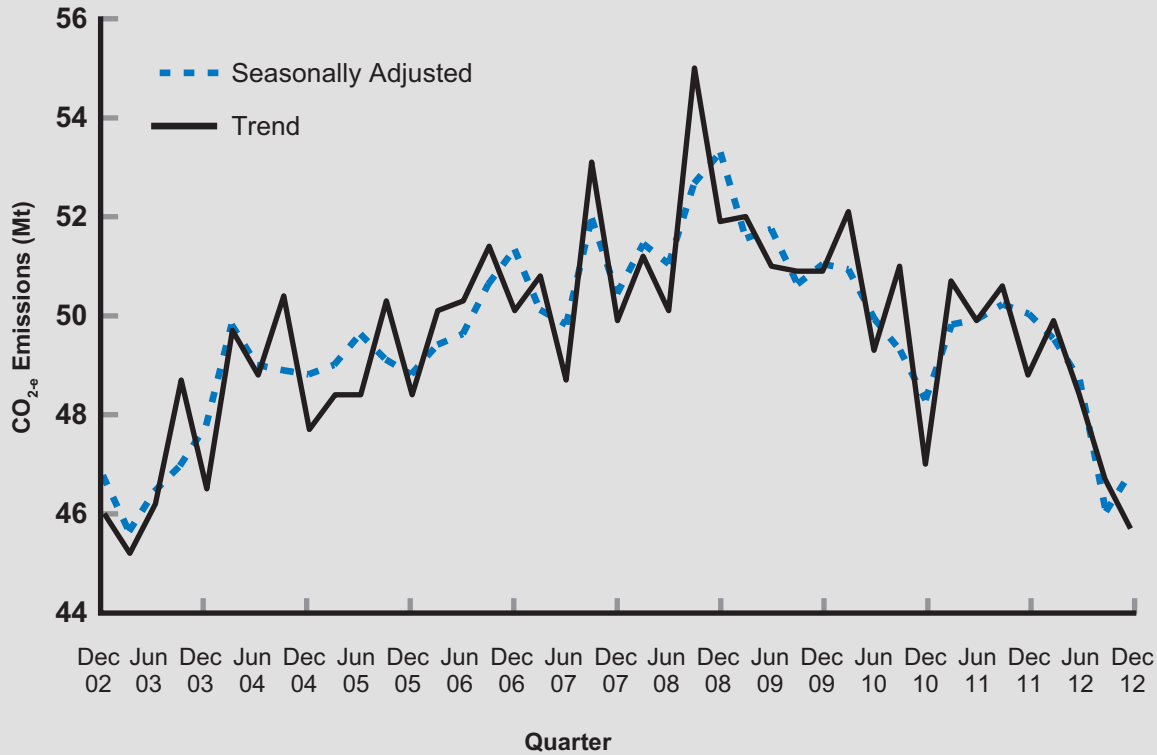
Standard producer theory can be used to examine the theoretical long run change in the mix of electricity production in response to an increase in input prices brought about by a carbon tax. The total response depends on a substitution or supply-side effect, and an output or demand-side effect. To see this,

suppose that as a result of the carbon tax being introduced, the after tax price of an electricity input (for example, black coal), labelled  $j$ , rises. Then the change in generators' demand for alternative sources of energy is given by:<sup>45</sup>

$$\eta_j^i = s^j \left( \sigma_j^i - \frac{1/(1+\varepsilon^{-1})}{1/(1+\varepsilon^{-1})-\theta} \right) = s^j \left( \sigma_j^i - \frac{m}{m-\theta} \right)$$

where  $\eta_j^i$  is the elasticity of demand for input  $i$  (an alternative source of energy, for example, such as wind or solar) in response to an increase in  $w_j$ , the after tax price of the input subject to the carbon tax;  $s^j$  is the share of input  $j$  in total electricity production costs,  $\sigma_j^i$  is the (Allen) partial elasticity of substitution between inputs  $i$  and  $j$ ,<sup>46</sup>  $\varepsilon < 0$  is the consumer price

FIGURE 5.11:  
AUSTRALIA'S ELECTRICITY CO<sub>2</sub>-E EMISSIONS, 2002-2012



SOURCE: AUSTRALIAN GOVERNMENT, QUARTERLY UPDATE OF AUSTRALIA'S NATIONAL GREENHOUSE GAS INVENTORY, DECEMBER 2012

elasticity of demand, and  $\theta$  is a measure of returns to scale in electricity production. The parameter  $m = 1 / (1 + \varepsilon^{-1}) > 1$  is the markup of retail electricity prices over marginal costs. If the production function for electricity exhibits constant returns to scale then we have:

$$\eta_j^i = s^j (\sigma_j^i + \varepsilon)$$

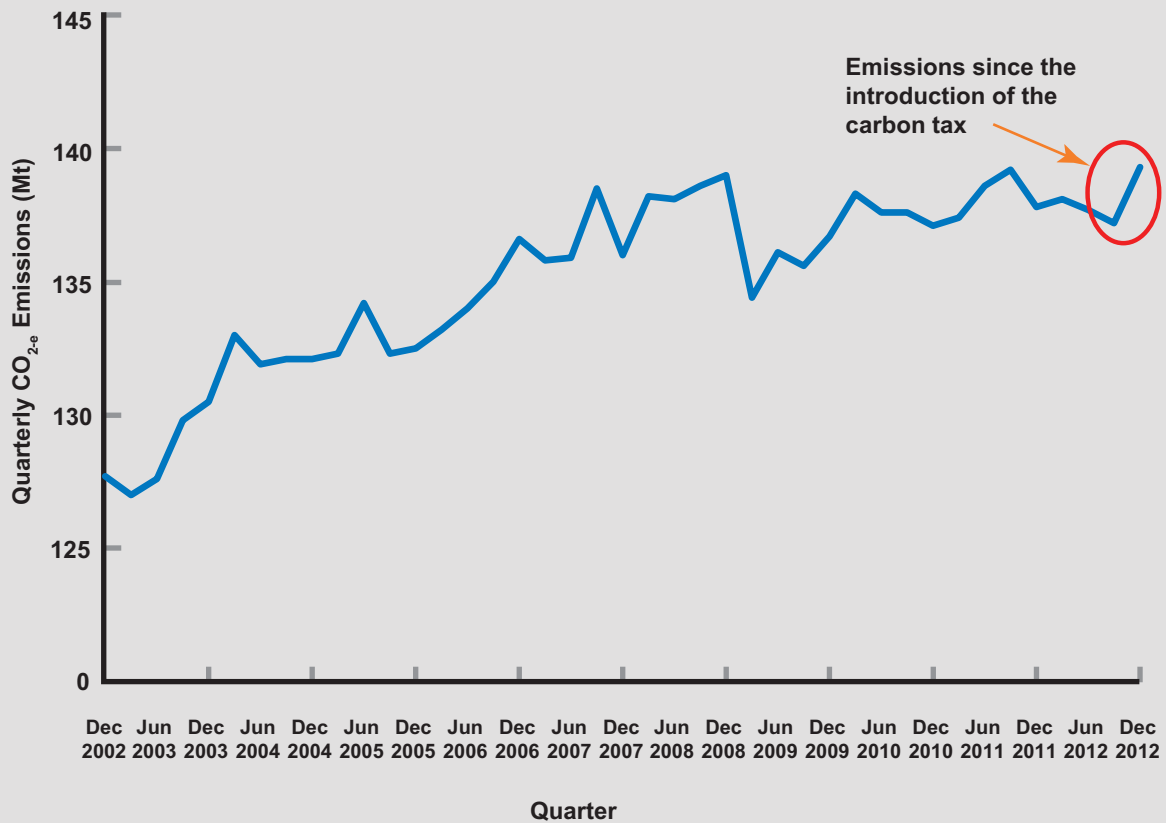
These expressions demonstrate that the theoretical effect of the carbon tax on the quantity supplied of alternative sources of electricity inputs consists of two conceptually separate effects. The first effect is that, holding output constant, the tax may cause electricity producers to switch to alternatives, depending on the elasticity of substitution. The second effect is a demand-side effect: the tax will reduce consumer demand for electricity as it becomes more expensive, and the quantity demanded falls. The latter two variables are likely to be relatively small (particularly in the medium term, as substitution possibilities are

limited on both the supply and demand sides), meaning that a relatively large carbon tax would be needed to reduce emissions in the short to medium term.

The Australian Government expects the electricity sector to be the most significant source of domestic emission reductions under the carbon tax, delivering over 40 per cent of total domestic abatement over the period to 2020. This equates to a 3.4 per cent reduction in the absolute level of emissions generated by the electricity sector on 2012 levels. Under the carbon tax, around half of total electricity sector abatement is expected to come from the demand side of the electricity market.<sup>47</sup>

Given that inflation adjusted electricity prices rose by 35 per cent in the four years prior to the carbon tax and that this produced a 5.5 per cent reduction in electricity demand over the period, the extent to which the carbon tax will contribute to the expected demand

FIGURE 5.12:  
 AUSTRALIA'S TOTAL CO<sub>2</sub>-E EMISSIONS, SEASONALLY ADJUSTED  
 WEATHER NORMALISED, 2002-2013



SOURCE: AUSTRALIAN GOVERNMENT, QUARTERLY UPDATE OF AUSTRALIA'S NATIONAL GREENHOUSE GAS INVENTORY, DECEMBER 2012.<sup>49</sup>

side effect remains unclear—particularly if the tax falls to the current EU price of around \$6, as the Government expects it will in 2014. The effect of the carbon tax on actual electricity emissions has been difficult to ascertain. In its recent report on the effect of the carbon tax on the National Electricity Market (NEM), the Australian Energy Market Operator (AEMO) found that “CO<sub>2</sub>-e intensity was largely unaffected in the first quarter of carbon pricing.”<sup>48</sup> It also found that

*“The mix of fuels used to generate electricity in the NEM has changed since the start of carbon pricing, but not always to the extent anticipated before 1 July 2012. Coal-fired generation reduced, but the majority of change to brown coal generation occurred due to flooding in the Yallourn open-cut mine before the introduction of carbon pricing.”*

As Figure 5.12 shows, official government data shows that Australia’s overall emissions have risen relatively rapidly since the introduction of the carbon tax. Given that a fall in the absolute level of Australia’s domestic emissions is not expected for another 15 years under the carbon tax, this is not surprising.



## 6. Conclusions: Policy Lessons from the Australian Experience

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There are a number of important lessons that policymakers around the world can draw from Australia's carbon tax experience.

### ***Lesson 1: In Assessing the Case for a Carbon Tax or Cap and Trade Scheme, Estimate the Incremental Net Benefits of All Feasible Policy Options, Rather than the Possible Costs of Climate Change***

The role of climate change policy is not to assess the possible damage of climate change, but rather to focus on the incremental net benefits of possible policy options. This is the domain of cost-benefit analysis. Whilst a number of Australian reports examined the expected economic costs of the carbon tax, there was never a full cost-benefit analysis of various options. In particular, there was never an assessment of the incremental net benefits to Australia of limiting emissions, versus other measures such as adaptation. The debate has been framed as limiting emissions on the one hand, versus doing nothing on the other.

The most important feature of climate change policy is that any policy (even the policy of doing nothing) is made under conditions of uncertainty and ignorance. Policymakers are unlikely to know what individual or aggregate abatement costs look like—either in total or at the margin—or indeed what the aggregate marginal benefits of abatement look like, either for individual countries or the world as a whole. And no matter what targets and timetables are announced by various countries, policymakers cannot know for sure today what other countries will actually do in the future – as opposed to what they say they will do.

Climate science may give us some idea of the possible effects of abatement (i.e. the avoided effects of climate change), but climate science cannot tell us what the *economic* difference is between (say) reducing emissions by 60 per cent of 2000 levels by 2040, or 80 per cent of 2000 levels by 2050. These questions are impossible to answer without an economic framework. But these and similar questions about economic tradeoffs are obviously very important for policymakers.

When policymakers are uncertain or ignorant about regarding the position of marginal costs and benefit curves, no climate change policy will be perfect—all

policies will create welfare losses, unless they just happen by chance to be right. Contrary to the Australian Government's approach, the relevant question for responsible economic policymakers is not whether one policy instrument (such as a tax or a cap and trade scheme) is more likely to achieve an environmental target, but which instrument creates the lowest welfare loss on average (i.e. the lowest expected deadweight loss), taking into account all costs and benefits. This involves careful, comprehensive and realistic assessment of:

- (i) The likely effects of policy changes on economic and environmental variables (such as the global temperature), relative to a realistic baseline;
- (ii) The likelihood of other countries undertaking similar policies, taking into account the very real risk that countries may commit to take action but later renege on such commitments;
- (iii) The incremental costs and benefits of all feasible policy changes, including adaptation;
- (iv) The nature and magnitude of the uncertainty surrounding estimates of costs and benefits of various policies.

Unfortunately, despite the Australian Government issuing a number of reports on climate change policy, such an analysis has never been undertaken. The reports focused on estimates of the costs of climate change rather than the costs that would actually be avoided by policies that were being considered.

***Lesson 2: Do Not Ignore the Effects and Costs of “Complementary” Policies, Which Are Likely to Result in Efficiency Losses Rather than Efficiency Gains, Compounding any Negative Effects of a Carbon Tax or Cap and Trade Scheme***

Proponents of carbon taxes argue that “market mechanisms” - cap and trade schemes and carbon taxes - are superior to direct command and control alternatives. The conventional economic argument is that introducing a price will allow other more costly schemes (such as renewable energy targets, green subsidies, efficiency standards and other forms of regulation) to be abolished. Proponents argue that since a cap and trade scheme achieves abatement at least cost, once the emissions or abatement target is fixed under a cap and trade scheme, the existing schemes will not create further emissions reductions (unless the “cap” is in addition to emissions reductions achieved by these other schemes).

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**The most important feature of climate change policy is that any policy (even the policy of doing nothing) is made under conditions of uncertainty and ignorance.**

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Although this is intuitively appealing, there have been a number of practical difficulties with this argument in Australia’s case. Firstly, the Australian Government has never actually demonstrated that “market mechanisms” are superior to non-market alternatives. Furthermore, many features of the policies that accompany Australia’s carbon tax bear a strong resemblance to command and control policies. Most notably, Australia’s Renewable Energy Target has remained in place. In addition, the carbon tax legislation introduced new forms of intervention, including the Clean Energy Finance Corporation. In

practice, complementary policies have remained in Australia, even after the carbon tax was put in place. Hence any hypothetical efficiency gains that may have occurred as a result of eliminating other programs have not materialised. The failure to remove existing “complementary” policies and the introduction of new instruments has also weakened the intellectual case for adopting so-called “market mechanisms.”

***Lesson 3: Cumulative Economic Costs are Likely to be Substantial Over the Long Term, with Lower Discount Rates Resulting in Higher Cumulative Costs in Present Value Terms***

The analysis in section 5 shows that although annual costs appear to be small (a fact which proponents like to emphasise), the cumulative costs of Australia’s carbon tax are likely to be high. The results show that depending on the discount rate used, the present value of the costs in the government policy scenario could be as high as 83 per cent of current Australian GDP. These costs must ultimately manifest themselves as lower incomes to capital or labour.

***Lesson 4: Fiscal Impacts are Likely to be Uncertain, with both Carbon Taxes and Cap and Trade Schemes Adding to any Existing Revenue Volatility***

By deliberate design, the Australian Government’s household compensation package was locked in over time and was based on assumptions about the path of carbon prices and emissions. In practice, emissions are uncertain, and after 2015-16 the price will fluctuate. This means that there is likely to be a sizeable fiscal gap between the revenues generated by the tax on the one hand, and the increases in government spending and tax cuts that accompanied the scheme on the other. In other words, the carbon tax has actually worsened Australia’s budget bottom line, leading to higher deficits and higher public debt than would otherwise have been the case. The carbon tax has introduced an additional source of volatility into the Australian Government’s tax revenues.

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**Major changes were made to the tax almost as soon as it took effect, and the Government has recently announced further major changes. As a result, there is a great deal of uncertainty surrounding the future status and design features of the tax.**

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***Lesson 5: Carefully Assess the Possibility and Costs of Carbon Leakage***

The effect of a carbon tax on emissions-intensive, trade-exposed industries is similar to a tax on exports or a tax on import-competing industries. Domestic emissions in these industries may fall after a carbon tax is imposed, but that cannot be counted as an environmental gain if the ultimate effect is that emissions simply rise overseas. The net effect is a pure deadweight cost to the economy.

***Lesson 6: The Double Dividend is Elusive***

Carbon tax proponents often claim that carbon tax revenue can be “recycled” and used to reduce marginal income tax rates, thus providing a “double dividend.” This is a dubious proposition in theory due to the interaction between the carbon tax and existing taxes. These interactions were never taken into account in the Government’s modelling.

In Australia’s case, as part of the compensation package for the carbon tax, the Australian Government lowered some average income tax rates but actually increased marginal tax rates for around 2 million taxpayers. Instead of mitigating the adverse effects of the carbon tax on the labour market, these changes to the personal tax system have likely exacerbated those effects. The increase in marginal tax rates is exactly the opposite policy of what a Government would do if it was trying to capture a “double dividend” from environmental taxation.

***Lesson 7: Establishing a Robust, Sustainable and Credible Carbon Tax is Politically Difficult. Policy Uncertainty and Time Inconsistency are the Norm Rather than the Exception***

The politics of carbon tax interacts with the economic effects in important ways. During the 2010 election campaign the Australian Government promised that should it win the election it would not introduce a carbon tax in its next three year term. Despite this commitment, the Government introduced the tax after the election, even though the Australian public opposed the policy, and political support for it has been weak. Major changes were made to the tax almost as soon as it took effect, and the Government has recently announced further major changes. As a result, there is a great deal of uncertainty surrounding the future status and design features of the tax. One of the theoretical justifications for introducing a carbon tax is that it provides a credible price signal and encourages future investment in alternative energy sources. With so much uncertainty surrounding current arrangements in Australia, it is doubtful whether the current price signal is very strong.

## References

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# Appendices

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## **Appendix A: The Clean Energy Future Legislation**

The 18 pieces of legislation are as follows:

### **The Carbon Pricing Architecture**

- *Clean Energy Act 2011*
- *Clean Energy (Consequential Amendments) Act 2011*

### **Establishment of Statutory Bodies**

- *Climate Change Authority Act 2011*
- *Clean Energy Regulator Act 2011*

### **Household Assistance Measures**

- *Clean Energy (Household Assistance Amendments) Act 2011*
- *Clean Energy (Tax Laws Amendments) Act 2011*
- *Clean Energy (Income Tax Rates Amendments) Act 2011*

### **Changes to the Fuel Tax Rebate**

- *Clean Energy (Fuel Tax Legislation Amendment) Act 2011*
- *Clean Energy (Excise Tariff Legislation Amendment) Act 2011*
- *Clean Energy (Customs Tariff Amendment) Act 2011*

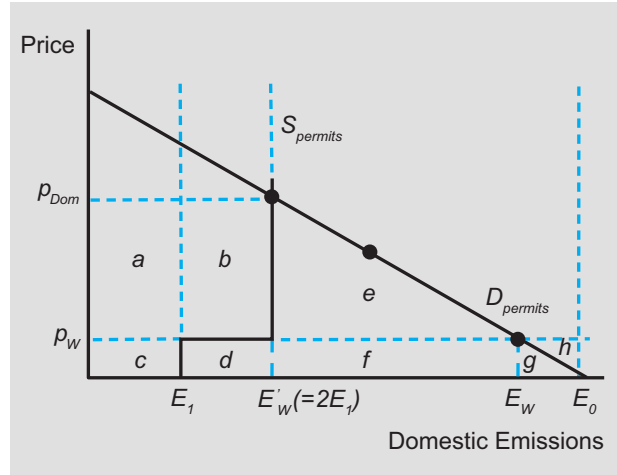
### **Charges Associated with the Carbon Pricing Mechanism**

- *Clean Energy (Charges—Excise) Act 2011*
- *Clean Energy (Charges—Customs) Act 2011*
- *Clean Energy (Unit Issue Charge—Auctions) Act 2011*
- *Clean Energy (Unit Issue Charge—Fixed Charge) Act 2011*
- *Clean Energy (Unit Shortfall Charge—General) Act 2011*
- *Clean Energy (International Unit Surrender Charge) Act 2011*
- *Ozone Protection and Synthetic Greenhouse Gas (Manufacture Levy) Amendment Act 2011*
- *Ozone Protection and Synthetic Greenhouse Gas (Import Levy) Amendment Act 2011.*

Further details of the Acts can be found on pages 23-25 of the Explanatory Memorandum<sup>50</sup> to the legislation.

## Appendix B: The Price of Domestic Permits with Restrictions on Purchases of Overseas Permits

Section 4.3.2 argued that the price of domestic permits is likely to exceed the overseas price, and provided an expression for the price markup. This section demonstrates how that expression is derived.



Consider the figure above, which is identical to Figure 4.6 in the main text. In the figure, the government issues  $E_1$  domestic permits, but allows Between  $P_{Dom}$  and  $P_W$ , the elasticity of the demand curve is approximately equal to:

$$\varepsilon = \frac{\frac{E'_W - E_W}{E_W}}{\frac{P_{Dom} - P_W}{P_W}}$$

So that:

$$\frac{P_{Dom} - P_W}{P_W} = \frac{E'_W - E_W}{\varepsilon E_W}$$

Manipulating this equation gives:

$$\frac{P_{Dom}}{P_W} = 1 - \frac{1}{\varepsilon} + \frac{E'_W}{\varepsilon E_W}$$

Now  $E_1 = \theta E'_W$ , where  $\theta$  is the share of annual liabilities that entities must meet with domestic carbon units. Hence the markup is:

$$\frac{P_{Dom}}{P_W} = 1 - \frac{1}{\varepsilon} \left( 1 - \frac{E_1}{\theta E_W} \right) > 1$$

This is the expression in the main text.

## Appendix C: The Hotelling Rule and Least Cost Abatement

This appendix derives the simple Hotelling rule for abatement at minimum cost across time. Suppose that an economy wishes to reduce its annual emissions from  $E_0$  today to  $E_1 < E_0$  in the future. This can be achieved through costly abatement. Suppose further that the total cost of undertaking actions that permanently achieve abatement of  $a_t$  in period  $t$  is  $c(a_t)$ . To achieve the emissions target, total abatement must satisfy  $E_T = E_0 - \sum_{t=0}^T a_t$ .

Suppose that the policy objective is to abate at least cost; that is, to minimise the present value of the total costs of achieving this abatement,  $\sum_{t=0}^T \frac{c(a_t)}{(1+r)^t}$ .

Let  $C(E_t)$  be the present value of the cost beginning at time  $t$  of reaching the target  $E_T$ , given that current emissions are  $E_t$ . The Bellman equation is:

$$C_t(E_t) = \min_{a_t} \left\{ c(a_t) + \frac{C_{t+1}(E_{t+1})}{1+r} \right\}$$

subject to  $E_{t+1} = E_t - a_t$ . The first order condition for this problem is:

$$c'(a_t) = \frac{C_{t+1}'(E_{t+1})}{1+r}$$

and the envelope theorem gives:

$$C_t'(E_t) = \frac{C_{t+1}'(E_{t+1})}{1+r}$$

So:

$$c'(a_t) = C_t'(E_t) = \frac{C_{t+1}'(E_{t+1})}{1+r} = \frac{c'(a_{t+1})}{1+r}$$

This states that to minimise the present value of the costs of achieving a given emissions reduction target, the marginal cost of abatement should grow at the rate of interest.

## Appendix D: Accounting for Reductions in GDP Relative to Baseline

This Appendix illustrates how the reduction in GDP relative to baseline will fall on labour income and capital income, as discussed in section xx in the text. Let  $Y(t)$  denote the level of GDP at time  $t$ . Then the income definition of GDP states that:

$$Y(t) = r(t)K(t) + w(t)L(t)$$

where  $r(t)$  is the gross rate of return to the capital stock  $K(t)$ ,  $w(t)$  is the real wage rate, and  $L(t)$  is the level of employment in time  $t$ . Taking the derivative with respect to time and dividing by  $Y(t)$  on both sides yields:

$$\frac{\dot{Y}(t)}{Y(t)} = s_K \left[ \frac{\dot{r}(t)}{r(t)} + \frac{\dot{K}(t)}{K(t)} \right] + (1 - s_K) \left[ \frac{\dot{w}(t)}{w(t)} + \frac{\dot{L}(t)}{L(t)} \right]$$

where  $s_K$  is the income share of capital and a dot over a variable indicates a derivative with respect to time. This expression states that the percentage reduction in GDP relative to business as usual at time  $t$  is equal to the weighted average of the percentage reduction in returns to capital (i.e. profit rates), the productive capital stock, real wages and employment levels.



## Appendix E: Electricity Prices, Household Compensation, and Household Electricity Demand

This appendix examines the effect of a price increase combined with compensation on the quantity of electricity demanded by households. Consider the response of a consumer, indexed by  $i$ , to the imposition of a carbon tax which increases retail electricity prices, followed by a cash payment or reduction in average tax rates which may or may not exactly compensate the household for the price increase. The standard Slutsky equation is:

$$\frac{\partial x_i}{\partial p} = \frac{\partial h_i}{\partial p} - \frac{\partial h_i}{\partial y_i} x_i$$

Where  $x_i$  is the ordinary demand for electricity,  $h_i$  is the compensated demand,  $p$  is the retail price of electricity, and  $y_i$  is the consumer's level of income. In elasticity form, we can write this as:

$$\varepsilon_i = \bar{\varepsilon}_i - \varepsilon_i^y \theta_i$$

where  $\varepsilon_i$  is the ordinary elasticity of demand for consumer  $i$ ,  $\bar{\varepsilon}_i$  is the compensated elasticity of demand,  $\varepsilon_i^y$  is the income elasticity of demand, and  $\theta_i$  is the individual's expenditure share of consumption of electricity.

For small changes in prices and income, the change in demand for the good is:

$$\begin{aligned} \frac{dx_i}{x_i} &= \varepsilon_i \times \frac{dp}{p} + \varepsilon_i^y \times \frac{dy_i}{y_i} \\ &= [\bar{\varepsilon}_i - \eta_i \theta_i] \frac{dp}{p} + \varepsilon_i^y \times \frac{dy_i}{y_i} \\ &= \bar{\varepsilon}_i \frac{dp}{p} + \varepsilon_i^y \left[ \frac{dy_i}{y_i} - \theta_i \right] \end{aligned}$$

So the change in quantity demanded will be positive if:

$$\frac{dy_i}{y_i} > \theta_i - \frac{\bar{\varepsilon}_i}{\varepsilon_i^y} \frac{dp}{p}$$

This expression states that the quantity of electricity demanded by an individual can actually *increase* under the carbon tax if there is enough overcompensation,<sup>51</sup> and the percentage increase in disposable income as a result of cash payments and other tax changes exceeds the difference between the expenditure share of the good and the price change multiplied by the ratio of the compensated elasticity to the income elasticity. For a consumer who is compensated just enough to put them back on their original indifference curve, the change in ordinary demand is by definition equal to the change in compensated demand (which is equal to the compensated elasticity multiplied by the price change), and so we must have:

$$\frac{dy_i}{y_i} = \theta_i$$

The main implication is that it is likely that the quantity of electricity demanded will fall in response to the carbon tax – but the fall is likely to be less than would have occurred in the absence of compensation.

## Endnotes

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- 1 Unless otherwise indicated, all dollar figures used in this paper refer to Australian dollars.
- 2 An up to date database of entities that are directly liable to pay the carbon tax can be found at <http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/Liable-Entities-Public-Information-Database/LEPID-for-2012-13-Financial-year/Pages/default.aspx>
- 3 Draft legislation for the new policy was released on July 25 2013. See: <http://www.climatechange.gov.au/sites/climatechange/files/files/consultations/Explanatory%20paper-Moving%20to%20ETS.pdf>
- 4 Draft legislation for the new policy was released on July 25 2013. See: <http://www.climatechange.gov.au/sites/climatechange/files/files/consultations/Explanatory%20paper-Moving%20to%20ETS.pdf>
- 5 See Robson (2007) for a detailed assessment of the Shergold Report. The Australian Labor Party, which was in Opposition between 1996 and 2007 and is currently in Government, committed to a cap and trade scheme in 2004.
- 6 See [http://pandora.nla.gov.au/pan/79623/20071127-1411/www.dpmc.gov.au/publications/climate\\_policy/docs/climate\\_policy\\_2007.pdf](http://pandora.nla.gov.au/pan/79623/20071127-1411/www.dpmc.gov.au/publications/climate_policy/docs/climate_policy_2007.pdf).
- 7 Shergold Report, page 48.
- 8 See the Garnaut Report's Terms of Reference at [http://www.garnautreview.org.au/ca25734e0016a131/pages/draft-report-draft-report\\_-terms-of-reference.html](http://www.garnautreview.org.au/ca25734e0016a131/pages/draft-report-draft-report_-terms-of-reference.html)
- 9 See <http://www.garnautreview.org.au/chp13.htm>
- 10 See <http://pandora.nla.gov.au/pan/86984/20080718-1535/www.greenhouse.gov.au/greenpaper/report/pubs/greenpaper.pdf>
- 11 See <http://pandora.nla.gov.au/pan/99543/20090515-1610/www.climatechange.gov.au/whitepaper/report/index.html>
- 12 See <http://lowpollutionfuture.treasury.gov.au/lowpollutionfuture/default.asp>
- 13 The former Prime Minister, Ms Gillard, stated that she would not introduce a carbon tax, instead offering to lead a "national debate to reach a consensus about putting a cap on carbon pollution." The full statement committing not to introduce a carbon tax can be viewed at [http://www.youtube.com/watch?v=-EyW7oFk6n8&feature=player\\_embedded](http://www.youtube.com/watch?v=-EyW7oFk6n8&feature=player_embedded). The Treasurer and Deputy Prime Minister, Mr Wayne Swan, also stated that if the Government was returned in the election, there would be no carbon tax introduced in its next three year term. See <http://www.smh.com.au/federal-election/climate/gillard-rules-out-imposing-carbon-tax-20100816-1270b.html>
- 14 See, for example, <http://www.theage.com.au/federal-election/pm-pledges-peoples-assembly-on-climate-20100722-10myh.html>
- 15 See <http://www.climatechange.gov.au/climate-change/multi-party-climate-change-committee/overview>
- 16 See <http://www.roymorgan.com/findings/finding-4687-201302150042>
- 17 The EU price as at 9 August 2013 was €4.48, or \$6.50 at current exchange rates.
- 18 Currently there is no market for emissions permits in Australia.
- 19 For example, under the new draft legislation released on July 25 2013, the default cap will be 25 million tonnes below total covered emissions for 2012-13.
- 20 On the other hand, refineries are covered by the scheme, and hence petrol prices are indirectly affected by the scheme.
- 21 The purpose of the diesel fuel tax credit scheme is to remove the effect of fuel tax on off-road business inputs to ensure that production decisions are not distorted either within an industry or across industries.
- 22 See <http://www.cleanenergyfuture.gov.au/clean-energy-future/securing-a-clean-energy-future/chapter-3-putting-a-price-on-carbon-pollution/>
- 23 The NEM covers the Australian States of Queensland, NSW, ACT, Victoria, South Australia and Tasmania. Western Australia and the Northern Territory have separate arrangements.
- 24 See <http://www.arena.gov.au/about/index.html>
- 25 Similar points were made by the Productivity Commission (2008) in its submission to the Garnaut Review.
- 26 As Williams (2011) explains, the effective marginal tax rate (EMTR) differs from the statutory rate because of the operation of Australia's low income tax offset (LITO).
- 27 The marginal cost of public funds (MCF) is the cost to the private sector of the government raising a dollar of revenue using distorting taxes. The Australia's Future Tax System Review estimated that the MCF of personal income taxation was 1.24.
- 28 For a discussion of this, see Robson, A. (2009) "Burning Carbon Permits," *The Australian*, March 3 2009. <http://www.theaustralian.com.au/opinion/burning-carbon-permits/story-e6frg6zo-1111119011596>
- 29 See, for example, Ergas and Robson (2012).

- 30 This methodology is standard. For example, page 62 of the Australian Government's Department of Finance *Handbook of Cost-Benefit Analysis* states that: "a project should be accepted if the sum of its discounted benefits exceeds the sum of its discounted costs; that is, where its net present value exceeds zero."
- 31 See Harrison (2010) for an excellent analysis of the issues surrounding the appropriate choice of the social discount rate.
- 32 Australia's GDP in the year to March 2013 was \$1.5 trillion. See Australian Bureau of Statistics, Cat. No. 5206.0, Australian National Accounts.
- 33 Firms will abate up to the point where the marginal cost of abatement is equal to the carbon price. Hence the estimates suggests that the average cost of abatement curve is above the marginal cost curve for a certain range of abatement. See Figure 5.2 below.
- 34 The survey results can be found at  
[http://www.aigroup.com.au/portal/binary/com.epicentric.contentmanagement.servlet.ContentDeliveryServlet/LIVE\\_CONTENT/Publications/Reports/2013/Carbon\\_price\\_impacts\\_Jan\\_2013.pdf](http://www.aigroup.com.au/portal/binary/com.epicentric.contentmanagement.servlet.ContentDeliveryServlet/LIVE_CONTENT/Publications/Reports/2013/Carbon_price_impacts_Jan_2013.pdf) and  
[http://www.aigroup.com.au/portal/binary/com.epicentric.contentmanagement.servlet.ContentDeliveryServlet/LIVE\\_CONTENT/Publications/Reports/2013/Carbon%2520Tax%2520report%2520FINAL.pdf](http://www.aigroup.com.au/portal/binary/com.epicentric.contentmanagement.servlet.ContentDeliveryServlet/LIVE_CONTENT/Publications/Reports/2013/Carbon%2520Tax%2520report%2520FINAL.pdf)
- 35 See Strong Growth, Low Pollution, Table 5.15. The Melbourne Institute has also found that the introduction of the carbon tax and the effect on electricity prices also led to an increase in inflationary expectations. See  
[http://www.melbourneinstitute.com/downloads/media\\_release/2013/CIE/CIE\\_Media\\_Release\\_11July2013.pdf](http://www.melbourneinstitute.com/downloads/media_release/2013/CIE/CIE_Media_Release_11July2013.pdf)
- 36 See [http://melbourneinstitute.com/downloads/media\\_release/2012/TDsec\\_MI/TD-MI\\_PR\\_Jul12.pdf](http://melbourneinstitute.com/downloads/media_release/2012/TDsec_MI/TD-MI_PR_Jul12.pdf)
- 37 The Government has argued that many consumers have been overcompensated for the adverse effects of the carbon tax.
- 38 <http://statements.qld.gov.au/Statement/2013/5/30/green-costs-driving-up-electricity-prices>
- 39 [http://www.ipart.nsw.gov.au/Home/Industries/Electricity/Reviews/Retail\\_Pricing/Review\\_of\\_regulated\\_electricity\\_retail\\_prices\\_2013\\_to\\_2016/17\\_Jun\\_2013\\_-\\_Final\\_Report/Final\\_Report\\_-\\_Review\\_of\\_Regulated\\_Retail\\_Prices\\_for\\_Electricity\\_-\\_From\\_1\\_July\\_2013\\_to\\_30\\_June\\_2016](http://www.ipart.nsw.gov.au/Home/Industries/Electricity/Reviews/Retail_Pricing/Review_of_regulated_electricity_retail_prices_2013_to_2016/17_Jun_2013_-_Final_Report/Final_Report_-_Review_of_Regulated_Retail_Prices_for_Electricity_-_From_1_July_2013_to_30_June_2016)
- 40 The Government's recent 2013-14 Budget estimated that the tax will raise over \$35 billion in the first five years of the scheme, which is around 2 per cent of anticipated tax revenues over the same period.
- 41 Under the original CEF package, assistance consisted of the following broad measures (total dollar amounts over the first 4 years of the scheme are shown in parentheses): Household Assistance Measures (\$15.3 billion), Jobs and Competitiveness Program and Other Support for Jobs (\$10.3 billion), Clean Energy Finance Corporation (\$0.95 billion), Energy Security and Transformation (\$3 billion), Land and Biodiversity Measures (\$1.2 billion), Governance (\$0.38 billion), Coal Sector Jobs Package (\$0.74 billion) and the Steel Transformation Plan (\$0.19 billion).
- 42 Figure 5.9 shows that revenue projections for 2014-15 and 2015-16 are far below earlier projections. This is due to prices being revised downwards. The revised 2014-15 revenue reflects an assumption that Australia will allow international permit trading in 2014-15, which is earlier than assumed in previous projections.
- 43 See pages 55-56 of the 2013 Pre-Election Economic and Fiscal Outlook released on August 13.  
[http://www.treasury.gov.au/~media/Treasury/Publications%20and%20Media/Publications/2013/Pre%20Election%20Economic%20and%20Fiscal%20Outlook%202013/Downloads/PDF/PEFO\\_2013.ashx](http://www.treasury.gov.au/~media/Treasury/Publications%20and%20Media/Publications/2013/Pre%20Election%20Economic%20and%20Fiscal%20Outlook%202013/Downloads/PDF/PEFO_2013.ashx)
- 44 See, for example, Strong Growth, Low Pollution, page 121, Chart 5.24.
- 45 For a derivation of this formula, see Cahuc and Zylberberg (2001), Chapter 4.
- 46 This is defined as  $\epsilon_{ij}$ , where C is total production cost, and  $\epsilon_{ij}$  and  $\epsilon_{ji}$  is the cross-price elasticity of the conditional demand for input  $i$  in response to a change in the price of input  $j$ .
- 47 The Government expects that there will be 120 Mt CO<sub>2</sub>-e of abatement in the electricity sector to 2020, with 60 Mt CO<sub>2</sub>-e of this accounted for by the demand side. In the first four years of the scheme the share of demand side abatement is much higher, at around 60 per cent. See Chart 5.24 of SGLP.
- 48 [http://www.aemo.com.au/Reports-and-Documents/Reports/~media/Files/Other/reports/CarbonPrice\\_MarketReview.ashx](http://www.aemo.com.au/Reports-and-Documents/Reports/~media/Files/Other/reports/CarbonPrice_MarketReview.ashx)
- 49 See <http://www.climatechange.gov.au/climate-change/greenhouse-gas-measurement-and-reporting/tracking-australias-greenhouse-gas-emissio-0/quarterly-update-australias-national-greenhouse-gas-inventory-december-2012>
- 50 The explanatory memorandum is available at: [http://parlinfo.aph.gov.au/parlInfo/download/legislation/ems/r4653\\_ems\\_065eea50-9f9d-46db-93be-cf3f5440a0c4/upload\\_pdf/11168rem.pdf;fileType=application%2Fpdf](http://parlinfo.aph.gov.au/parlInfo/download/legislation/ems/r4653_ems_065eea50-9f9d-46db-93be-cf3f5440a0c4/upload_pdf/11168rem.pdf;fileType=application%2Fpdf)
- 51 The Government has argued that many consumers have been overcompensated for the adverse effects of the carbon tax.



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