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TWO ISSUES IN CARBON PRICING: TIMING AND COMPETITIVENESS

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1 *The two issues*

There is wide recognition that one of the most effective ways to deal with climate change is to introduce a price signal (either coming about through a carbon tax or through an emissions trading scheme) to encourage efficient abatement of greenhouse gas emissions.

In considering such a signal, there are two issues have emerged in recent policy discussions. These are:

- The question of the timing of a price signal in particular whether the signal should be introduced ‘early’, or whether it would be more appropriate to first subsidise R&D — and so lower the cost of abatement — before introducing price signal; and
- The question of whether, and how, Australia could ‘compensate’ for trade effects (or a loss of ‘competitiveness’ that could be experienced by particular industries) if Australia did introduce a significant carbon price signal before such a signal was introduced by our trading partners.

Timing a price signal

A considerable amount of recent discussion (as well as a number of policy initiatives) has focused on the need for technological solutions to reducing emissions. In particular, discussion has focused on the need for completely new low emitting energy technologies (including, for example, carbon capture and storage).

The development of these technologies is sometimes seen as quite separate from the introduction of any carbon price signal. In this view, appropriate policy action involves large subsidies to R&D (and possibly to implementation) now, with actual abatement taking place at some point in the future. An implicit view expressed in this debate is that a price signal can be implemented separately from R&D policies and that the price signal aspects could in fact take place much later than the R&D based policies.

The discussion in chapter 2 below sets out a basic framework for considering the timing of abatement efforts, particularly as the cost of abatement changes over time. A key finding is that R&D policies and carbon pricing policies should not be considered as independent, but rather as closely interrelated and complementary.

Loss of competitiveness

A common concern with the introduction of a price signal (through a carbon tax or through emission trading) is that in the absence of similar policies adopted by our key trading partners (particularly developing country partners), Australia (or specific industry groups within Australia) would suffer a 'loss of competitiveness' that would impose unnecessary costs on the economy.

Some arguments have been put that this loss could be offset through a variety of mechanisms, including the use of border price adjustments applied to affected commodities (which are equivalent trade taxes or subsidies) and other forms of compensation to firms in particular industry groups that suffer from this competitiveness loss.

The discussion in chapter 3 below sets out a framework for carefully defining the 'loss of competitiveness' and tracking how it comes about. There is an important distinction between the overall effects on the economy of Australian and rest of world carbon prices, and the effects on particular industries of these policies. The chapter then considers various means of addressing the loss of competitiveness of particular industry groups, including border price adjustments and other forms of subsidies. A key finding is that these various measures are limited in what they can ultimately achieve, and that there is considerable scope to mitigate adverse competitiveness effects through the careful design of the pricing scheme.

What is the policy objective?

It is important when considering both timing and competitiveness issues to be clear about the exact nature of the policy objectives and the appropriate welfare measures in evaluating policies to achieve those objectives.

At it's broadest level, the objective must be to achieve abatement up to the point where the marginal costs of abatement are equal to the expected marginal benefits (climate change avoided) of that abatement (and must also be balanced with the marginal costs and benefits of adaptation). Such a cost benefit framework has not been much of a feature of international negotiations of the Kyoto Protocol but is a major part of the key economic critiques of the targets approach under the Kyoto Protocol[1]. Thus, for example, various critiques of the Kyoto-style approach have pointed out the risks of targets without regard for costs, while others have pointed out the relative merits of price versus quantity regulation[2]. More recently, the Stern Review undertaken for the UK Treasury implicitly advocates a broad cost benefit approach to climate change.[3]

For Australia choosing its actions, a global benefit-cost analysis may not be appropriate, and it may be more appropriate to think about achieving an amount of cumulative abatement (over a particular time period) at minimum cost. Cumulative abatement — rather than a particular target in any particular year — is an appropriate target because it is greenhouse gas concentrations that influence the climate, rather than particular emissions in a given year. It is common now to consider cumulative abatement in analyses of various kinds.

In the discussion of timing (chapter 2) we mostly take a cumulative abatement at minimum cost perspective. However, in some cases the benefit cost approach is more revealing, so we use that where necessary.

For the competitiveness discussion, the policy objective behind introducing some form of carbon pricing in Australia before it is necessarily in place in our trading partners has a number of components.

- First, it provides an opportunity for Australia to display 'leadership' on the climate change issue and to demonstrate policies in this area.
- Second, putting some mechanisms in place in Australia allows 'learning by doing' in the policy process. Implementing low cost mechanisms now provides time for both policy makers and other participants to learn how they work and what they will mean when broader schemes ultimately come into play.
- Third, optimal greenhouse policy is often likened to a form of insurance — purchasing something now with the prospect (but not certainty) of gaining in the future. Setting up a carbon pricing scheme in Australia now can be seen as a similar form of insurance. In this case, the 'cost' may also include some loss of competitiveness for some industry groups.

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[1] See, for example, Nordhaus and Boyer *Warming the World*, MIT Press, 2000.

[2] See, for example, McKibbin and Wilcoxen *Climate Change Policy after Kyoto*, Brookings Institution Press, 2002.

[3] Stern, N. *The Economics of Climate Change*, HM Treasury and the Cabinet Office.

- With an appropriate form of pricing it may be possible to avoid short term losses by offsetting the cost of carbon with a reduction in the risk of carbon intensive investments on company balance sheets. Put another way, there may be gains by providing mechanism for companies to manage risk and to reduce the risk of government policy changing in the future.

2 *Issues in the timing of abatement*

A basic framework

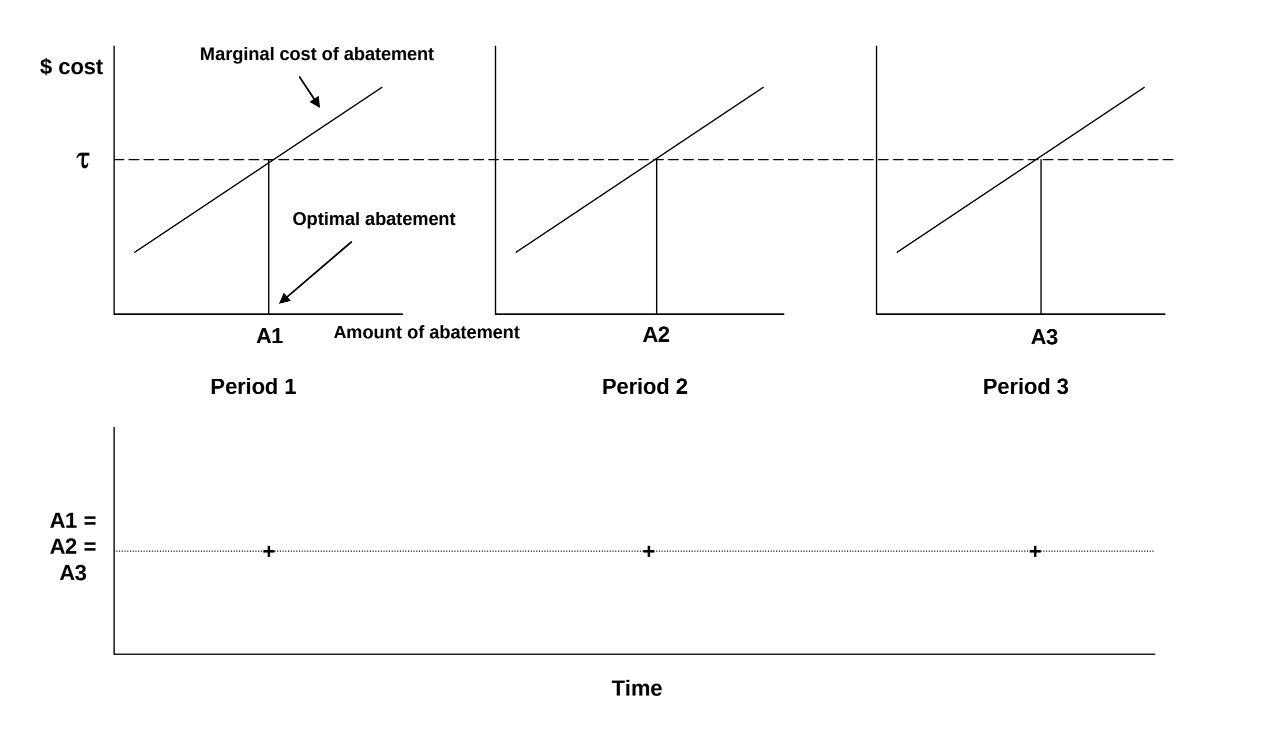
Timing issues can be considered using the basic framework set out in chart 2.1. It shows three points in time, with identical marginal costs of abatement at each point. In the top panel, the upward sloping curve in each period is the marginal cost of abatement. As the amount of abatement (on the horizontal axis) increases, so to does the marginal cost (on the vertical axis). If the target for abatement in period 1 is A1 (tonnes), then in period 1 the optimal carbon price will be τ.

If the total cumulative abatement target is equal to A1+A2+A3, then with identical marginal costs of abatement in each period, and ignoring the discount rate (see below), it is optimal to abate by equal amounts each year. Optimality requires that the marginal cost of abatement is equated in each year. The optimal carbon price is τ. The bottom panel of the chart shows the amount of abatement in each period of time, which in this case is identical.

With a cumulative abatement target, the initial level of the optimal carbon price, τ, is determined by the target (the total level of desired abatement over time) while the path of the price is determined by the marginal cost of abatement in each period.

Under emissions trading, this carbon price would result from the trading activities of the various participants of the scheme. It reflects the equating of the marginal cost of abatement between different emitters. Under a carbon tax, this price would be directly imposed on emitters.

2.1 **Equating the marginal cost of abatement over time**



The discount rate

Of course, equating the marginal cost of abatement in each period requires putting those costs on a common basis that is, discounting them. Chart 2.2 shows the effect of including the discount rate. With discounting, the optimal carbon price increases by the discount rate in each year[4]. Thus, even assuming identical marginal costs of abatement in each year, abatement will tend to increase over time.

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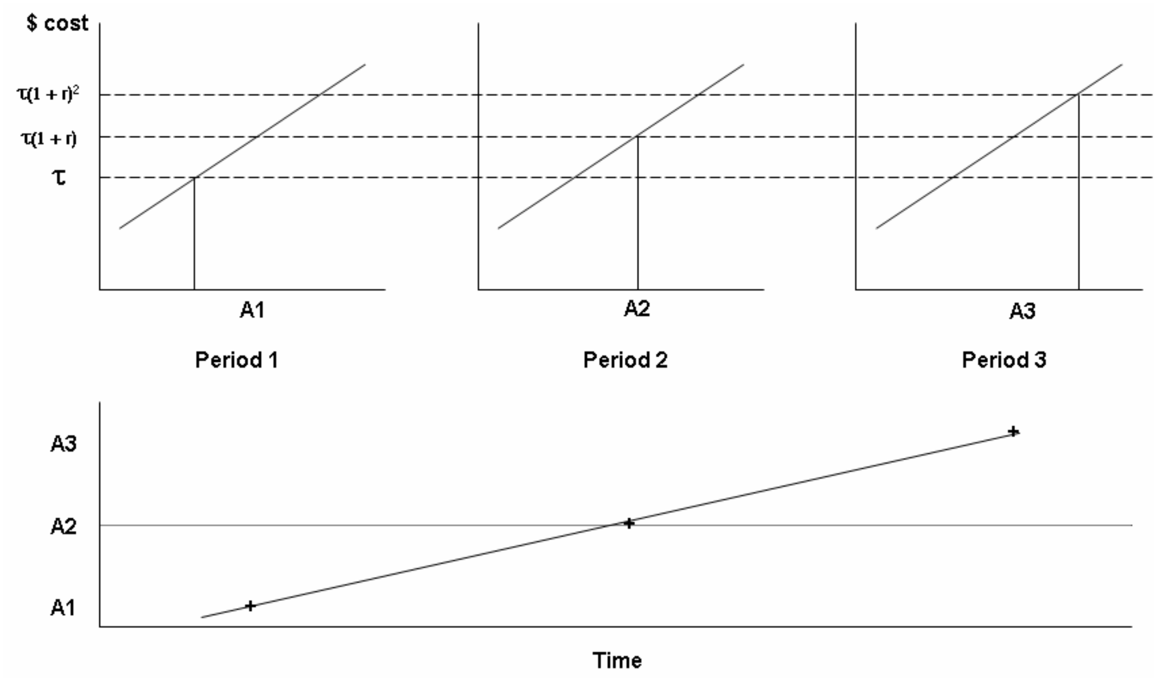
[4] The appropriate discount factor may be more complex than this if we account for the dynamics of carbon in the atmosphere. For example, some of the carbon emitted today may be absorbed (by oceans, for example), so the discount factor needs to include this absorption rate.

2.2 **Including the discount rate**



The choice of discount rate will clearly have a significant influence on the optimal rate of abatement over time. There is no general agreement on the discount rate that should be used when undertaking analysis of the benefits and costs of climate action. Many analysts, however, argue for a relatively low discount rate.[5]

Declining marginal cost of abatement over time

Chart 2.3 shows the effect of the declining marginal cost of abatement (MCA) over time. Here we have abstracted from the discount rate in order to show the MCA effect. With declining MCA over time, there are two effects. First, more abatement will be done in later years given the initial optimal carbon price. However, with this initial rate, the cumulative amount of abatement is greater than initially, so to achieve the same cumulative abatement, it is optimal to lower the carbon price. The net result is an upward shift in the profile of abatement, less now and more later.

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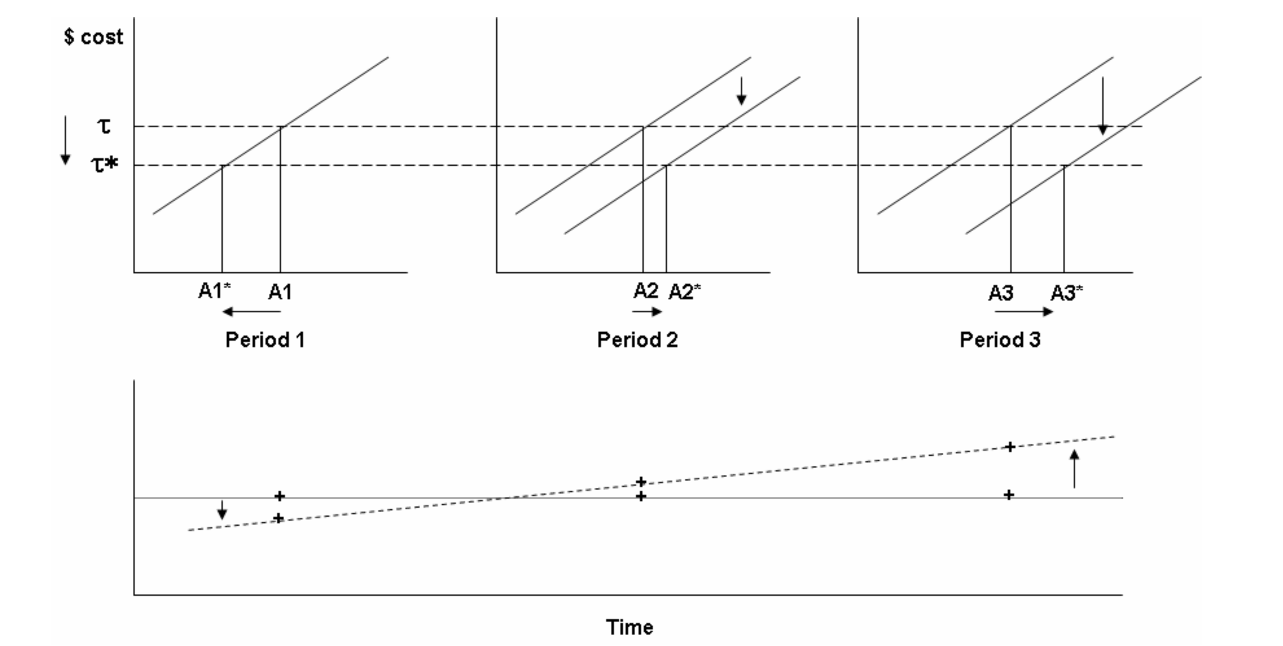
[5] See, for example, W. Cline *Climate Change* in B. Lomborg (ed) *Global Crises, Global Solutions*, Cambridge University Press, 2004. See also Portney and Weyant (eds) *Discounting and Intergenerational Equity*, Resources for the Future, 1999. The Stern Report (op. cit.) uses a very low discount rate.

2.3 **Declining marginal cost of abatement over time**



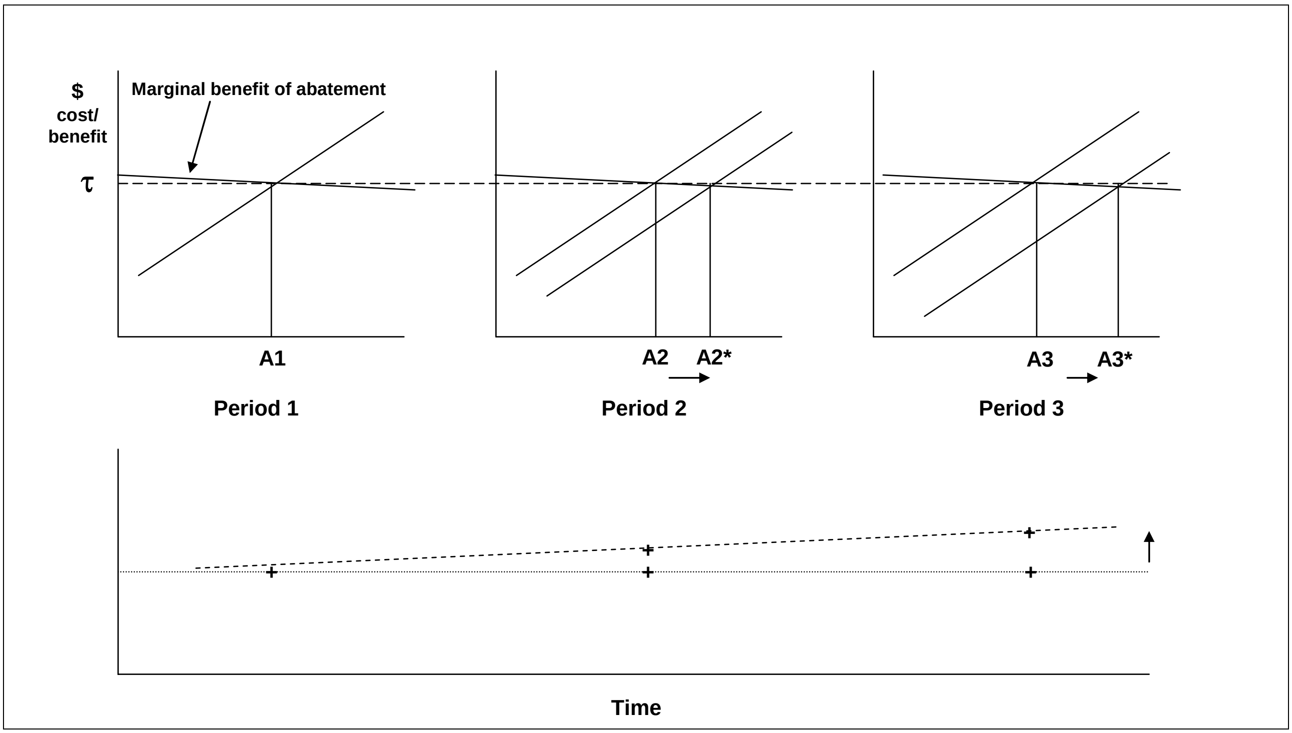
From the perspective of optimal climate policy

It is interesting to note that the results are slightly different from the point of view of optimal climate policy — that is, rather than minimising the cost of a given level of abatement, this approach chooses the level of abatement that equates the marginal cost with the marginal benefit of abatement. This is illustrated in chart 2.4, which as well as showing the marginal cost of abatement, also shows the marginal benefit of abatement. The marginal benefit of abatement is the flip side of the marginal damage done for each tonne of carbon in the atmosphere (by making the climate worse). The marginal damage curve, or the marginal benefit of abatement curve, is frequently argued to be fairly flat as illustrated in chart 2.4.

As illustrated in chart 2.4, the marginal benefit of abatement curve is designed to show the benefits of abatement in that year. The objective of optimal climate policy is then to minimise present value of the total net cost (ie cost of abatement less of benefit of abatement) over time. In chart 2.4 the marginal benefit of abatement curve is drawn in the same position each year for the sake of illustration, but this will not necessarily be the case. The marginal benefit of abatement will depend on the level of emissions (that is, the amount of induced climate change) and so may vary over time.

Chart 2.4 illustrates that if the MCA is reduced, the effect on the optimal carbon price is very small, as the optimal price is essentially determined by the marginal benefit of abatement (or the marginal damage of carbon). With a declining marginal cost of abatement, the optimal carbon price remains roughly the same, the optimal amount of abatement increases over time, but the optimal amount of abatement in period 1 does not decline (in contrast to chart 2.3).

2.4 **Declining marginal cost of abatement assuming optimal climate policy**



Why would the marginal cost of abatement decline?

The MCA may decline over time for a variety of reasons. Many models, for example, include autonomous energy efficiency improvements (AEEI) which can (although not always) have the effect of lowering the marginal cost of abatement.

One of the most significant reasons why the MCA could decline over time is because of R&D which leads to technical improvements, or entirely new technologies, that are less carbon intensive, leading to a lower cost of abatement.

Technical change may be induced by a price signal (that is, by the carbon tax rate or permit price). Such induced technical change (ITC) is a feature of the price response to carbon prices in some models. Depending on the nature of the research 'production function' (that is, how responsive knew knowledge is to R&D spending), it may be optimal for a firm or the economy to put resources into R&D rather than abatement early on in order to lower the future marginal cost of abatement. There is clearly a trade off here: in effect it is important to ensure that the marginal benefit of R&D spending (lower MCA in the future) is equated with the marginal cost of abatement in each year. It is not optimal to put unlimited amounts into R&D.

Is technical change 'exogenous'?

An important feature of induced technical change as it is frequently modelled is that the technical change is in response to a price signal of some sort and that the decision about how much to spend on R&D to lower the marginal cost of abatement is made at the same time as the decision about how much to abate now. Indeed, without some idea of the shadow cost of carbon (either in terms of an overall cumulative abatement objective, or in terms of optimal climate change) it is impossible to know what resources should be devoted to R&D.

Some recent policy discussions have suggested that R&D spending, particularly subsidised by the government, should replace any form of pricing of carbon[6]. Under this view, R&D proceeds independently of any price or profitability incentives, and that once the object of the R&D is discovered or developed, it is diffused immediately throughout the economy and adopted, lowering the economywide marginal cost of abatement.

In reality, individual firms would have little incentive to adopt new technologies unless they also face a price signal which suggests that the new technology is likely to be profitable.

Research in the US suggests that technical change does in fact respond to price signals in the energy market[7]. This suggests that price signals in combination with R&D subsidies will help generate an appropriate response.

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[6] See, for example, Montgomery, D. and Smith, A. 2005 *Price, Quantity, and Technology Strategies for Climate Change Policy,* CRA International. For an alternate view, see Pezzey, J., Jotzo, F. and Quiggin, J. *Fiddling While Carbon Burns*, Australian National University Economics and Environment Network Working Paper EEN0611, December 2006.

[7] See, for example, David Popp "Induced Innovation and Energy Prices", *American Economic Review*, March 2002.

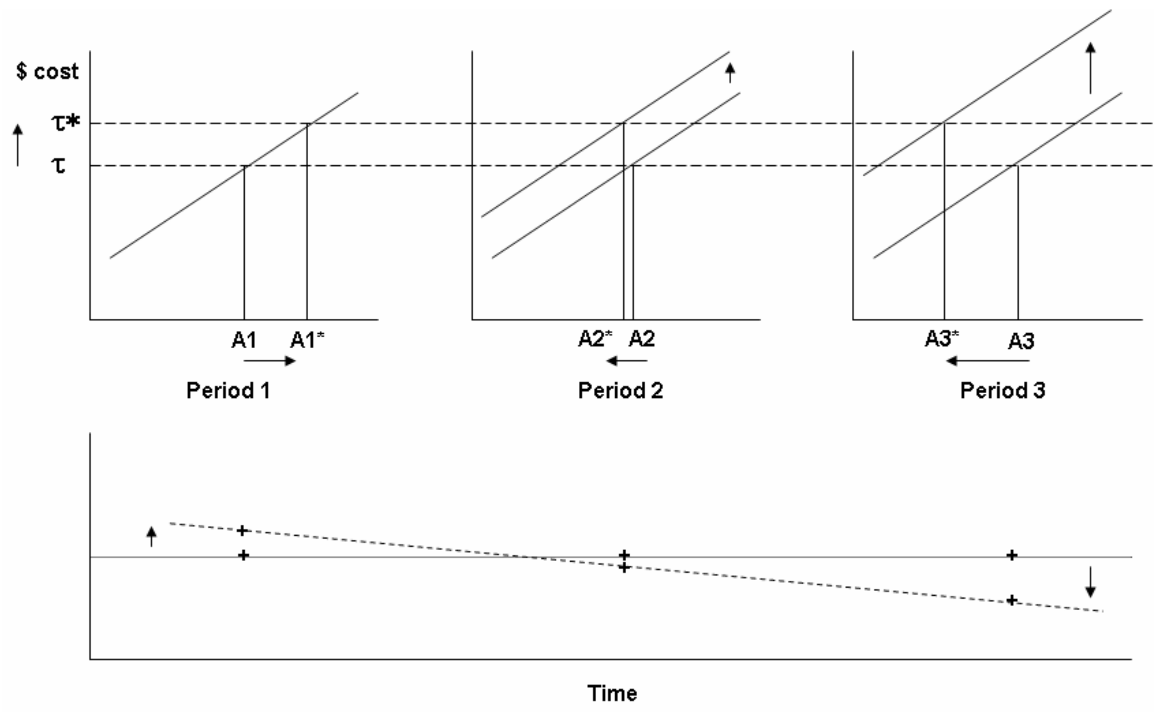
How much should be spent on R&D to lower the MCA?

The reduction in the MCA illustrated in charts 2.3 and 2.4 does not come free. It requires real resources to be devoted to developing the new technologies and to putting them in place. As is always the case, these resources have an opportunity cost (the R&D funds, for example, could have been spent elsewhere in the economy).

Increasing marginal cost of abatement over time

In contrast to the situation presented above, if the marginal cost of abatement increases over time, then it is optimal to do more abatement now and less later (chart 2.5).

2.5 **Increasing marginal cost of abatement over time**



The marginal cost of abatement may increase over time for a variety of reasons.

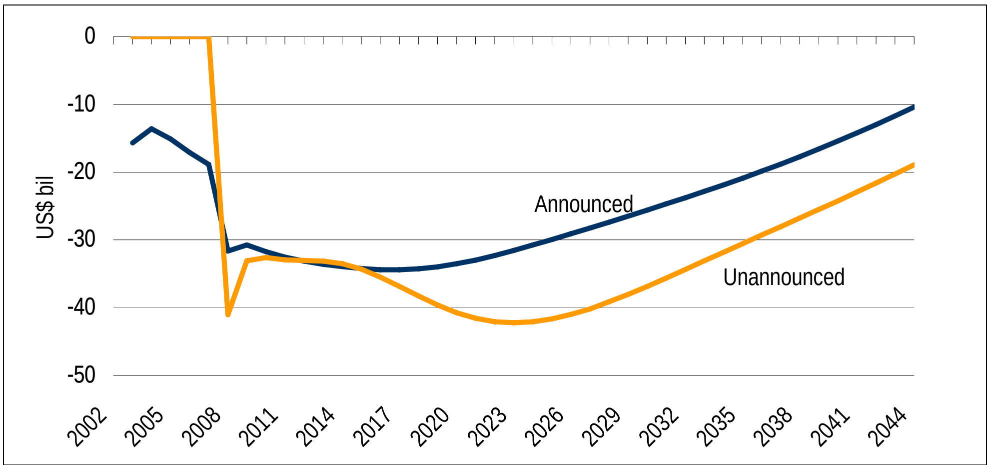
First, it is not necessarily the case that new technologies — particularly if they are developed independently of a carbon price signal — will lower the *marginal* cost of abatement. New technologies are designed to solve technical problems of various kinds, only some of which are related to carbon. New cost saving technologies may be adopted regardless of their carbon characteristics in response to pricing signals that already exist.

Second, new technologies — particularly energy cost saving technologies — have two distinct effects: a substitution effect and an expansion effect. The *substitution* effect leads to a substitution away from energy inputs. This generates an increase in real income which may results in an *expansion* effect involving the increased total use of energy. Despite the technical change, the baseline emissions path may increase which — depending on the industries involved — may lead to an increase in the marginal cost of abatement. This effect is avoided however, where the expansion effect is modified by a clear price of carbon.

Third, in the absence of an appropriate price signal, new capital that is carbon intensive may be put in place (in period 2 say). This capital is put in place according to normal capital turnover dynamics in a variety of industries. With no carbon price signal, there is no particular incentive for this new capital to be less carbon intensive than the original capital stock. Given, however, that there are cost of adjustment in installing and replacing new capital, the new capital spending will tend to increase the marginal cost of abatement.

This effect is evident, for example, in simulations using the G-Cubed model[8] where both announced and unannounced carbon taxes are imposed. Chart 2.6 illustrates this result, showing the effect on real consumption of a uniform carbon tax.

2.6 **Effect on real consumption of announced and unannounced carbon tax**
Deviation from baseline



Data source: G-Cubed simulation

[8] See McKibbin W. and P. Wilcoxen (1998) “The Theoretical and Empirical Structure of the G-Cubed Model” *Economic Modelling* , vol 16, no1,

The carbon tax is actually introduced in 2008, but credibly announced in advance (in effect, an early price signal). Under the announced tax, abatement starts immediately, and so welfare immediately declines. With the unannounced tax, welfare does not decline until 2008.

Under the *announced* path, the present value of the loss of real consumption is 3 per cent *lower* than under the *unannounced* path. The welfare loss per unit of cumulative abatement is about 5 per cent *lower* under the *announced* path than under the *unannounced* path.

The implication of this is that when abatement starts *earlier* (in response to credible price signals), the total cost of abatement is *lower*. In the G-Cubed model this largely comes about as a result of firms better managing changes in their capital stock in response to carbon prices. Changing the capital stock is costly and uses real economic resources. Where the carbon price is known in advance, firms can plan a cost minimising path of adjustment. Where the price comes in later, and is a surprise, adjustment is considerably more costly.

Learning by doing

While some technical change leading to a reduction in the MCA may result from R&D, other forms of innovation may result from 'learning by doing'. Learning by doing is innovation that results not from specific R&D activities but from non-R&D innovation expenditure[9].

With learning by doing, the reduction in the marginal cost of abatement next year depends on the amount of abatement this year. This gives an additional value to abatement this year (the knowledge gained this year which is applied next year). Learning by doing is illustrated in chart 2.7. Because the MCA curve declines in the future, the carbon price can decline relative to no learning by doing. However the optimal amount of abatement today is set not just by equating the marginal cost of abatement and the carbon price, but by equating the marginal cost of abatement with a carbon price *plus* the marginal benefit of abatement today (K, or the value of knowledge from learning by doing).

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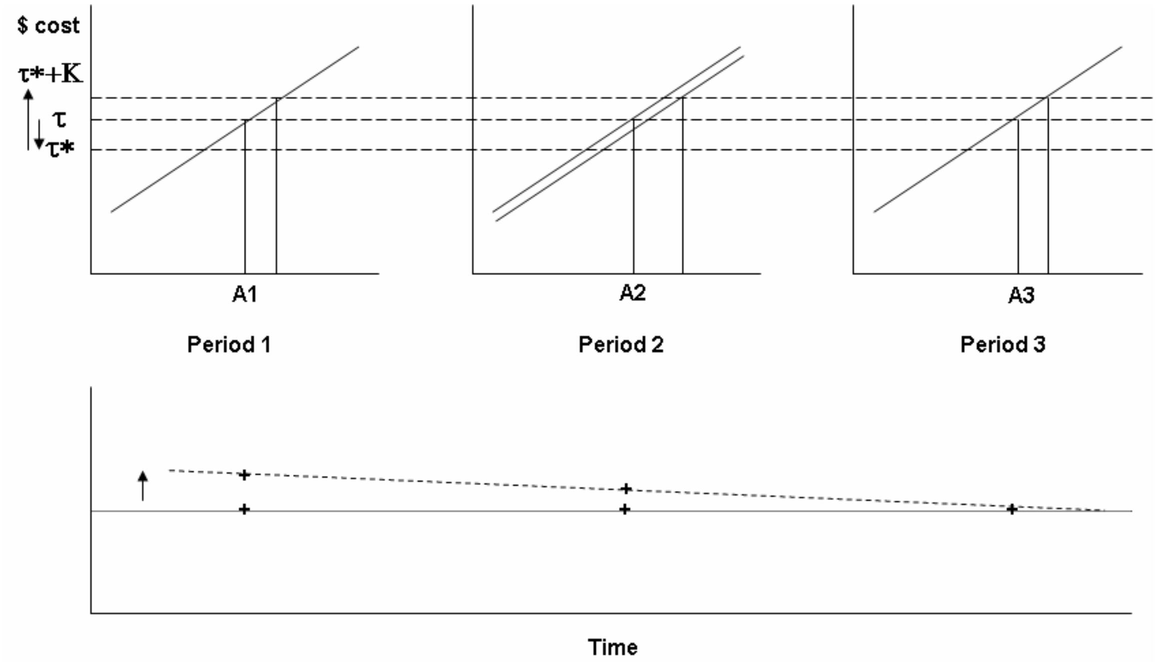
[9] Surveys by the ABS indicate that non-R&D expenditure on innovation represents 70 per cent of total expenditure on innovation. See ABS *Patterns of Innovation in Australian Business 2003*.

2.7 **Learning by doing**



As illustrated in chart 2.7, it is possible (but not guaranteed) that with learning by doing it is optimal to do more abatement now and less abatement in the future.

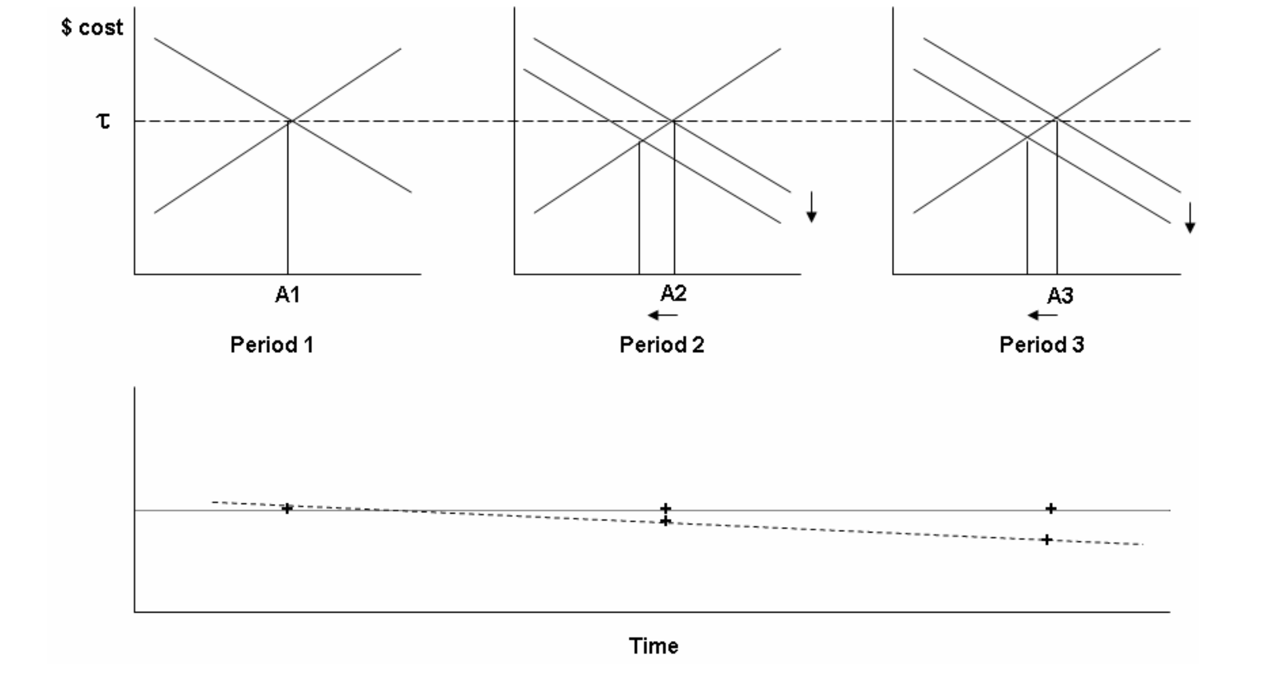
It is likely that learning by doing characterises a considerable amount of potential innovation in carbon emission reduction. While much discussion has focused on new large scale technologies (clean coal, carbon capture and storage and so on) there is also a large range of smaller innovations which can take place in a variety of firms in a variety of industries. These opportunities are unlikely to be identified in centralised subsidy schemes, but need to be discovered in the process of every day business in response to price signals.

Changes in the climate damage function

While the discussion so far has considered the effect on timing of abatement of changes in the marginal cost of abatement, timing will also be influenced by changes in marginal damages from climate change itself.

This is illustrated in chart 2.8. The optimal amount of abatement can be determined by setting the marginal cost of abatement equal to the marginal benefit of abatement (assumed to slope downwards in chart 2.8). It is possible that for a variety of reasons, including research, the marginal benefit of abatement could decline over time. This would imply decreasing abatement over time.

2.8 **Changes in the damage function**



Put another way, one avenue for research is methods of cost effective adaptation to climate change so that the damage from that climate change is reduced.

Clearly there is considerable uncertainty associated from this type of research. Research into minimising the costs of climate change (or maximising the opportunities that it may present) probably involves a considerable amount of basic research (understanding, for example, the dynamics of plant growth under higher temperatures and higher carbon dioxide). There is probably a very strong public good argument for this avenue of research.

From a risk management perspective, what is important is the uncertainty surrounding the marginal benefit of abatement (or the marginal damage from emissions). If, for example, the climate is characterised by non-linear are threshold effects[10], there is a risk of too little abatement in the early years leading to threshold damages (a jump in the marginal benefit of abatement) leading to an outcome that more early abatement would be appropriate.

What forces drive the results

These illustrations indicate a number of points about the timing of abatement.

- There are factors which suggest relatively more early abatement, and other factors which suggest relatively later abatement.
- High discount rates suggest later abatement, while low discount rates suggest earlier abatement. The choice of a discount rate from the perspective of policy is problematic, and there is no general agreement about an appropriate discount rate.
- The possibility for technical change which lowers the marginal cost of abatement in the future suggests later abatement. However, decisions on how much to spend on such research need to be informed by an appropriate pricing signal.
- The possibility of technical change or capital expenditure which raises the marginal cost of abatement suggests more abatement now, and less abatement in the future.
- The 'learning by doing' characteristics of much innovation may suggest relatively more abatement today.

What does this mean for policy?

Two targets, two instruments

The overall policy objective is to reduce emissions at minimum cost. There are a number of ways of achieving this ranging from changed practices (for example, design of buildings, changing individual consumption patterns and so on) to fundamental changes in energy production technology. Technological solutions are well recognised as forming a major part of any

[10] See, for example, Rial, J. et. al 2004, 'Nonlinearities, feedbacks and critical thresholds within the Earth's climate system', **Climatic Change** 65 pp. 11-38, Kluwer Academic Publishers.

measures to reduce emissions. It is also well recognised that there are market failures in undertaking R&D to generate new ideas. In Australia a range of policies are used to subsidise R&D.

A conclusion commonly drawn from this is that because of the need for a technical solution, and because of the need for R&D subsidies of various kinds, an appropriate policy response is to subsidise low emitting technologies of various kinds, and that carbon pricing based policies are not needed.

That this conclusion is incorrect can be seen by considering the general principle that different policy targets often require different policy instruments. The target for an R&D subsidy is the development of a new technology and the correction of a 'market failure' the generation of new knowledge. But there is a second set of targets, and that is the *adoption* of (new or existing) technologies that reduce emissions, or the *discouragement* of increased used of high emitting technologies. None of these second targets are addressed by technology or R&D subsidies. This second target requires a second instrument, which essentially amounts to some form of carbon price.

Indeed, as illustrated above, it is quite possible that the use of new technologies alone will not actually result in lower emissions, but in increased emissions. Another instrument is required to ensure this does not happen.

The need for R&D subsidies

In their most recent review of the need for public funding of R&D, the Productivity Commission found that there were two rationales for public funding support of science and innovation:

> The first is that publicly funded R&D is a significant contributor to innovation in the functions performed by government…The second significant rationale is the existence of 'spillovers' from innovation. These are benefits that cannot be captured by the innovator — ideas that can be used, mimicked or adapted cheaply by firms or others without payment to the originator.[11]

There are good reasons to consider that these broad findings would also apply to R&D funding for new technologies needed to produce energy with low emissions or to sequester carbon emissions in various ways.

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[11] Productivity Commission *Public Support for Science and Innovation: Productivity Commission Research Report Overview*, 9 March 2007, p. xvii

The need for a price signal

There are several reasons, however, why a carbon price signal is needed in conjunction with R&D subsidies.

Incentives to avoid new carbon intensive investments

Given that many energy investments are long lived, while new technologies are being developed, it is important that firms are given a clear price signal discouraging or limiting new investments in carbon intensive activities. As was argued above, a clear price signal is likely to help minimise the cost of abatement over time.

Price signals are needed for planning in advance of new technologies

Related to this is the idea that firms need clear price signals when planning future activities and making judgements about what production methods, technologies and products will be profitable in the future. Clear price signals enhance this planning process considerably.

Incentives for adoption of new technologies

Even with the development of a new low emitting technology, without a price signal there is unlikely to be incentive to actually adopt that new technology. A price signal provides firms with a firm indication of the tradeoffs involved in using new technologies and will allow them to choose the appropriate level of use of the new technology.

Setting bounds on how much to spend on R&D

While R&D spending on new technologies is a very important component of any response to climate change, there are clearly bounds on how much it is sensible to spend on that R&D. All R&D spending has an opportunity cost — the same funds could have been spent elsewhere and the resources used in the R&D (talented researchers, for example) could have been deployed elsewhere. Without a carbon price signal, it is extremely difficult to make judgments about the appropriate amount of R&D spending.

R&D does not necessarily lower the optimal carbon price

As noted above, R&D which lowers the marginal cost of abatement does not necessarily lower the marginal benefits of abatement (or conversely, the marginal damage of carbon in the atmosphere). This means that R&D itself does not lower the optimal carbon price. Put another way, an R&D subsidy may solve a knowledge externality problem, but does not in itself address the climate externality problem.

Price signals needed to ensure that emissions actually decline

Even with low emitting technologies forming part of the energy mix, without a carbon price signal there is no guarantee that emissions will actually decline. To the extent that a new technology lowers the price of energy, a subsequent expansion in economic activity may lead to an increase in total energy use, including emitting energy sources. A carbon price signal will ensure that this *expansion* effect does not outweigh the *substitution* effect of shifting to lower emitting sources.

Summary of issues

Table 2.9 summarises some of the key issues outlined above when comparing R&D subsidies with price instruments.

2.9 **Summary of instruments, targets and issues**

		INSTRUMENTS
TARGETS	***R&D subsidies***	***Carbon pricing***
Development of new technologies	Will assist in knowledge generation externalities	Will create some incentives for development of new technologies, by may still face knowledge externality problems to some degree
Adoption of low emitting technologies and practices (already existing, or yet to developed)	No automatic incentives for adoption. Possibility of perverse effects No planning signals Does not change need to price marginal damage of carbon	Creates incentive for adoption Provides planning signals Provides benchmark to estimate value of new technologies
Challenges in using the instrument	How much to subsidise? Accounting for opportunity cost of R&D funds	Choice of mechanism to create a price: tax, or emissions trading or a hybrid

When should the price signal start?

The various points presented above suggest that it would be sensible for a low price signal to start in the very near term.

How do we get the price signal right?

While details of mechanism are beyond the scope of this paper, but there are a variety of ways of delivering an efficient price signal. In the case where Australia takes action before other countries it is clear that the price should start low and rise over time as more countries take on carbon prices.

3 Competitiveness

The policy issue

Like any policy measure, the introduction of a carbon pricing mechanism in Australia now (ahead of a similar price mechanism in our trading partners) will have both benefits and costs.

Benefits

There are a number of potential benefits from the introduction of carbon pricing in Australia, even before other trading partners do so.

- First, it provides an opportunity for Australia to display 'leadership' on the climate change issue and to demonstrate the sensible construction of policies in this area.
- Second, putting pricing mechanisms in place in Australia allows 'learning by doing' in the policy process. Implementing low cost mechanisms now provides time for both policy makers and all those affected to learn how they work and what they will mean when broader schemes ultimately come into play.
- Third, optimal greenhouse policy is often likened to a form of insurance — purchasing something now with the prospect (but not certainty) of gaining in the future. Setting up a carbon pricing scheme in Australia now can be seen as a similar form of insurance — insurance against ultimate need for more dramatic policies in the future.
- Fourth, the implementation of an appropriate pricing scheme provides an opportunity for companies to manage their highly uncertain climate risks, and to reduce the risk of unexpected changes in government policy in the future.

Costs

The cost associated with these benefits is that there will be a potential increase in the price of energy, a reduction in activity in carbon based areas (potentially offset by an increase in activity in other sequestering activities) and a potential reduction in activity in industries that are energy intensive and that compete on international markets with other energy intensive firms that are not currently facing a carbon price. It is important to note that energy exports themselves (eg coal, oil and gas) would not normally be subject to an emission price in Australia, but may be subject to a carbon price in the ultimate destination country.

There are two conceptually distinct components to these costs.

- *Those that will arise even under international schemes for pricing carbon.* Some reduction in carbon intensive activities is a necessary consequence of even full global abatement (that is, even where there is no loss of Australian exports of particular products relative to our trade competitors). The problem with the loss of activity that would have been lost anyway with a global scheme is that with an early Australian scheme, the loss happens sooner than otherwise.
- *Those that arise because of the fact that the carbon pricing is implemented in Australia but not in our trading partners.* If Australia were to introduce a carbon pricing (tax or emission trading) mechanism ahead of our trading partners (particularly developing country partners), one effect of this could be to reduce the 'competitiveness' of some of Australia's trade exposed and energy (or carbon) intensive industries, resulting in a loss of export income and hence national income

While this second component is the most immediately evident, it is important to keep this distinction in mind, as any sensible policy will seek to minimise all costs, not just those that seem immediately apparent. Further, it is important that a policy which seeks to minimise one type of costs does not inadvertently increase the other type of costs.

The extent of any cost effects as a result of a carbon price will vary considerably from industry to industry. The highest costs are likely to occur in energy intensive export activities (such as aluminium). At next level, industries which themselves are not necessarily energy intensive but which use the output other energy intensive industries will experience a 'diluted' cost increase.

Net benefits or net costs?

While an Australian scheme may lead to a loss of 'competitiveness' for some industries, such a loss is not inevitable and there may also be significant benefits, even for carbon intensive and trade exposed industries, associated with particular forms of carbon pricing schemes. Policies which create a new asset class associated with the property rights created by a carbon constraint that allows firms to manage their climate and greenhouse risk will bring significant benefits to some industries.

Effects on trade and investment

The introduction of a carbon price in Australia will almost certainly have some effect on Australia's trade and investment patterns, with the magnitude of this effect depending on a variety of factors (considered further below). As an energy exporter as well as a significant energy user, these effects will be both direct and indirect — direct through changes in exports (and possibly imports) of energy intensive products and indirect through changes in exports (or imports) of goods what while themselves not energy intensive, use other energy intensive products as inputs.

In addition, the expectation of an energy price increase may lead to some changes in investment patterns, particularly for new projects. Specifically, new energy intensive projects of various kinds may be developed in countries without any form of carbon pricing rather than in Australia. Whether this happens also depends on a variety of factors (considered further below) and may be quite sensitive to the overall design of any carbon pricing mechanism.

As noted above, some of these effects on trade and investment may be an undesirable consequence of an Australian carbon price mechanism put in place for the reasons outlined above, but not necessarily put in place in our trading partners. These effects may be of concern if they are considered to impose an unnecessary short term cost on energy intensive exporters (or import competing industries). While these industries may ultimately face long term costs — even when all countries impose a carbon price — it may be sensible to explore ways of minimising the short term costs to these particular industry groups.

The prospect for minimising effects on trade and investment

The need to minimise the short term costs on energy intensive and trade exposed industries leads to two broad questions:

- how can the carbon pricing policy be designed in order to minimise the cost; and
- what complementary measure might be needed to offset the cost (while still maintaining the benefits)?

These questions will be addressed after considering in more detail exactly what is meant by a loss of competitiveness.

Can the negative effects be eliminated?

It is important to note that any policies to address the potential effects of carbon pricing on trade and investment will inevitably be limited in what they can achieve. The fact that a carbon price will lead to pressure on trade and investment flows means that even with policies to compensate particular industries, this pressure will, in effect, come out somewhere. As noted below, any domestic measures to address that fact that trading partners do not yet impose a carbon price cannot change the fact that this price has not been imposed. Rather, domestic measures will involve a transfer from one group of Australians to another.

Put another way, these measures will not in themselves lower the marginal cost of abatement. Indeed, to the extent to which they result in different costs of abatement on different groups, they may in fact increase the economywide cost of abatement.[12]

Criteria to assess different mechanisms for addressing competitiveness

There are a number of criteria against which the various mechanisms to deal with competitiveness issues experienced by particular industries can be assessed. These include the following.

- **Consistency with the underlying objectives of the carbon price scheme**. As noted above, there are a number of reasons why the introduction of carbon pricing in Australia could be beneficial. It is important that any mechanisms to adjust for competitiveness effects are consistent with these criteria including:

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[12] It is a standard result of the economic analysis of greenhouse abatement that the cost of a given level of abatement is minimised when the marginal cost of abatement in equated across different emitters. Any policy, therefore, that has the effect of changing the marginal cost of abatement between emitters will not be cost minimising, and may result in higher economywide costs. These policies may still be appropriate, however, when considered as a transitional measure to deal with adjustment costs.

– Maintaining incentives to abate
– Allowing for learning-by-doing
– Providing Australian leadership
– Ensuring appropriate future investment

- **Indirect and economywide effects**. The various measures targeted at particular industries will have different indirect effects and different effects on other industries.
- **Effect on overall efficiency of the carbon price scheme.** There are three aspects to the way in which measures to address competitiveness in particular industries may affect the overall efficiency of a carbon price scheme.
  – First, a 'static' notion in terms of whether the measures maintain the efficiency objective of equating the marginal cost of abatement between different emitters or whether the measure creates a difference between the marginal cost of abatement of different sectors.
  – Second, a dynamic notion in terms of whether the measure maintains a tendency to equate the marginal cost of abatement over time, and in particular whether the measure contributes to making investment decisions today in the light of expected carbon prices in the future.
  – Third, the way in which the measure enhances or subtracts from the carbon price scheme's ability to deal with risk and uncertainty in climate change policy. Risk and uncertainty are central features of the climate change problem, and policies to deal with it must explicitly take uncertainty into account. Measures to deal with competitiveness would be preferable if they also helped deal with uncertainty.
- **Practicality and ease of implementation**. The more practical the measure is to implement (especially within existing tax structures) the more likely it is to be successful.
- **Ability to merge with long term international measures**. Given that the long term objective is for Australia to be part of an international scheme to reduce greenhouse gas emissions, it is important that any short term mechanism to deal with competitiveness issues has a clear end point and is able to merge with the ultimate international scheme.
- **Effect on firms' ability to manage risk**. Various measures to address competitiveness will affect the ability of firms to manage risk in different ways.

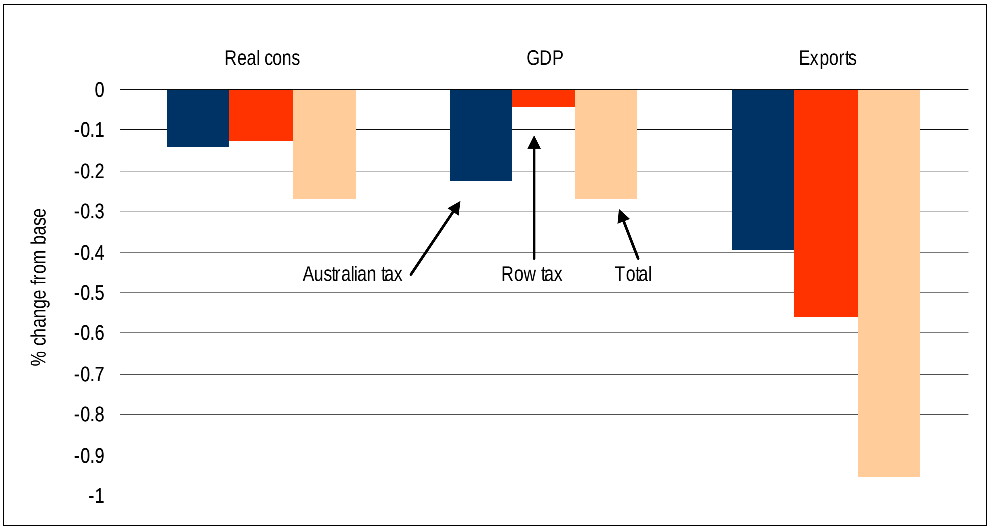
Model illustrations

To illustrate some of the issues associated with defining competitiveness and assessing the effect of carbon pricing policy measures, we present some illustrative simulations from the Oz-Cubed model. Oz-Cubed is a detailed Australian representation of the well known G-Cubed model. Oz-Cubed covers 57 industry groups for two country blocks (Australia and rest of the world) and contains all the macroeconomic and general equilibrium detail of the original G-Cubed model.

Australian and ROW carbon tax

Chart 3.1 shows the effect of the introduction of a small carbon tax first in Australia (the first bar in each of the charts), then in the rest of the world (the second bar) and then the total effect (third bar)[13]. Results are presented for Australian real consumption, GDP and exports. For illustrative purposes these results are presented at a single point in time, but we have constructed the simulation so that this gives an accurate indication of the changes over time.

3.1 **Effect on Australia of a carbon tax in Australia and the rest of the world**



Data source: Oz-Cubed model simulation

Looking first at the real consumption results, the chart shows that the introduction of the carbon tax in Australia only leads to a 0.14 per cent

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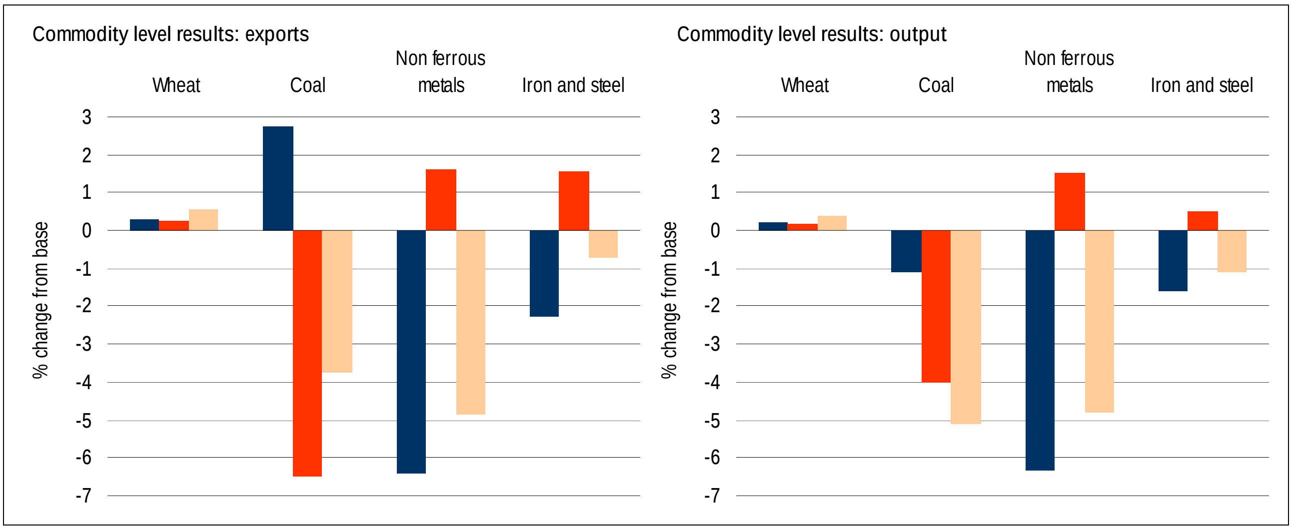
[13] Although this is simulated as a carbon tax, it could also be thought of as an emissions trading scheme in which the permit price turns out to be the same as small carbon tax we have simulated. For the purposes of the illustration here, tax or emissions trading are equivalent ways of imposing a price of carbon on the economy.

decline in real consumption. The ROW tax alone leads to a 0.13 per cent decline in Australian real consumption, and the total effect is a 0.27 per cent decline when both the taxes are in place. Thus in terms of a broad measure of economic welfare (represented by real consumption opportunities), the Australian tax leads to a decline, and the introduction of the ROW tax leads to a further decline.

At the macroeconomic level, the loss of competitiveness from the Australian tax alone is evident in the reduction in Australian exports as a result of the Australian carbon tax alone (-0.4 per cent). However, this effect is *amplified*, not offset, at the economywide level by the introduction of the ROW carbon tax (following which, exports decline by 0.56 per cent). Despite the common intuition that a domestic tax will lead to competitiveness losses that would be offset when the ROW tax is put in place, at the economywide level, the introduction of a ROW tax does not offset the initial introduction of an Australian tax. The reason for this is that the ROW carbon tax has many effects in addition to evening up Australian export prices with prices in our competitor countries. For example, a ROW tax leads to a decline in demand for Australian energy products (such as coal) as well as leading to an increase in the price of a number of items that Australia imports.

Chart 3.2 shows the pattern of export and production results for selected sectors. This illustrates that the export effects, and the changes in competitiveness from the introduction of carbon taxes are more complex than a simple 'loss of competitiveness' notion might apply. Indeed, the effects differ considerably between sectors.

3.2 **Sectoral level effects of a carbon tax in Australia and ROW**



Data source: Oz-Cubed simulations

For example, in the case of agriculture (represented as wheat here), both the Australian and ROW carbon taxes lead to an *increase* in exports. This is the result of a real exchange rate effect which effectively increases the resources that flow into agriculture.

Looking at the results for the coal industry, the Australia alone carbon tax leads to an increase in coal exports, which is the opposite direction to the effect of a global carbon tax. It is only following the introduction of the ROW carbon tax that Australian coal exports decline; because of reduced international demand for carbon intensive energy sources.

In the case of non ferrous metals and iron and steel, the 'loss of competitiveness' from the Australia only tax is clearly evident. Exports are lower under the Australia only tax than they are under with the global tax. In this particular case, the loss of competitiveness (seen as a reduction in exports) is in fact offset by the introduction of the ROW tax.

The right hand panel of chart 3.2 shows the production effects of the different carbon taxes. These are broadly similar to the export effects, except in the case of coal.

These simulations illustrate that 'competitiveness' effects vary considerably from sector to sector. What appears as a competitiveness problem for a sector such as non-ferrous metals that is improved when the ROW tax is put in put in place, actually makes life worse for other sectors such as coal.

Overall, in terms of total Australian welfare, the introduction of a tax in ROW makes Australia worse off than in the case of a domestic tax alone. However, this should not be interpreted as implying that Australia should go alone, as the global environmental benefits have not been considered here.

Examining a 'loss of competitiveness'

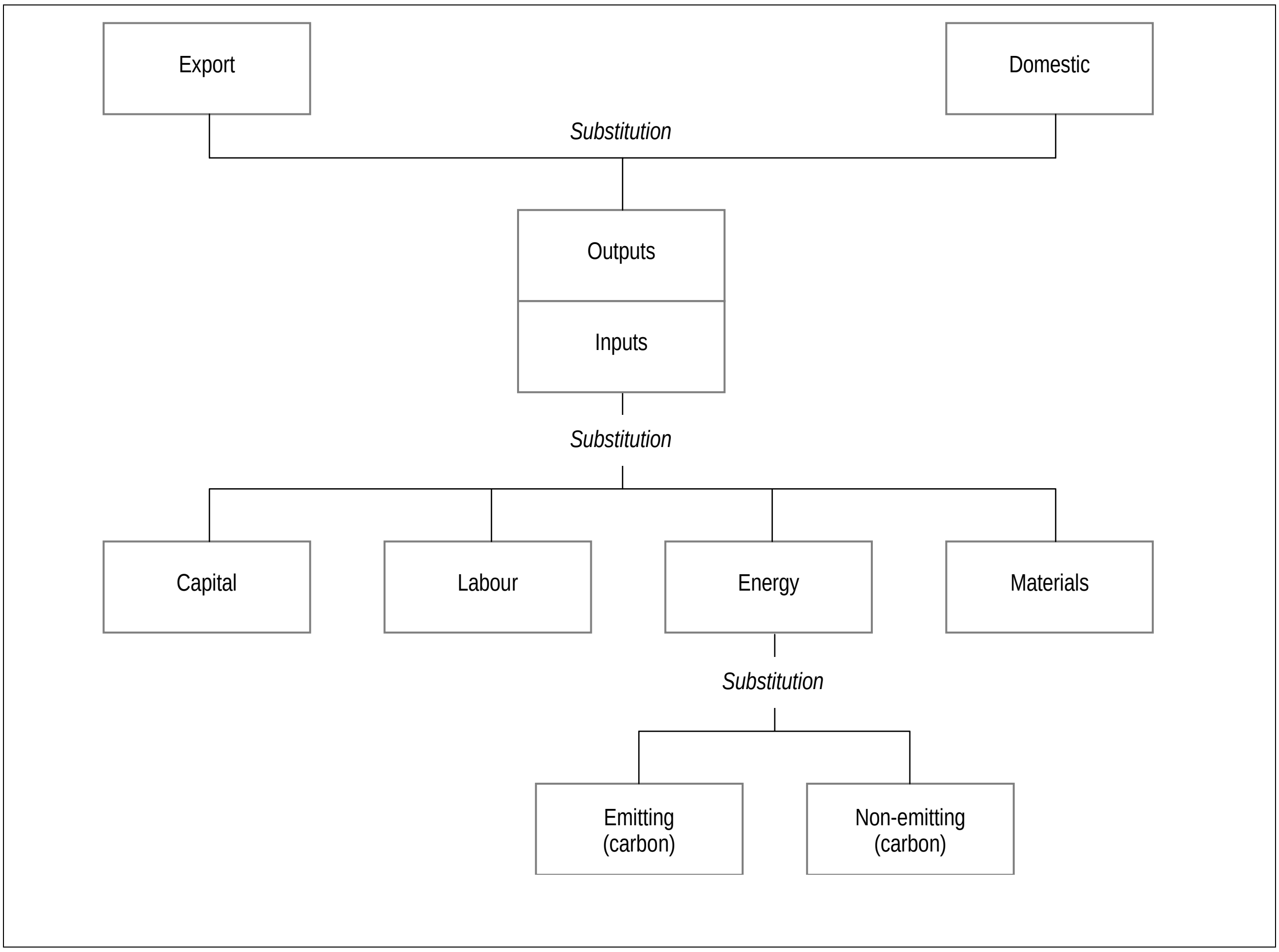
In considering the competitiveness effect and how it might arise, it important to be very clear about what is meant by a 'loss of competitiveness' and which aspects of this loss are of most concern. Put another way: which aspects of the loss provide the best targets for any policy to correct?

Chart 3.3 presents a stylised production system that can be used to consider the effect of increasing the price of carbon based energy. Starting from the top, the chart shows that the output of the firm or the industry can be sold on either the export or domestic markets. Depending on the details of the firm or industry concerned, there may be scope to substitute between these different sales destinations.

The combination of export and domestic sales makes up the entire production of the firm, which is in turn produced through a combination of inputs. Those illustrated here are capital, labour, energy and materials. Again depending on the industry, there may be scope to substitute between these different inputs in response, for example, to relative price changes.

The energy input is itself made up of two types of energy 'emitting' (of carbon) and 'non-emitting'. Depending on the case, there may be scope to substitute between these two types of energy. This energy structure is clearly a gross simplification of the economy's energy system, but it will serve to illustrate some key points.

3.3 **Stylised production system**



Working from the bottom up, the introduction of a carbon price will increase the price of the emitting source of energy. If there is scope to substitute between emitting and non-emitting energy sources, the response of the firm will be to substitute towards non-emitting carbon. If the ability to substitute is very high, the firm will completely switch and there will be little effect on its overall output or sales. Indeed, the major constraint in this case will be the availability of the non-emitting energy sources. If this is restricted (that is, if it is hard to get additional capacity) then any attempt to substitute into this energy source will lead to an increase in its price and so will have an effect on the firm's prices and output. In this case, the cause is the lack of supply of non-emitting carbon sources.

If there is very little ability to substitute between energy sources (or the supply of non-emitting energy is highly restricted) then the overall price of energy will increase (the magnitude of this increase will be equal to the share of emitting energy in total energy multiplied by the increase in the carbon price). As a consequence of an increase in the price of energy, there are again a number of possibilities for a response. If the firm is easily able to substitute between the energy and the other inputs, then it will do so. If the degree of substitution is very high, then the effect on the firms overall costs will be small. In this case, the most important parameter will be the availability of supply of other inputs (capital, labour and materials).

If the firm is not able to substitute away from energy, the firm's costs will increase (the magnitude of this increase will be equal to the share of energy in total costs multiplied by the increase in the price of energy).

The effect of this increase in costs on sales will depend on the demand conditions in the markets the firm sells to, and the ability of the firm to switch between markets. If, for example, demand on the export market is highly sensitive to price changes, then there is likely to be a reduction in exports. If the firm can easily switch these lost sales onto the domestic market, then there will be little effect on the firm's total output. If domestic sales are constrained, however, or the firm cannot switch for a variety of reasons, then production will decline. The firm is also likely to lose domestic sales, depending on how responsive domestic sales are to price changes. Some firms may sell entirely on the domestic market in competition in imports. In this case, the firm is likely to lose domestic sales which are then replaced by imports.

Indirect effects

The above discussion implies that firms are directly affected by an increase in the price of carbon. There is also a potential range of indirect effects. For example, firms that do not export directly, but sell to those that do are likely to have reduced domestic sales.

Also, firms that export but that do not themselves use a lot of energy, but purchase their inputs from other energy intensive firms are also likely to experience a cost increase.

Investment flows between countries

Another potential implication of increase carbon prices in Australia but not in other trade partner countries is the effect that it may have on the location of new investment projects. At the margin, it is reasonable to expect that a firm considering a new project with a reasonably consistent energy component would choose to do so in countries without carbon pricing in place. In this case, new investment projects that would otherwise have taken place in Australia now take place in some other location.

However if the carbon policy can be designed to reduce the risk of existing and new capital, a firm may be more likely to locate in a country that has a clear carbon policy than one which may have a policy in the future.

Investment decisions are driven by many factors, some of the most important ones being perceived risk of a particular location.

Change in ability to manage risk

What is not explicitly captured in chart 3.3 is the effect of a carbon pricing scheme of the ability of firms (and therefore the economy) to manage the various risks associated with climate change and the need for abatement now and in the future. Firms face considerable uncertainty about the future price of carbon which has an important impact on their investment and planning decisions. Some carbon pricing schemes, in particular those associated with long lived property rights over emissions, deal with this risk by providing an explicit mechanism for trading around different expectations and perceptions of risk.

This improved ability to manage risk may, at least in part, offset a loss of competitiveness in the traditional sense. Firms in countries with an explicit set of risk management instruments will have a competitive advantage relative to firms in countries that do not.

How a loss of competitiveness will appear

This analysis illustrates that there is a number of ways of thinking about how a ‘loss of competitiveness’ could emerge, either in a particular industry, or economywide. These could be related to:

- Reduction in *exports*, relative to what was the case before the carbon price was put in place and abstracting from other developments in exports markets. This reduction could either be ‘direct’ in industries that are energy intensive and rely on exports, or ‘indirect’ for industries that buy inputs from other energy intensive industries.
- Reduction in *domestic sales*, partly because of reduced domestic demand but also potentially because of increased import competition. This could arise for directly trade exposed industries or indirectly for industries selling to other trade exposed industries.

- Reduction in *output* coming about as a result of a mix of changes in exports and sales on domestic markets
- Reduction in *profits* arising because firms are not able to reduce costs and so offset the effects of sales reductions or because firms are unable to manage risks associated with carbon pricing.
- Changed *investment* flows relative to what would otherwise have been the case.

None of these is inevitable in response to an increase in the price of carbon for any particular industry, but depends on the particular features of the structure of production in that industry. Put another way, it depends on the firm's marginal cost of abatement which is itself is built up from a number of different factors. With high substitution elasticities and elastic supply of non-emitting energy and other factors of production, the marginal cost of abatement will be very low. In the special case where there is zero substitution between inputs (or supply of other inputs is inelastic) then the marginal cost of abatement will depend on the share of carbon in energy and the share of energy in total costs. The total loss of production through a loss of exports will also depend on the share of exports in total sales.

Policies to address 'competitiveness'

From this analysis, it is clear that there is a range of points of intervention to compensate for the effects on particular industries of increased carbon and hence energy prices. Some of these directly target trade measures (exports and imports) while others are focused within the domestic market. They include the following.

Measures targeted at input use

These measures are concerned with increasing the ability of firms to substitute to either lower emitting energy sources, or to substitute away from energy towards other inputs.

- Subsidies to the supply or use of non-emitting energy sources.
- Measures to increase the ability to substitute towards non-emitting energy.
- Measures to increase the ability to substitute away from energy and into other factors of production.
- Subsidies to the production or use of complementary factors of production — that is, subsidies to capital, labour or other inputs.

The various measures targeted at input use are in fact general complementary measures that may be part of any carbon pricing scheme, regardless of perceived effects of the scheme on competitiveness.

Measures target at profits, output or exports

These measures are concerned with the output side of firm activity, either in terms of total production, export volumes or profits.

- Direct ('lump sum') compensation for a loss of profits.
- Output subsidies which compensate for price increases in both domestic and export markets.
- Export price adjustments (or implicit subsidies) which compensate for price increases in export markets.
- Import taxes which compensate for price increases in import competing markets.

All of these various measures when used to target particular industry level competitiveness issues are indirect ways of trying to deal with the fact there is a carbon price in place in Australia, but not necessarily in place in key trading partners. For some industries (such as non ferrous metals as illustrated in chart 3.2) a better solution could be to persuade other countries to put a carbon price in place. If this option is not immediately available; for those industry the only potential alternative is to use domestic measure to attempt to improve their particular situation.

This situation is analogous to the problem Australia faces in dealing with the reality of export subsidies or import taxes imposed by our trading partners: can we compensate using domestic measures (targeted at particular industries) for the costs these foreign policies impose? The general answer to this question has been *no* because the indirect measures themselves have imposed additional costs.

Table 3.4 summarises the link between particular manifestations of competitiveness loss, they key drivers of that loss and the policies that could be used to target it.

3.4 **Loss of competitiveness, underlying causes and policies to target**

Measure of competitiveness loss	***Key factors that determine the amount of the loss***	***Policies that could target the loss***
Reduction in exports	Size of the carbon price (permit price) Foreign demand conditions Energy and carbon intensity of industry Ability to substitute to low carbon energy or away from energy	'Border' price adjustments in the form of rebates or other implicit export subsidies to offset the price increase as a results of the carbon price
Reduction in production:		
- overall	Size of the carbon price (permit price) Ability to substitute to non carbon intensive sources of energy	Production subsidy set at a rate to offset the carbon cost on all production
- from demand decline due to an increase in imports	Size of the carbon price (permit price) Domestic demand conditions — tendency for domestic consumers to substitute for imports following a price change	'Border' price adjustment in the form of taxes in imports of carbon intensive goods of a magnitude to offset the change in relative price between the domestic
- as a result of reduced exports	- as above -	- as above -
Reduction in profits	Size of the carbon price (permit price) Ability to make compensating adjustments in firm activity.	'Lump sum' compensation equivalent to the amount of loss in profit Allocation of a new asset to offset profits
Changed investment incentives	Size of the carbon price relative to returns from alternative investment destinations	Any of the measures above

Implementation under carbon charges or emission trading

There are three broad means of introducing a carbon price to the economy: first, through an explicit carbon tax or carbon charge, second through an emission trading scheme and third a hybrid of charging and emission trading (using a charge to determine a short term carbon price and trading to determine a long term price).

Taxes and emissions trading are in some ways flip sides of the same coin. A given carbon tax will achieve a particular level of abatement. It that level of abatement were to be imposed as a cap in an emissions trading scheme then the resulting permit price should be roughly equal to the carbon tax that yielded that level of abatement. While taxes directly set a carbon price, emissions trading effectively sets one through a constraint on quantities.[14]

This dual relationship between prices and quantities also flows through to the ways in which measures to target competitiveness in particular industries might be implemented. This is illustrated in table 3.5 which shows how the various policies set out in table 3.4 could be implemented under either emissions trading or carbon taxes.

For example, border price measures on the export side would naturally be implemented as some form of rebate under a carbon tax scheme. The firm might, for example, submit a return (perhaps as part of the existing BAS) to the tax office detailing the amount of exports with an audited estimate of the carbon content of those exports. Under emission trading there are two alternatives: either the firm could be exempt from the scheme for its exports or it could be freely allocated permits covering either historical exports or expected exports.

In general, allocation of permits would be preferable to exclusion from the scheme because once the firm holds permits, it automatically faces an opportunity cost for its emissions. That is, the firm has a choice to use the permits to cover its exports or to sell the permits and so make a profit. In terms of the learning by doing rationale for an Australian carbon price scheme, it is extremely important that firms actually face this opportunity cost.

The same broad arguments follow for the other policy measures, with either direct cash subsidies or rebates under a carbon tax, or the allocation of permits under emissions trading.

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14 There are, in fact, some important differences between price and quantity measures targeting emissions (particularly with how they deal with uncertainty) but these are beyond the scope of the discussion here.

3.5 **Implementation of policy measure to target competitiveness**

Policy measure	*Implementation under a direct carbon charge*	*Implementation under emissions trading*	*Implementation under hybrid of charge and trading*
Border price adjustments	For exports, a rebate on the carbon charge for products that are exported (similar to GST rebate)	Exemption from the need to acquit permits for the proportion of production that is exported OR Grandfathered allowance of permits covering exports	For both exports and imports, in the short term, as for under a direct carbon charge. In the long term as for emission trading.
	For imports, a charge imposed on imported products based on their carbon content	Requirement to acquit permits for energy intensive imports (based on carbon content).	
Production subsidies	A tax rebate, or direct subsidy equivalent to effective rate of the carbon tax for the firm	Exemption from the need to acquit permits for a given level of production (effective exclusion from the scheme) OR Grandfathered allocation of permits covering a given level of production	As for a carbon charge in the short term. OR Exclusion from coverage in the scheme OR Grandfathered allocation of long term permits
Lump sum transfers	Fixed dollar compensation set at estimated net effect of carbon charge	Fixed (free) allocation of permits in addition to any permits generally freely allocated	Either dollar compensation of allocation of permits

Are the measures linked to exports or production or do they allow firms to choose?

A fundamental feature of the implementation of measures to deal with competitiveness in particular industries is the extent to which these measures are linked, or de-linked, from production and exporting decisions. This aspect of implementation will have a major influence on how the various measures score against the evaluation criteria outlined above.

Consider a border adjustment that rebates a trade exposed energy intensive exporter for their exports *after* they have happened. That is, regardless of the level of exports, a rebate is provided (based on the carbon tax component of the export value). In this case, the value of the rebate is clearly linked to the amount of exports.

In contrast, consider an export adjustment under emissions trading where the firm is allocated at the beginning of the year permits sufficient to cover historical exports (perhaps with some adjustment for growth). In this case, the permits are granted regardless of the ultimately resulting level of exports and so the compensation measure is not linked to exports.

Table 3.6 shows that compensation can be linked or unlinked under either a carbon tax or emissions trading.

3.6 Is compensation linked to exports or production?

	Compensation not linked to exports or production (amount of compensation set ex ante)	*Compensation linked to exports or production (compensation determined ex post)*
Carbon tax based price	Dollar compensation set at a fixed amount in advance. Amount of compensation based on carbon content of expected exports.	Rebate calculated on actual export performance over a given period.
Emissions trading based	Fixed allocation of permits (at beginning of year for example) to cover expected exports.	Permits automatically granted to cover exports that actually took place over a given period. This is equivalent to exemption from the scheme for that part of exports

An important feature of measures that are linked to exports or production is that they eliminate any incentive for abatement at the margin, whereas measures not linked to exports or production may retain some incentive for abatement (this incentive is itself stronger under emissions trading, as discussed further below).

Importance of other carbon price mechanism design features

An important part of ensuring that any Australian scheme minimises its trade and investment impacts is in the actual *design* of the pricing scheme so that the design itself builds in compensation mechanisms. There are number of overall design features that are relevant.

- The level of the price (set by the tax under a carbon tax scheme or set by the level of the cap under emission trading). A very low initial carbon price will still bring many of the benefits outlined above but will have extremely small effects and will not necessarily require compensation.
- Coverage of the scheme and allowance for offsets of various kinds. A pricing scheme such as emissions trading with very broad coverage is more likely to lead to lower marginal cost of abatement. The broader the coverage of the scheme, the less likely some form of compensation will be needed.
- Design of the scheme to include the creation of a new class of assets that can be used both as a form of compensation and as a mechanism for risk management. This point is discussed further below, but is closely related to the idea of providing grandfathered permits under an emissions trading scheme.

A closer look at some policy mechanisms

Border price adjustments

Implicit export subsidy

The various tradeoffs involved in border price adjustments are most easily examined by looking at adjustments to export prices. As noted above, the basic mechanism is to provide rebates for exporters that effectively remove the cost effect of the carbon price. Given that other domestic producers still face the charge this is in effect equivalent to an export subsidy as it involves a transfer from producers selling on the domestic market to producers selling on the export market.

Identifying targets for adjustment

A key challenge is to identify the commodities that require this form of rebate. This is complex, because a carbon price will flow through the economy in a variety of ways. While it will clearly initially affect carbon intensive activities, a variety of economic linkages will lead to a flow on to other activities. For example, exporting industries that are not themselves energy intensive but that purchase inputs from other energy intensive producers will also be affected through changes in their costs.

While in practice there may be a few clearly identifiable export activities that are affected by the carbon price, there will nevertheless be pressure from exporters indirectly affected to also receive some form of compensation.

Who pays the implicit subsidy?

It is also important to note that the implicit export subsidies will be paid not by foreigners, but by other Australian firms. There are a number of indirect ways this could come about. Under emissions trading, for example, (with a fixed cap on emissions) and free allocation granted to one firm will effectively increase the permit price paid by other firms.

Illustration of the effects of border adjustments

Chart 3.7 illustrates some basic mechanics of how border adjustments or trade compensation may work. The left side panels of the chart shows the relationship between two inputs to the production process: carbon and non-carbon. These represent in summary inputs that do and don't require an associated emission of carbon. The solid curved line represents the initial relationship between carbon and non-carbon inputs; it shows the various combinations of the two inputs that are feasible for a given level of production. The initial equilibrium here is the intersection between this curve and the relative price of the two inputs.

The right panels of the chart show the relationship between domestic production and exports. In this case the solid curve shows the initial combinations of production for the two markets that are technically possible; it is a production possibility frontier. The initial equilibrium is where the relative price line intersects the curve.

The imposition of a carbon price initially affects the top left relationship between inputs. It appears as a shift in the relative price line and leads to both a substitution away from carbon inputs, and a reduction in the total level of activity of the firm. With the increase in the price of carbon, the firm can afford to purchase fewer inputs in total and so the activity level falls to the new dashed level of production. The extent of this inward shift depends on a variety of factors including the ability of the firm to pass on price increases to its customers.

The top right panel shows the effect of the carbon price on the output equilibrium of the firm. The production possibility frontier moves inwards along with the inward shift in the input substitution curve. Assuming no changes in relative product prices, this inward shift results in a reduction in both domestic and export production.

The attempt to compensate for this loss in exports is show in the bottom right panel of the chart. The implicit export subsidy (coming about through the rebate) is represented as a shift in the relative price line. The new equilibrium is at a higher production level, biased towards exports, as with the subsidy the firm can afford a higher level of production. In this case, the chart shows a situation where exports return to their initial level, but domestic production does not.

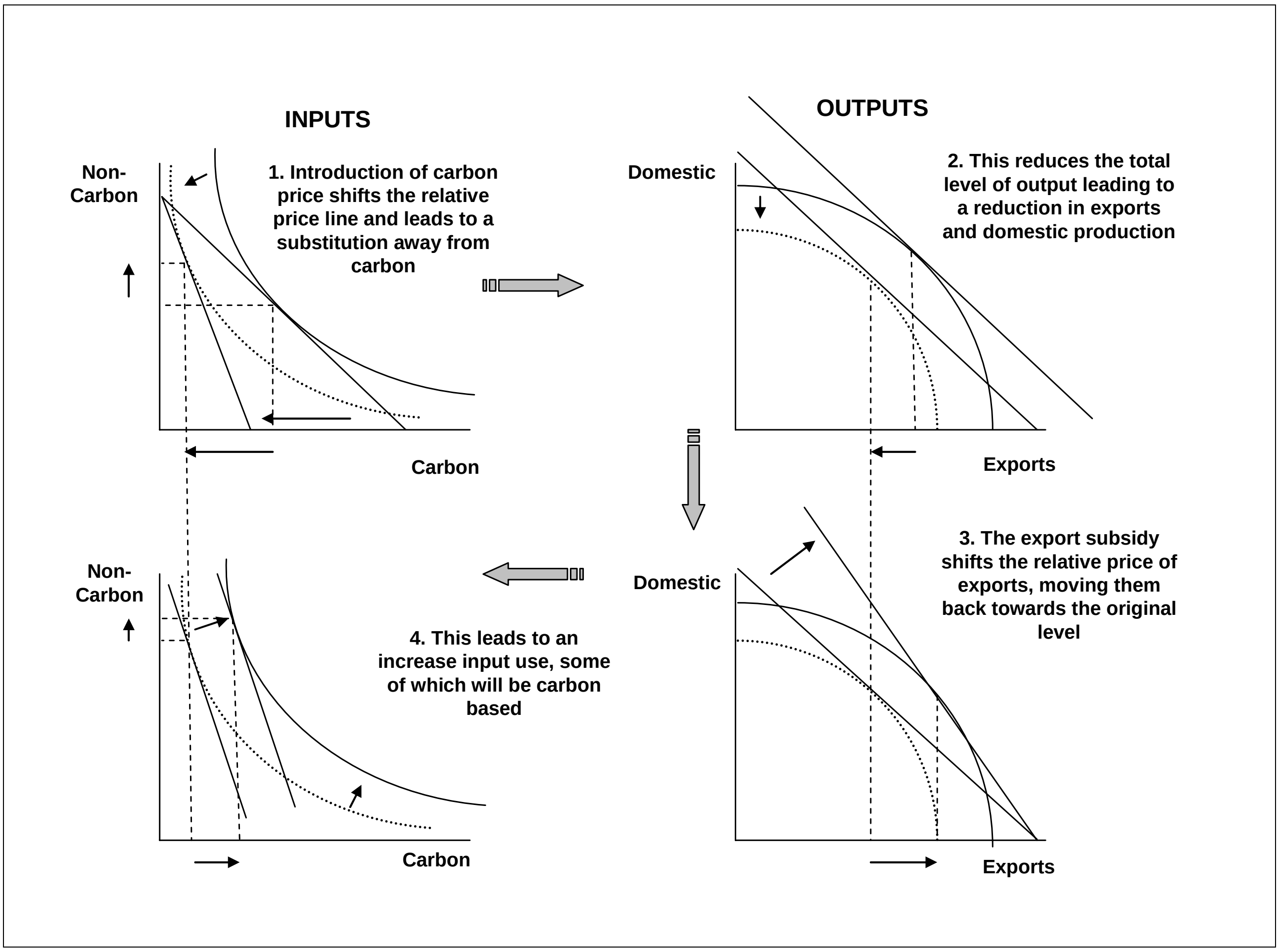
The effect of the export subsidy on the input decisions of the firm is shown in the bottom left panel of the chart. The increase in production is represented by an outward shift in the input-substitution frontier, and given the new relative prices between carbon and non-carbon inputs (as a result of the carbon tax), results in an increase in both carbon and non-carbon use.

Several points are evident in examining this overall process.

- The introduction of the implicit export subsidy results in an offset to the original reduction in carbon use (reduction in emissions). Depending on production relationships and market conditions, it is possible for this to be a complete offset.
- While this illustration shows a case where the implicit subsidy offsets the initial loss of exports, it some cases it may be difficult to calculate the export subsidy needed to do this.
- The input (carbon) tax affects the output decisions, and the export subsidy also affects input decisions.
- The final equilibrium could have been achieved through either a direct production subsidy or rebate (not biased towards exports) or through a lower carbon price in the first place.

This illustrates a trade-off in using implicit subsidies to correct a competitiveness effect. The original carbon price creates an incentive for a particular action, where as the implicit export subsidy tries to directly counteract some of this incentive. The two measures work against each other, an effect which is likely to create unnecessary costs.

3.7 **Illustration of trade compensation**



Evaluation against the criteria

Table 3.8 provides a summary evaluation of border price adjustments against the criteria outlined above.

A key point is that implementations that preserve the equality of marginal cost of abatement between different emitters and that also enhance risk management abilities of firms will provide greater benefits.

3.8 **Evaluation of border price adjustments against criteria**

Criteria	*Carbon price based on a carbon tax*	*Carbon price based on emissions trading*
Incentive to abate	An ex post rebate on actual exports removes any incentive to abate at the margin for production related to exports.	Ex ante permit allocation (based on expected exports) creates an opportunity cost of emissions (equal to the permit price) and so also creates incentive to abate at the margin. Ex post permit allocation or exemption from the need to acquit permits for export does not create incentive for abatement.
Learning by doing	Limited scope for learning by doing in export sector with an ex post rebate	Where exporters are included in scheme and given permits ex ante, then there is significant scope for learning by doing.
Effect on investment decisions	With an ex post rebate, there is no incentive to account for carbon prices in new investment decisions	Ex ante permit allocation provides some incentive to account for carbon prices in new investment decisions
Indirect and economywide effects	Implicit subsidy to one group will ultimately be paid by other Australians, either other firms or taxpayers.	Allocation of permits to exporters may affect the overall cap under the scheme. It the overall cap is not adjusted, a greater burden for abatement is placed on other emitters. This is in effect a transfer from these emitters to exporters.
Overall economic efficiency	Ex post rebate creates a divergence in marginal cost of abatement between different emitters and so will reduce the overall economic efficiency of the carbon price scheme.	Ex ante permit allocation maintains the equalisation of the marginal cost of abatement originally in the emissions trading scheme, so its economic efficiency is not reduced
Practicality and ease of implementation	Relatively easy to calculate and implement the rebate	Relatively easy to implement under an established emissions trading scheme
Ability to merge with long term international measures	Either form of rebate could be phased out over time as international measures change	Special treatment of trade exposed industries could be phased out over time.
Effect on ability to manage risk	Neither ex ante of ex post rebates improve the firm’s ability to manage risk as neither introduce a new instrument for such management.	Allocation of permits, particularly under a hybrid scheme creates some ability for firms to manage risk through their decisions about the use of permits.

Production subsidies

Whereas border price adjustments are designed to address the competitiveness issue by using export volumes as a target, production subsidies address the issue using overall production as a target. Any loss of competitiveness in a particular industry may appear as reduced production (probably because of a reduction in export volumes) and this form of compensation targets production levels rather than more specific export volumes. Here the firm is free to choose how this compensation may be used.

As illustrated in chart 3.7, a direct production subsidy avoids one of the tradeoffs inherent in an export subsidy, and can be used to more directly target production outcomes.

A production subsidy could be implemented as a unit subsidy based on the expected carbon content of production (multiplied by the carbon price) or through the allocation of permits under an emission trading scheme.

Under an emission trading scheme, if permits are allocated ex ante, then production subsidies will in practice be very similar to a border based adjustment in that both will involve an allocation of permits that the firm can then use as it chooses.

The calculation of an appropriate amount of compensation is likely to be more complex than in the case of border price adjustments as it will be important to ensure that only the export (or import competing) component of production is covered. Of course, by its nature, the subsidy will not necessarily be used by the firm to adjust exports — the firm may find it more profitable to make adjustments to domestic production.

Table 3.9 provides an evaluation of the production subsidies against the key criteria.

A number of the key points of this are very similar to the border price adjustment evaluation. In particular, a production subsidy can be implemented in a way that maintains the equality of marginal cost of abatement between different emitters and allows for learning by doing. Under a carbon tax, the subsidy is more general and is less likely to be linked to a particular level of exports. Under emissions trading, allocating of permits to compensate for a production loss is in fact very similar to the allocation of permits to compensate for an export loss.

3.9 Evaluation of production subsidies against criteria

Criteria	*Carbon price based on a carbon tax*	*Carbon price based on emissions trading*
Incentive to abate	An ex post rebate for production loss removes any incentive to abate at the margin for production related to exports. An ex ante adjustment maintains some incentive	Ex ante permit allocation (based on expected production loss) creates an opportunity cost of emissions (equal to the permit price) and so also creates incentive to abate at the margin. Ex post permit allocation or exemption from the need to acquit permits for a proportion of production does not create incentive for abatement.
Learning by doing	Limited scope for learning by doing in export sector	Where exporters are included in scheme and given permits ex ante, then there is significant scope for learning by doing.
Effect on investment decisions	With an ex post rebate, there is no incentive to account for carbon prices in new investment decisions	Ex ante permit allocation provides some incentive to account for carbon prices in new investment decisions
Indirect and economywide effects	Implicit subsidy to one group will ultimately be paid by other Australians, either other firms or taxpayers.	Allocation of permits to exporters may affect the overall cap under the scheme. It the overall cap is not adjusted, a greater burden for abatement is placed on other emitters. This is in effect a transfer from these emitters to exporters.
Overall economic efficiency	Ex post rebate creates a divergence in marginal cost of abatement between different emitters and so will reduce the overall economic efficiency of the carbon price scheme.	Ex ante permit allocation maintains the equalisation of the marginal cost of abatement originally in the emissions trading scheme, so its economic efficiency is not reduced
Practicality and ease of implementation	Relatively easy to calculate and implement the rebate	Relatively easy to implement under an established emissions trading scheme
Ability to merge with long term international measures	Either form of rebate could be phased out over time as international measures change	Special treatment of trade exposed industries could be phased out over time.
Effect on ability to manage risk	Neither ex ante of ex post rebates improves the firm's ability to manage risk as neither introduces a new instrument for such management.	Allocation of permits, particularly under a hybrid scheme creates some ability for firms to manage risk through their decisions about the use of permits.

Lump sum compensation

In terms of compensating for losses of profits by trade exposed industries, an alternative mechanism is a direct lump sum transfer (set equivalent to the increased carbon cost). Such a transfer will not alter production or export patterns following the introduction of the carbon price, but will allow firms to choose how to respond. The compensation could be implemented as a cash rebate (through the tax system, for example) or through the allocation of permits under an emission trading scheme.

By its nature, the lump sum compensation should be provided ex ante (that is, not linked to production or export levels).

As with the export and production compensation, under an emission trading scheme, the allocation of permits ex ante as a form of compensation are very similar in practice.

Table 3.10 provides an evaluation of lump sum adjustments against the criteria.

3.10 **Evaluation of lump sum adjustments against criteria**

Criteria	*Carbon price based on a carbon tax*	*Carbon price based on emissions trading*
Incentive to abate	Ex ante lump sum compensation maintains a carbon price and so maintains incentive to abate.	Ex ante permit allocation (based on expected exports) creates an opportunity cost of emissions (equal to the permit price) and so also creates incentive to abate at the margin..
Learning by doing	Scope for learning by doing in abatement	With permits allocated ex ante, then there is significant scope for learning by doing.
Effect on investment decisions	Maintains incentive to account for carbon prices in new investment.	Maintains incentive to account for carbon prices in new investment.
Indirect and economywide effects	Compensation must be paid out of the tax system. With budget neutrality, this means a greater burden for other taxpayers	Allocation of permits as a lump sum transfer may affect the overall cap under the scheme. It the overall cap is not adjusted, a greater burden for abatement is placed on other emitters. This is in effect a transfer from these emitters to exporters.
Overall economic efficiency	Lump sum compensation will not create a divergence in marginal cost of abatement between different emitters and so will not reduce the overall economic efficiency of the carbon price scheme.	Ex ante permit allocation maintains the equalisation of the marginal cost of abatement originally in the emissions trading scheme, so its economic efficiency is not reduced
Practicality and ease of implementation	Relatively easy to calculate and implement the compensation	Relatively easy to implement under an established emissions trading scheme
Ability to merge with long term international measures	If compensation is once off, there is no need for adjustments as international measures change	If compensation is once off, there is no need for adjustments as international measures change
Effect on ability to manage risk	Lump sum compensation does not improve the firm’s ability to manage risk as neither introduce a new instrument for such management.	Allocation of permits, particularly under a hybrid scheme creates some ability for firms to manage risk through their decisions about the use of permits.

Measures to increase deal with input use

As noted above, there are a number of non-price based compensation measures that could be used to assist high marginal cost of abatement producers substitute towards lower emitting inputs.

One set of these relates to technical changes that effectively increase the ability of the firm to substitute into lower emitting technologies. As the discussion in chapter 2 indicated, there is considerable scope for R&D to deliver on this form of assistance. Indeed, such research is sensible regardless of whether Australia is introducing a carbon signal alone or in conjunction with other countries.

The importance of system design measures

As noted above, an alternative way of dealing with the compensation issue is to design the pricing scheme so as to reduce or eliminate the need for secondary compensation that is outside the scheme itself.

Within emissions trading, for example, one way of doing this is through the initial allocation of permits which could be adjusted according to where there are most likely to be competitiveness issues.

Another alternative is to use the scheme to create a new asset type (related to emission permits) that when allocated to firms not only provides compensation in terms of any losses on the balance sheet, but also provides a mechanism for firms to manage risk.

One design that would allow this is the McKibbin-Wilcoxen proposal for climate policy.[15] The McKibbin-Wilcoxen blueprint is a hybrid price and quantity scheme.[16] It contains two types of permits: a short term annual permit that is available from the government at a fixed price, and a long term permit that provides entitlement to a stream of annual emissions. As in emissions trading, either of these permits can be traded, although trade is most likely to take place for in the long term permit.

In effect, the long term permit is a new type of financial asset which can be used as an instrument to both manage the firm's emissions profile and to manage risks related to climate change.

Under this scheme, rather than compensating firms with adjustments to trade or production taxes or subsidies, firms are given an initial allocation of long term permits which cover current emissions. These permits have a value, and thus become an asset for the firm (a positive addition to the balance sheet). The allocation of these permits can be used to offset any loss of profits from lost sales from existing capital. More importantly the market

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[15] Details of this can be found in *A Credible Foundation for Long Term International Cooperation on Climate Change* by Warwick McKibbin and Peter Wilcoxen, available at http://www.lowyinstitute.org/Publication.asp?pid=408. See also *Climate Change Policy after Kyoto: A Blueprint for a Realistic Approach,* by the same authors and published by the Brookings Institution, December 2002.

[16] For a discussion of price, quantity and hybrid schemes see Cameron Hepburn 'Regulation by prices, quantities or both: a review of instrument choice', *Oxford Review of Economic Policy*, Vol 22, No. 2, 2006.

for these long term permits provides an instrument for managing the risk of climate change or change in future climate policies. For example if a fossil fuel intensive firm installs a new factory it can hedge the investment by using existing long term permits or by buying long term permits. If a dramatic change in emissions is required and carbon prices rise sharply, even though the value of the new factory will fall, the value of long term permits on the firm’s balance sheet will rise so that shareholders do not lose from the decline in the value of the physical investment.

Some implications

Several observations arise from the discussion above.

- None of the measures to deal with competitiveness issues faced by particular industries eliminate the issue, and they each involve transfers from one group of Australians to another. They cannot, in general, lower the marginal cost of abatement.
  - An exception to this is measures that allow for the better treatment of risk by firms covered.
- *Ex post* adjustments (to either production or exports) are not efficient in that they eliminate any incentive for abatement within those sectors covered.
- More generally, measures which create a difference in the marginal cost of abatement between sectors will not be economically efficient.
- All of the measures potentially involve economywide costs. Ultimately someone must pay for the implicit subsidies involved.
- Different rationales for the allocation of permits under emissions trading converge on the same practical outcome — an initial free allocation of permits to cover the loss.
- There is considerable scope for benefits through the allocation of long lived permits, that is, permits or property rights over emissions that allow firms to manage risks associated with the future price of carbon.

While it is possible to implement transfers to deal with the competitiveness issues, and there is no reason for that to be a single stumbling block to the establishment of a carbon price in Australia, overall, the most important determinant appears of competitiveness effects appears to be the design features of the price scheme itself.

4 Conclusions

Price signals and R&D

- A number of factors determine the 'optimal' pathway for abatement, some suggesting relatively earlier abatement, and others suggesting later abatement.
- Looking at these various factors and their determinants suggests that price signals and R&D measures are complementary and both necessary. They should not be thought of as separable measures.
- In particular, R&D measures *alone* are unlikely to be effective as they do not create the price signals necessary to ensure adoption of new technologies or to encourage firms to plan appropriately. They need to be implemented along with carbon price policy instruments.
- At the same time, carbon pricing does not solve the issue of the public good nature of much research leading to lower marginal costs of abatement. Other complementary measures are needed along with carbon prices.
- Because of the risk of ongoing investments in high emitting technologies (regardless of what research is taking place at the present) which could lead to an increase in the marginal cost of abatement over time, *an early price signal is appropriate*.

Competitiveness issues

- At the economywide level, the introduction of a carbon price signal in Australia will lead to a reduction in economic welfare. The subsequent introduction of a price signal in the rest of the world will not offset this (as is commonly believed) but will lead to a further reduction in welfare.

- At a sectoral level, introduction of a carbon price signal in Australia before the same signal is introduced in key trading partner countries may lead to a loss of 'competitiveness' for some particular Australian industries, although the effect of this will vary considerably by industry.
  - The effect on different industries essentially depends on their marginal cost of abatement. Two key factors determining this are demand conditions and the share of production being sold into particularly price sensitive markets.

- There are a variety of approaches that could be taken in addressing the loss of competitiveness for particular industries, however they are all indirect in that they cannot actually deal with the lack of a price signal in trading partner countries.
  - These measures will either directly or indirectly involve a transfer from one Australian industry to another. Put another way, measures to deal with competitiveness issues faced by particular industries cannot lower the economywide cost of abatement.

- Any measures adopted to deal with competitiveness issues need to be implemented to ensure that they do not create a wedge between the marginal cost of abatement of different emitters — otherwise the overall economic cost of the carbon price scheme will increase.

- Key measures to do with the fundamental underlying design of any price signal are likely to be considerably more effective in dealing with the competitiveness issues.
  - In particular, it is possible to design a scheme that includes a new asset class which can be used both to compensate firms and to provide them with a mechanism to manage climate related risk.

Linking timing and competitiveness issues

- Timing and competitiveness are clearly linked in that a large part of competitiveness relates to the introduction of measures in Australia before they are necessarily fully in place in the rest of the world.

- There are some interesting trade-offs between the two issues. On the one hand, it may be possible to avoid some of the competitiveness issues (at least for some specific industry groups) by delaying the timing of any specific Australian measures.

- This would not be cost free however, because as the timing discussion pointed out, there are risks in not establishing a price signal for carbon.

- By far the most effective response would be to establish a policy framework that had instruments for dealing with both issues — that was able to create a price signal on the one hand, and also introduce to firms tools for managing climate risk on the other.

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