REPORT

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Comparing effective carbon prices

Methodological issues

Prepared for

Australian Industry Greenhouse Network

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Executive Summary

- **This report considers some broad methodological issues involved in comparing carbon prices between countries.**
- **A key point to emerge is that price comparisons must have a very clear and well defined purpose or objective. Empirical measures without a clear underlying objective have the potential to be misleading.**
- **There are two broad reasons for comparing carbon prices.**
  - First, to contribute to policy dialogues regarding comparable effort, and related to this, issues around the efficiency of different policies.
  - Second, to contribute to an understanding of the trade competitiveness effects faced by Australian producers.
- **These different objectives have related but distinct comparative prices associated with them. This report makes a distinction between:**
  - a '*shadow'* or *implicit* carbon price (the price equivalent a range of policy measures, whether or not they are explicitly price based); and
  - an *effective* price of carbon (the net carbon price faced by industries in purchasing inputs, undertaking activities and selling outputs)
- **While it is possible to calculate carbon prices for a range of policies, policies cannot be compared on their implicit price alone, and the comparative price does not contain all the information of interest when comparing policies between countries.**
- **It is crucial that carbon price comparisons account for the very different properties of different types of greenhouse mitigation policy.**
- **Carbon price comparisons should be viewed as a long term activity. There are strong analogies between the need to compare carbon policies between countries and the long standing exercise of comparing protection between countries. The later has important implications for the former.**

1 This report

This report provides an overview of the methodological challenges involved in comparing carbon mitigation policies between countries — with a particular focus on the challenges involved in developing a summary shadow or effective price of carbon[1] as a basis for comparing policies.

In particular, this report suggests:

- a motivation or purpose for comparing carbon prices;
- a distinction between the closely related 'shadow' and 'effective' carbon price notions;
- a discussion of a range of challenges in making these measures and comparing them between countries.

The impetus for this report was the explicit inclusion of carbon price comparisons in the terms of reference of the Multi-Party Climate Committee and the subsequent tasking of the Productivity Commission to undertake these comparisons. The report is design both to help AIGN members understand and to communicate the various issues involved with a view to assisting them to productively contribute to the policy development process.

While the immediate focus of analysis relates to Australia's current task of developing a policy for putting a price on carbon, the issue of comparing climate policies between countries is a very long term one and will remain topical throughout the many years of global policy development and implementation to come. For this reason, it is essential that the task of collecting and comparing carbon prices is placed on a sound conceptual basis. As will be noted below, there is a strong analogy between carbon price comparisons and ongoing comparisons of trade and protection policies that have taken place for a number of decades.

[1] Throughout this report, 'carbon' is used a shorthand way of referring to greenhouse gas emissions in general, and 'carbon' and 'non-carbon' production as a shorthand way of referring to production techniques that are more or less intensive in greenhouse gas inputs (or outputs).

2 *Overview of the challenge*

Empirical estimates should be collected with a clear purpose in mind. Without this, estimates can easily be confused and misleading. There are at least two reasons for comparing carbon prices between countries.

Policy comparisons between countries

In applied economic analysis there is a long history of trying to find summary measures of the effects of policies that allow the comparison of different and often complex policy structures between countries.

A trade policy analogy

The longest running and best known examples come from trade and industry support policies (broadly termed 'protection' policies). These policies have proved in practice to be diverse and complicated (and often deliberately obscure), and the impact of the entire structure of protection is often very different to how it might seem on the surface. Australian work on the effective rate of protection, on the impact of non-tariff barriers and on general equilibrium modelling of trade policies each represent significant work programs to understand and compare the structure of protection between countries.

Within the broader area of support policies, agricultural support policies around the world have proved to be particularly diverse and creative, with the OECD working for many years to develop a methodology that provides a summary calculation worked on preparing cross country comparisons. The OECD's *PSE Guidelines* comprise a substantial body of empirical experience, illustrating how complex a comparatively simple measurement enterprise can turn out to be.

The findings and experience in trade policy provide a broad analogy in the task of comparing diverse and complex climate policies (in particular, emissions mitigation policies) between countries on a common basis[2].

[2] While very useful, care should be taken not to push this analogy too far. In particular, the issue of trade policy based 'protection' should not be confused with the possible need to address competitiveness disadvantage faced by exporters and import competing firms in an uneven transition to a world carbon price. Dealing with this competitive disadvantage should not comprise 'protection' to any indusry.

Comparing climate policies

Just as it turned out that simple 'nominal rates of protection' are not sufficient to understand the impact of trade policies around the world, it is increasingly understood that simple comparisons of mitigation targets (to reduce emissions by X per cent relative to some base year) is not sufficient to understand the comparative impact of climate policies, or even the relative effort countries are applying to reducing their emissions.

The comparison of climate policies requires a broader approach that allows the measurement of the differential economic effect of various policies. In the same way that trade policies have effects that extend well beyond the specific sector targeted, carbon is such a ubiquitous input in most economies that mitigation policies will also have economywide effects that extend well beyond the individual sectors that may have particular mitigation options.

Comparison of appropriately structured effective or shadow carbon prices (these are defined in more detail in section 3 below) serves a role similar to that of PSEs or effective rates of protection in trade policy debates.

Why compare shadow or effective carbon prices?

In both the terms of reference for the Multi-Party Climate Committee, and in the Productivity Commission's terms of reference, the purpose of making carbon price comparisons is not explicitly stated. In order to effectively undertake this empirical work, it will be important to have a very clear purpose for the comparisons.

A common basis for policy dialogue

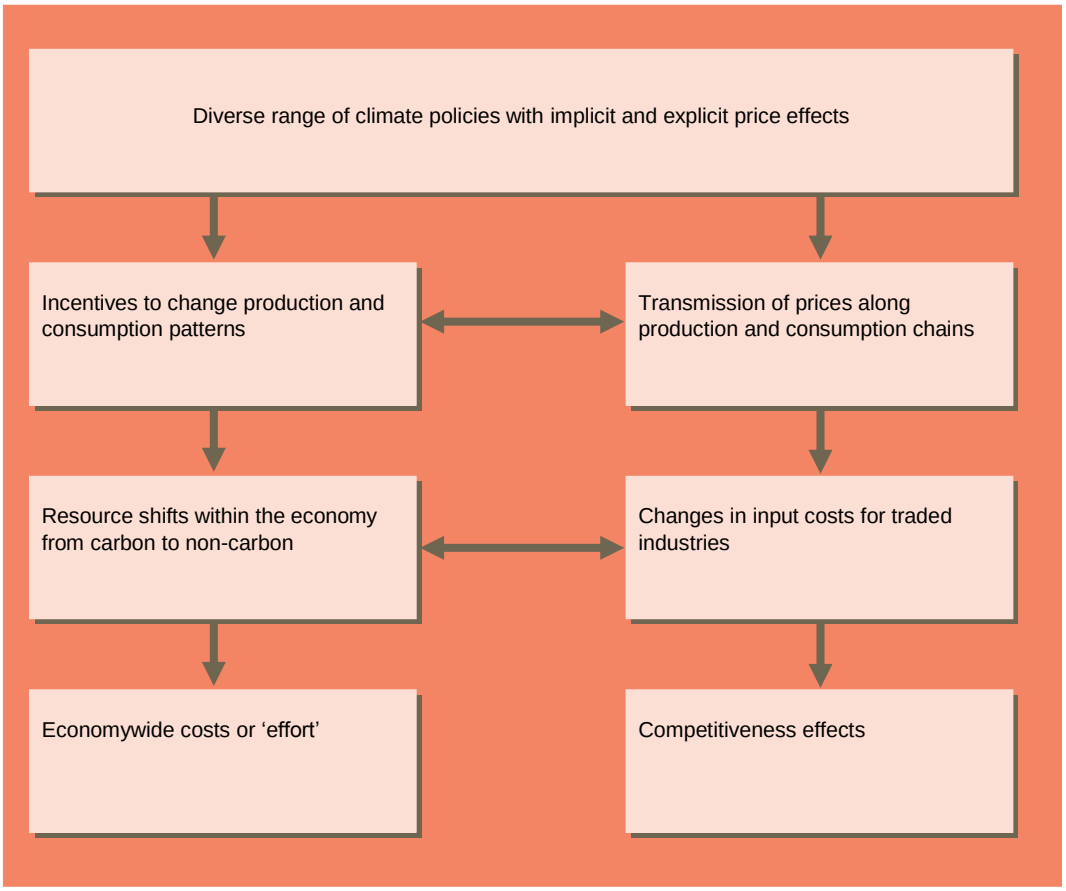
In the words of the OECD, one purpose for summary comparisons of policies between countries is to provide a 'common basis for a policy dialogue'. Rigorous and evidence based comparisons provide a solid foundation for discussions, particularly when interactions between countries is needed. These discussions are always difficult enough without disagreement on what should be basic matters of fact.

Two dialogues in climate policy

There are two broad dialogues or reasons why a good understanding of the relative carbon prices between countries is an essential component in formulating carbon policy. These relate to two different channels of effects that carbon policies have, as illustrated in chart 2.1. Down the left channel, climate policies will have a major impact on the allocation of resources within an economy, leading to economic costs and in a broad sense a level of 'effort' needed to satisfy the policy objectives.

Down the right channel, climate policies will change the structure of costs and revenues within an economy and will lead, among other things, to a change in 'competitiveness' for trade exposed industries. That is, different climate policies, by changing cost structures between economies will lead to a change in the relative cost of traded industries. Some of this change in competitiveness is a major concern for policy makers.

2.1 **Two broad channels of effects of carbon policies**



A dialogue about 'comparable effort'

The first policy dialogue that comparisons of carbon prices can contribute to is the dialogue *between* countries concerning the level of 'effort' countries are applying in trying to reduce greenhouse emissions. There is a long running literature on defining 'comparable effort' between countries, and some notion of an effective carbon price could clearly contribute to this debate.

Comparing the level of effort is in many ways an economywide issue. The interest is in the broad resources shifts within the economy (shifts from carbon to non-carbon based production). While comparing carbon prices will provide some indication of this, prices alone cannot do all the analytical work.

A closely related dialogue: 'efficiency of policies'

Closely related to the comparable effort dialogue is an understanding about the relative efficiency of policies in different countries. It is clearly in the global interest to work towards the most efficient policies in each country.

The process of calculating comparative carbon prices, if done properly, will also help elucidate the relative efficiency of policies. Indeed, as noted below, relative efficiency of policies will be a major methodological issue in making carbon price comparisons.

A dialogue about competitiveness effects on trade exposed issues

The second policy dialogue that comparisons of carbon prices can contribute to is the dialogue *within* a country concerning the approach that should be taken to offsetting any competitive disadvantage that may be faced by trade exposed industries in the transition to a global carbon price — that is, during the period where some countries have a carbon price, and others do not.

A number of approaches to the this issue have been proposed, ranging from the pragmatic permit allocation approaches under the CPRS to the more principled approach of the *Garnaut Climate Change Review*.

Whatever the ultimate approach taken, it is clear that dealing with this issue requires:

- an understanding of the differential effects of different carbon policies between countries on competing traded industries within those economies;
- understanding the magnitude of this difference, particularly on a commodity by commodity basis.

Measures of different carbon prices between economies can clearly contribute to practical policy development in this area.

In this case, the carbon price comparison needs to be industry (or activity or commodity based). Economywide comparisons are unlikely to be sufficient if it turns out that different industries face different effective carbon prices.

Monitoring and measuring developments in carbon policy

The OECD also uses agricultural support comparisons to monitor and compare developments over time. This would also be a useful function for carbon price comparisons; assessing developments and progress over time.

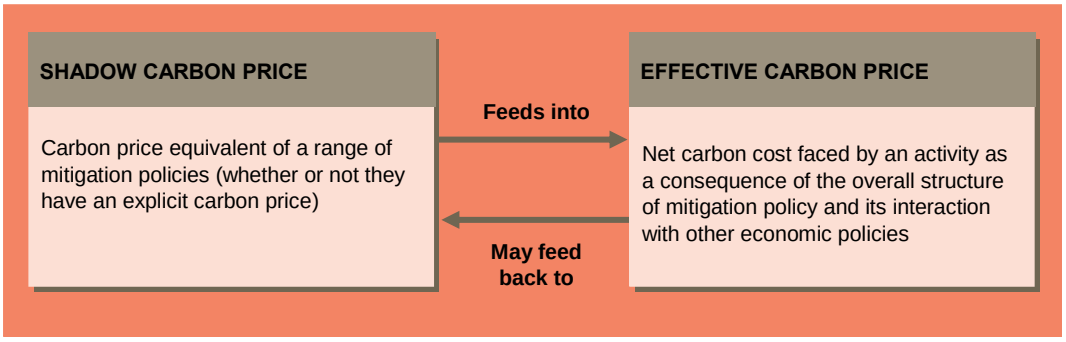
3 What needs to be measured?

The different purposes behind carbon price comparisons have different measures associated with them. There is likely to be a range of carbon prices of interest and a hierarchy of ways of measuring them.

Shadow and effective carbon prices

The terms 'shadow carbon price' and 'effective carbon price' are often used interchangeably, however it is useful to distinguish between these two in order to clarify the usefulness of different carbon price concepts (see chart 3.1).

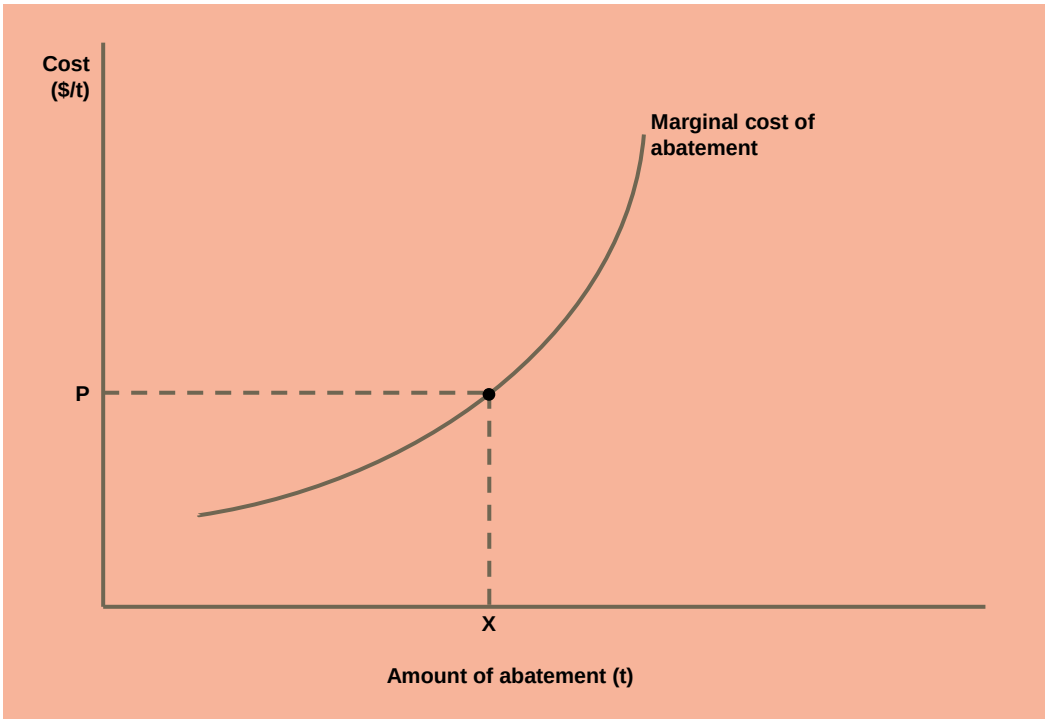
3.1 **Shadow and effective carbon prices**



Shadow carbon price

The shadow carbon price is the carbon price equivalent of a range of mitigation measures that may or may not have an explicit price associated with them. It is essentially the notional price, which if implemented directly (through a tax, for example) would achieve the same abatement as that targeted by the mitigation measures actually in place. Chart 3.2 illustrates how the shadow price of carbon for a particular abatement target is related to the economywide marginal cost of abatement.

3.2 Shadow carbon price



The shadow carbon price (which could also be called the 'carbon tax equivalent' or 'explicit carbon tax equivalent'), is premised on the notion that quantity constraints in general have a shadow price associated with them, although it is generally recognised that in practice price and quantity based carbon policies have different properties.

The shadow carbon price is analogous to the tariff equivalent of an import quota (the border tariff that would be needed to achieve the same restriction on imports as the quota) or the subsidy equivalent of a local content scheme.

The more complex the policy, the more assumptions needed to construct the shadow price, and in doing so an important question is the extent to which *behavioural responses* to the policies are incorporated into the construction of the shadow price.

As discussed further below, there is a fundamental trade off in analytical methods here. Methods that assume no behavioural responses are less data intensive and much easier to implement, although they run the risk of being misleading. Measures based on models that allow a greater range of behavioural responses provide a more complete picture of the policy at the cost of considerably greater data and information requirements.

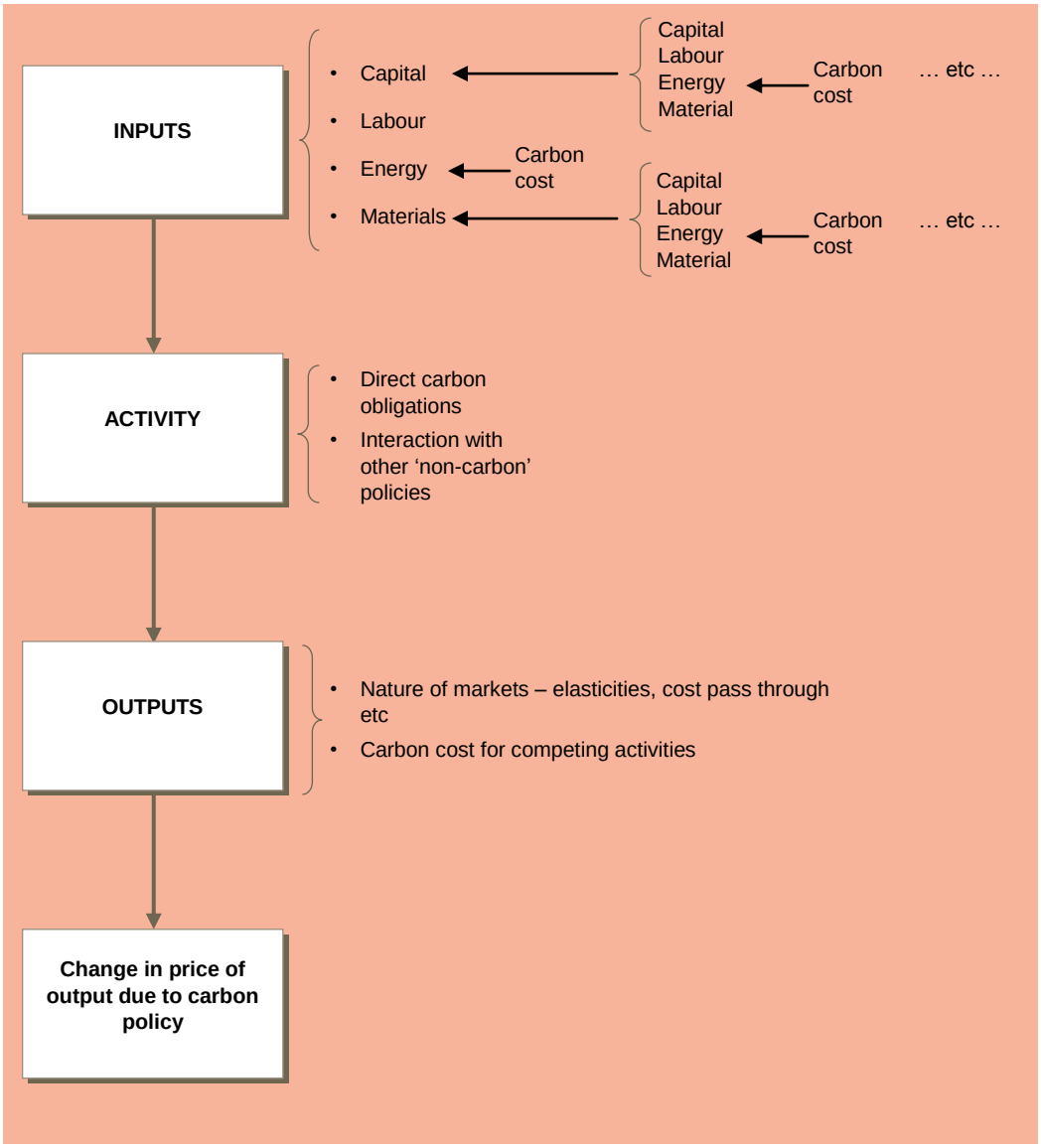
Effective carbon price

The effective carbon price is a measure of the net carbon cost faced by an activity (which could be mapped to an industry, or the subset of an industry) as a consequence of the overall structure of mitigation policy.

The *effective* notion is used here in the sense that the effective rate of protection (ERP) is used in trade policy. Where the ERP was designed to capture the net effect of protection to inputs and outputs of an activity (specifically, the net increment to value added afforded by the protective structure) the effective carbon price is designed to perform a similar role in analysing mitigation policy.

Chart 3.3 illustrates how the effective carbon price is built up through a range of interactions within the economy.

3.3 **The effective carbon price**



The effective carbon price naturally feeds into questions of competitiveness as it is the effective price faced by import competing industries and exporters in different countries that will have a direct bearing on challenges facing trade exposed industries during the transition to full coverage of carbon policies around the world.

In particular, the information that feeds into the construction of an effective carbon price is precisely the sort of information needed to implement the various suggestions for the treatment of trade exposed industries including the proposal from the *Garnaut Climate Change Review*.

Relation between the two

The shadow carbon price and the effective carbon price are clearly related, but are conceptually distinct. In the simplest case of a carbon tax (where there is no ambiguity about the shadow price) the effective carbon price faced by any activity depends on factors such as:

- the distribution of the incidence of the tax up and down the production chain (itself determined by the reactions of producers and consumers up and down the chain);
- the pattern of exemptions and offsets in the policy; and
- the interaction of the carbon policy with other policy instruments (such as general tax policy).

Just as a particular system of nominal tariffs can have very different effective rates associated with it, so too could a set of shadow carbon prices be associated with a complex set of effective carbon prices.

Where carbon policies are not explicitly price based, industries will still face an 'effective' carbon price. In this case, the effective price will be built up as a consequence of the 'shadow' or implicit prices throughout the production chain.

In this case, the shadow price will be an important input into estimating effective carbon prices for activities. At the same time, it is possible to measure a shadow carbon price in an economywide sense at the same time as having a zero effective carbon price for a particular activity.

Measuring resource flows

It is possible to create a shadow carbon price for any policy (as noted further below, which policies to include in the calculation is a crucial analytical question). But this price will not necessarily in itself answer the question being asked.

From the point of view of comparing effort between countries, what needs to be measured are the resource flows (or the incentives for resources flows) from carbon based production to non-carbon based production, or equivalently, the effort in decarbonising the economy.

Here an analogy with protection is useful. The 'effective rate of protection' was designed to indicate the extent to which resources were encouraged to move within the economy (broadly from unprotected to protected industries, which in most cases effectively meant from export to import competing). The purpose of the measure was not the construction of the rate per se, but as an indication of the kinds of distortions that could be emerging.

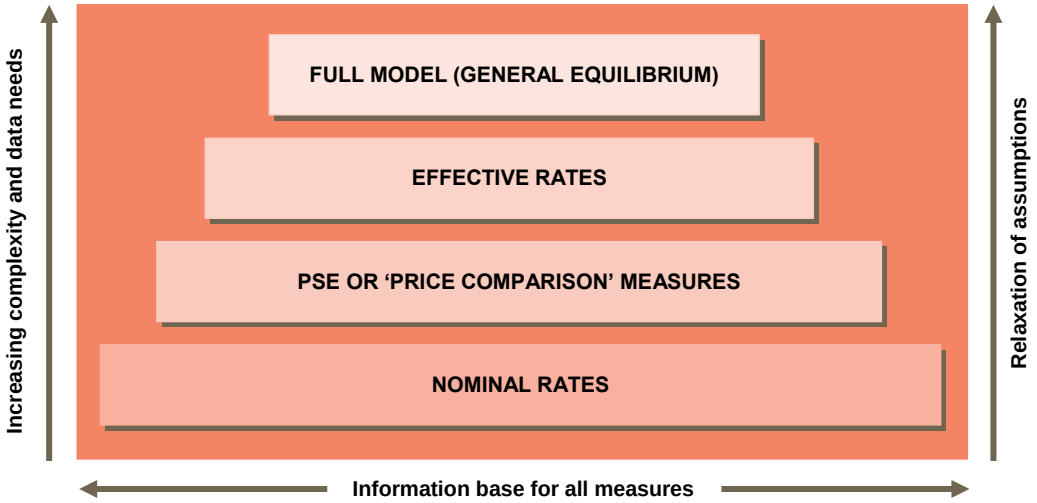
Thus, to be useful, effective carbon prices must provide an indication for this type of movement. In choosing methods of calculating carbon prices, this overall resource flow objective should be kept in mind.

From the point of view of trade competitiveness, the purpose is to measure the extent to which relative carbon policy structures (when understood in conjunction with other policy measures) are likely to lead to relative resource flows between industries in different countries. In particular, the crucial issue is to understand whether these flows are consistent with the long term global policy objectives or whether they move against them – that is, whether they create 'leakage' or whether they lead to a net reduction in emissions.

A hierarchy of measures

In undertaking comparisons of carbon prices between countries, there is in effect a hierarchy of measures that can be used. Again an analogy with trade policy is useful. Chart 3.4 illustrates this in terms of some traditional trade policy measures, while table 3.5 draws out the analogy with carbon prices.

3.4 Hierarchy of trade policy measures



The simplest measure in trade policy is the nominal rate, essentially the tariff rate[3]. While this measure provides and initial indication of the effects of protection, it is not sufficient to indicate resource flows within an economy and does not, of course, cover non-tariff measures.

3.5 Trade policy measures and carbon policy equivalents

Trade policy measures	*Equivalent in carbon policy terms*
Nominal rates of assistance: simple rate of tariff or subsidy	Carbon price arising from explicit price based measures (or rate based subsidies)
Price comparison measures: price equivalent of quantitative measures and measures without an explicit rate of tariff or subsidy	Indirect imputation of the rate of the carbon tax or subsidy. Essentially the shadow price of the carbon policy measure.
Effective rates of assistance: net effect of the structure of nominal and price equivalent measures	Estimate of the effective carbon price paid up and down the production chain.
General Equilibrium Models: simulated effect of trade policy structure. Draws on nominal and price comparison measures, input-output tables as in the case of effective rates as well as significant other information and parameter needs.	Simulation modelling of sectoral output and price changes as a consequence of carbon policy measures throughout the economy

The next layer in the hierarchy is a range of 'price comparison' measures which essentially attempt to measure the tariff equivalent of quantitative or other border restrictions — often by making direct price comparisons between countries. This measure is in itself very complicated, but it does not contain as much information in

[3] Although simple in principle, there are significant practical issues in dealing with large tariff schedules and in aggregating tariffs across commodity items.

the next layer of the hierarchy, the effective rate of protection. The ERP draws on both nominal and price comparison rates of assistance to provide a more complete picture of the effects of protection.

Even the ERP is limited, however, and is based on restrictive behavioural assumptions. The next layer of analysis that allows the relaxation of many of these assumptions — but at the cost of considerably greater information requirements — is formal CGE modelling.

The implication of this is that answering all the questions we may have about the effect of carbon policies is likely to require formal modelling.

The complex relationship between abatement, carbon prices and economic costs

The use of economic models clearly reveals that there is a complex relationship between abatement targets, carbon prices and resource movements (as measured, for example, by changes in GDP).

Chart 3.6 illustrates this for one set of modelling analyses recently undertaken using a global general equilibrium model. The first panel shows the reduction in emissions relative to business as usual (BAU) required by proposal put forward by individual countries as part of the Copenhagen accord[4]. While the initial proposals were expressed in very different terms, modelling of changes relative to BAU allows a comparison of the actual targets proposed.

The second panel of chart 3.6 shows the carbon price needed (within each country individually) to achieve these targets. This is essentially the modelled shadow price of the quantity commitments in the first panel. This shadow price is determined by the input-output relationships, substitution parameters (particularly within the energy sector) and other demand and supply relationships within the model.

The final panel of the chart shows the effect on GDP (at a single point in time relative to BAU) of the actual implementation of this carbon price. The GDP effect also depends on a wide variety of factors captured in the overall model structure.

[4] The various proposals reflect emissions targets for 2020 and are: Australia, 5 per cent reduction relative to 2000; USA and Rest of OECD, 17 per cent reduction relative to 2005, Japan, 25 per cent reduction relative to 1990; Europe, 20 per cent reduction relative to 1990; China 40 per cent reduction in per unit GDP emissions relative to 2005; India, 20 per cent reduction in per unit GDP emissions relative to 2005; and Eastern Europe and Former Soviet Union, 28 per cent reduction relative to 1990.

Lessons

There are several lessons that emerge from this model based comparison.

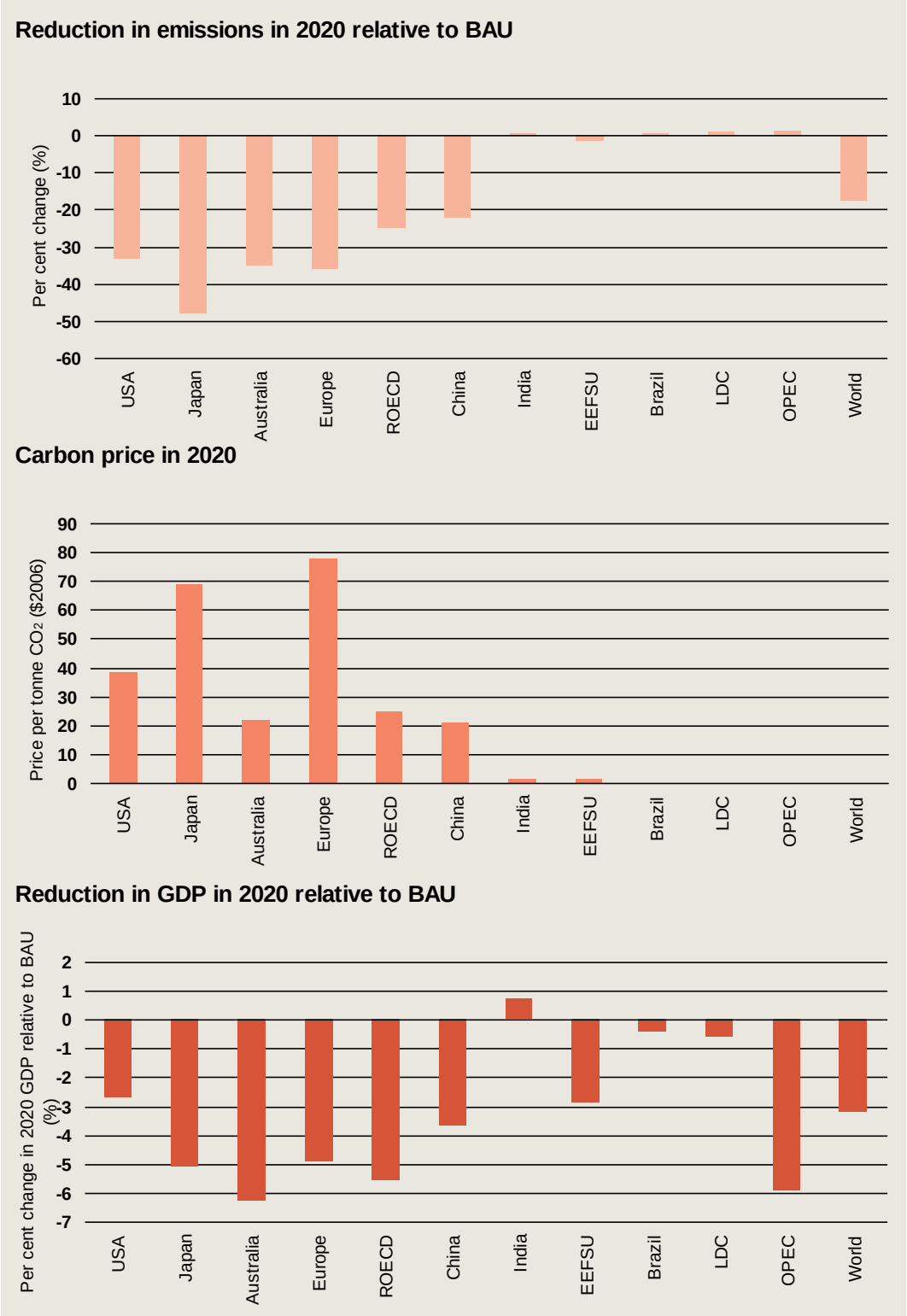
First, putting abatement targets on a common basis (particularly relative to BAU emissions) is an essential first step in any analysis. This exercise is in itself quite complicated as it requires judgements about how emissions would emerge in the absence of explicit policies to limit them.

Second, there is only a very broad relationship between the magnitude of commitments and the carbon price required to achieve them. While in general a higher commitment requires a higher carbon price, there is not a simple linear relationship between the two.

Third, there is not a unique relationship between the implicit carbon price to achieve a particular target and the reduction in GDP that results from imposing this price. Broadly, the higher the price, the greater the reduction in GDP, however once again there is not a simple linear relationship.

Thus, while comparative carbon prices contain important information, they do not provide a full indication of the effects of particular targets or policies to achieve those targets.

3.6 Modelled implications of Copenhagen targets



Data source: McKibbin et al *Comparing climate commitments: a model based analysis of the Copenhagen Accord*. (http://belfercenter.ksg.harvard.edu/files/McKibbin-DP-June2010-final.pdf)

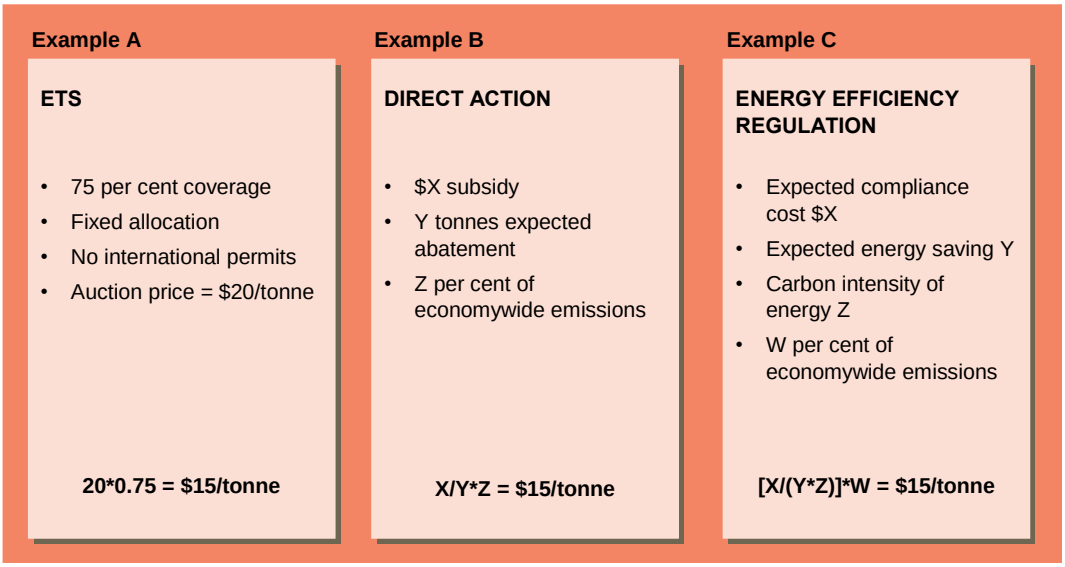
4 A look at measurement challenges

While comparing carbon prices is ultimately about understanding an 'equivalence' between policies in different countries, different policies have many dimensions and equivalence can only be defined in selected dimensions. Understanding this is crucial to interpreting carbon price comparisons.

Three illustrations

Chart 4.1 illustrates three examples of a simple approach to estimating the shadow carbon price of three different policies.

4.1 **Shadow carbon price, examples**



The first of these is the most straightforward — an emissions trading scheme with clearly defined coverage and allocation and with a known starting permit price. In this example the economywide carbon price is $15 per tonne (after accounting for the coverage of the ETS, and assuming no policies outside this coverage).

Example B shows a 'direct action' measure, in this case a direct subsidy designed to target specific abatement, perhaps in a particular sector or more broadly. The dollar subsidy divided by the tonnes of expected abatement provides one indication of the shadow carbon price.

Example C shows a more complex energy efficiency regulation. This could be, for example, the requirement to achieve a particular level of energy efficiency in a particular process, or perhaps the compulsory sale of energy efficiency appliances, and so on. In this case, the cost of the policy is the expected compliance cost of the regulation[5]. The reduction in emissions depends on the expected ultimate energy saving and the on carbon intensity of the energy saved. Combining these (assuming appropriately equivalent units) provides a measure of the shadow price of carbon.

Even though in these examples the same carbon price emerges, the nature of the policy approaches are so different as to require very careful interpretation of what the price comparison actually entails. It may not be appropriate, for example, to conclude that these three policies either induced the same resource flows or that they had the same flow on effect to trade exposed industries. Further, it may not be appropriate to add these different measures to form an economywide price.

There are two broad reasons for this:

- measurement uncertainties; and
- economic differences between the policies.

Measurement uncertainties

Each of these measures has different uncertainties involved in the actual calculation of the carbon price. Most importantly, the subsidy and efficiency measures, if they are examined *ex ante*, have uncertainties about:

- the amount of abatement actually achieved (in the case of the subsidy);
- the compliance cost;
- the overall energy saving; and
- the nature of the energy that is saved (whether it was carbon based).

At the very least, these uncertainties imply that care should be taken when using a single point estimate.

Economic differences

As well as the practical measurement challenges for these policies, there are significant conceptual differences in the economics of their operation and in the ways in which producers and consumers are likely to react to them.

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[5] Here compliance costs is understood in its fullest sense to include the investment cost of meeting the requirements of the regulation, as well as the administrative costs of proving compliance, and so on.

Different balance of risks

Under emissions trading, covered sectors face price risk (the future price of emissions is not known with certainty). Under the subsidy measures the taxpayer faces either an expenditure risk (because the cost of a targeted level of abatement is unknown) or possibly international compliance risk (because the abatement from a fixed level of expenditure is unknown). Under regulatory measures, the balance of risks is often itself very unclear, but in many cases compliance risk will be passed on to industries.

Different initial distribution of burden

The three different policies clearly involve a different initial distribution of burden, ranging from taxpayers to industry. The final distribution will depend on a range of economic factors that together determine whether affected industries and activities are able to pass on any carbon costs. For example, trade exposed industries will be unable to do so and will bear most of the burden themselves. On the other hand, activities that do not face trade competition will be able to pass costs on to their customers.

Different flow on effects

The different policies clearly have different flow on effects. In the case of the ETS, it would be expected that the carbon price (the permit price in this case) would be transmitted throughout the economy in what is in principle a transparent way (although in practice calculating this transmission will be complex).

In the case of the direct subsidy, the carbon price is not really transmitted directly around the economy in the same way. The transmission of the policy is related to its effect on taxes and revenue raising rather than on an explicit price.

For regulatory measures, the transmission of costs around the economy will depend on the precise nature of the regulation and is unlikely to be particularly transparent.

Different behavioural responses

The transparent price formation in an ETS is likely to induce different behavioural responses to the more hidden effects of the energy efficiency measures. Importantly, the price in an ETS provides direct incentive to reduce emissions, while the energy efficiency improvement, without a direct price on carbon, provides muted incentive to reduce carbon emissions.

Understanding the economics of different policies

These differences between policies imply that both constructing and interpreting shadow and effective carbon prices requires an understanding of the underlying economics of different mitigation measures.

5 A measurement process

The process of selecting countries and policies for comparison requires solid methodological discipline as well as continual reference to the original purpose of the price comparisons.

Identify, distinguish and classify

The experience from comparison of protection between countries suggests that the broad process of identifying, distinguishing and classifying policies (as broadly outlined in the OECD *PSE Manual*, for example), as illustrated in table 5.1, is an important component of undertaking any comparative analysis.

5.1 **Identify, distinguish and classify**

	Agricultural policies	*Mitigation/carbon polices*
Identify	Identify policies that involve a transfer where the incidence is at the farm level and is directed specifically at agricultural producers (or treats agricultural producers differently to other agents in the economy). Importantly, policies generally available throughout the economy are not covered.	Identify policies where the specific intent is to change production and consumption incentives towards less carbon intensive products and activities. Policies generally applicable to all forms of production and consumption should not be covered.
Distinguish	Policy measures distinguished on the basis of the economic groups that are the intended recipients (eg producers, consumers, producers collectively etc).	Policy measures distinguished on the basis of initial incidence eg sectors, producers, consumers etc
Classify	Identify the way in which the policy is implemented and the economic features important for subsequent analysis	Policy measures could be classified according to a variety of criteria including whether they target emission quantities or prices or involve budgetary transfers

Identify carbon mitigation measures

This step involves identifying which policies should be included in the analysis. In principle, a shadow carbon price could be calculated for any policy, simply because anything that affects economic activity levels is likely to also change emissions and

will therefore have some implicit price associated with it. Such a broad definition, however, would clearly be inappropriate.

The identification of carbon policies needs to account for whether the policies specifically act towards changing incentives in production or consumption away from the use of carbon as an input (or the emission of carbon as a by product) or which create incentives to remove carbon from the atmosphere.

Policies which change incentives for all forms of production and consumption (carbon or otherwise) should not be included. This may mean that some judgements are needed. For example, policies which generally increase energy efficiency, but do not distinguish between carbon intensive and other forms of energy use would be borderline according to these criteria. A similar argument might apply to policies such as fuel excises and related taxes or to very general policies such as energy market reform.

Distinguish between different measures

Carbon policy measures can broadly be distinguished on the basis of their intended targets (consumers, producers etc) and on their intended coverage (specific sectors or economywide). Targets and coverage will clearly imply differences in economic effects.

Classify measures appropriately

This step essentially involves thinking through the different economic effects of different policy measures in order to understand the factors that need to be accounted for in measuring the impact of the policy.

There are a number of ways of classifying mitigation policies in order to distinguish their economic effects. Many policies can easily be distinguished by the major mechanism of delivery (emissions trading versus a carbon tax, for example), on the ways in which these mechanisms interact with other policies, on the nature of flow on effects and so on.

Here the details of the taxonomy are not as important as the process involved in considering the different nature of policies and in understanding their different economic effects.

Just as the alternative configurations of trade policy have different effects (tariffs are different to local content schemes and regular tariffs are different to tariff-quotas) so to do alternative configurations of mitigation policy.

A sample classification

Table 5.2 contains a sample classification of different policies (in the rows) along with particular factors that need to be taken into account when considering the impact of these policies.

The important point here is not the specific classification approach used — there are many ways to classify climate policies — but the recognition that different policies will be distinct in the nature of their economic effects.

Explicit and broad based policies (such as emissions trading or a carbon tax) are likely to be the easiest to estimate shadow and effective carbon prices for. Even in these cases, however, it will be important to account for exemptions and offsets as well as any interactions with existing policies, particularly tax policy.

Budgetary outlay measure may have a clear revenue cost, but the abatement will be uncertain. The budgetary cost also has an economywide opportunity cost associated with it (the deadweight cost of revenue raising) that may need to be taken into account in some way.

Indirect or proxy carbon policies (renewable energy targets, white certificates and so on) along with energy efficiency regulations may be associated with rebound effects and other unintended consequences.

Finally, command and control measures or new project requirements may be associated with carbon leakage if they result in increased production elsewhere in the economy.

The point of all of these illustrations is to suggest that for most policies a range of second round effects and implications need to be kept in mind when estimating and comparing shadow and effective carbon prices.

5.2 **Sample classification of policies and effects**

	Base policy	*Exemptions and offsets*	*Other elements of flexibility*	*Interaction with other policies*	*Effects to watch for*
Quantity measures	Emission trading (cap and trade, baseline and credit etc)	Coverage Trade exposed	Price safety valve Other adjustments to cap	Tax system	Effect of price uncertainty
Price measures	Carbon tax or levy	Rebates	Rate of tax adjustment	Interaction with broader tax system (eg fuel excise)	Distribution of incidence
Budgetary outlay measures	Direct abatement subsidies	Compliance penalties	Enforcement of compliance	Budget neutral?	Deadweight loss of revenue raising
Efficiency related regulations	Energy efficiency regulations.	Treatment of different activities			Rebound effect from energy efficiency
Indirect or proxy abatement measures	Renewable energy target White Certificates	Coverage			Rebound effects
Command and control measures	Shut down requirements for 'dirty' plants				Leakage and rebound effects
New project requirements	Efficiency or other requirements on new projects				Leakage

Measures that are harder to classify

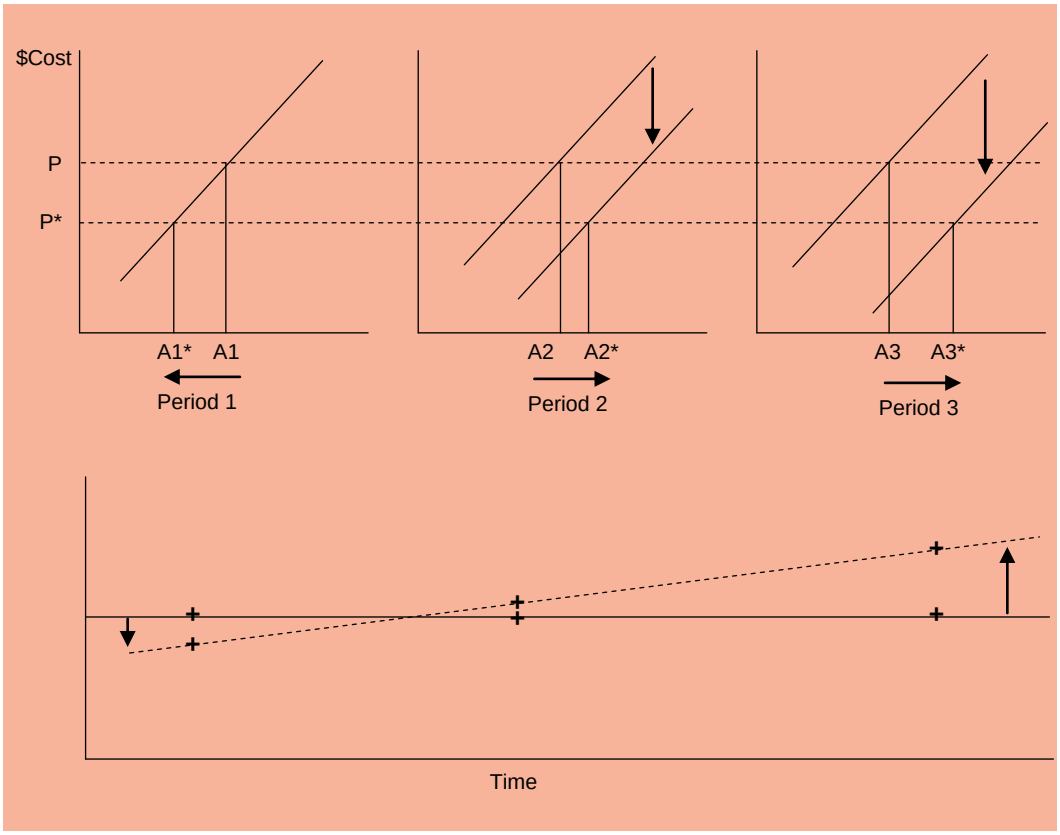
Some particular carbon policy measures will prove harder to classify and analyse. One example is various R&D measures that are designed to find new technologies that will allow abatement in the future. In principle, such R&D will lower the marginal cost of abatement in the future. This will change both the shadow price of carbon and the optimal timing of abatement.

This effect is illustrated in chart 5.3 which shows abatement over an illustrative three periods. The optimal pattern of abatement is to equate the marginal cost of abatement over time. For simplicity, chart 5.3 ignores the discount rate and shows that for a give marginal cost of abatement curve, the carbon price is P, and the amounts of abatement over time are A1, A2 and A3[6].

[6] By construction, this is the same amount of abatement in each year. Incorporating the discount rate would mean that the optimal amount of abatement (and the optimal carbon price) increases over time.

R&D has the effect of lowering the marginal cost of abatement, possibly by increasing amounts over time. This means that the shadow price of carbon, and the optimal abatement in each year, changes. The shadow price is now lower (P*) , and it becomes optimal to do less abatement early (A1* versus A1), and more abatement later (A2* and A3* rather than A2 and A3).

5.3 **R&D, abatement and shadow prices**

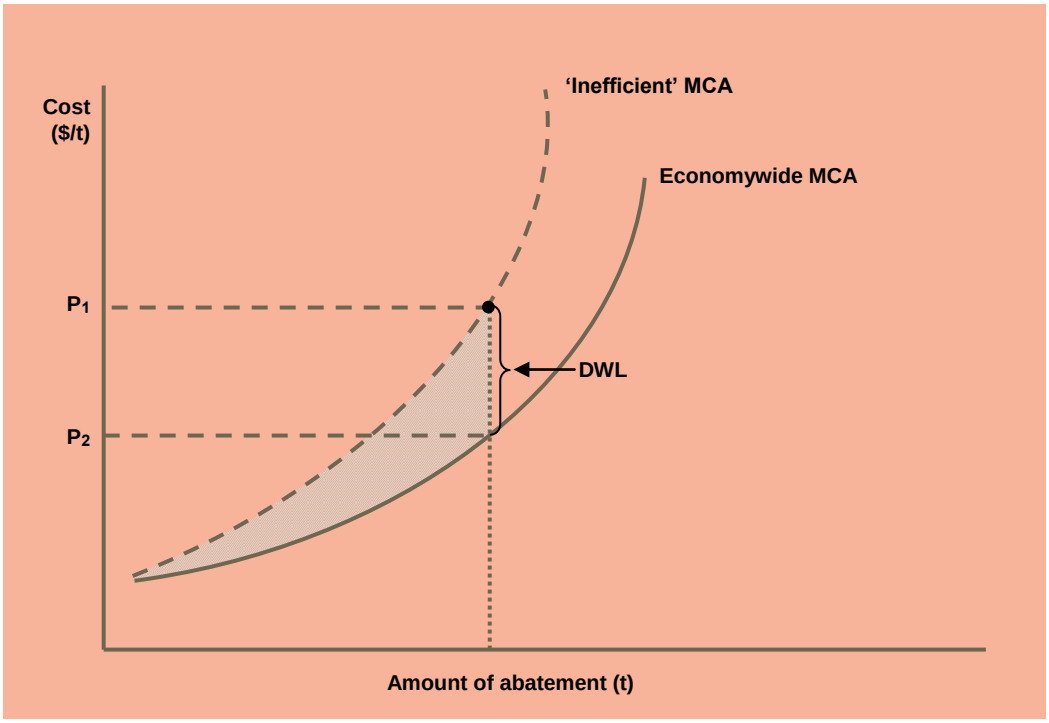


The challenge here is in how to calculate a shadow carbon price for R&D measures that allows them to be compared on the same basis with other measures. In this case the lower shadow price does not imply less effort. It is, however, likely to result in lower flow on price effects.

Dealing with inefficient carbon policies

A second classification and measurement challenge is in dealing with policies that are known to be economically inefficient in that they do not encourage the lowest marginal cost of abatement. This is illustrated in chart 5.4 where the shadow carbon price for a given level of abatement (P1) appears high because of inefficiencies in abatement.

5.4 **Shadow prices and inefficient carbon policies**



Inefficient policies may arise for a variety of reasons, but most likely because abatement is constrained to a single sector or inefficient policy mechanisms are used. In these cases, the 'inefficient' shadow price may produce a misleading indication of the resource flows associated with the mitigation policies. In this case, some form of benchmark of the economywide marginal cost of abatement may be appropriate in calculating the shadow price.

Choosing countries for comparison

In undertaking international comparisons, the choice of countries will clearly be an important component of the overall methodology. There are a number of ways of choosing country comparisons, but three broad principles could be applied:

- share in global emissions;
- policy variety;
- Australian competitors.

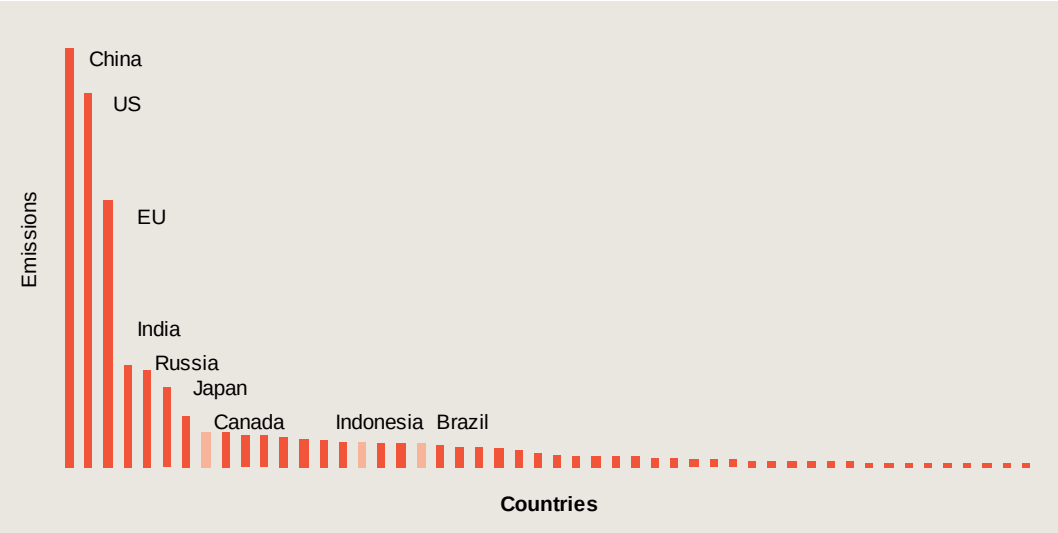
Share in global emissions

As is well known, the global distribution of emissions is highly skewed (chart 5.5). The top six countries (or regions, including the EU as a single entity) account for almost three quarters of global emissions. Focusing on these countries would clearly

be appropriate. In particular, as a minimum China, US, EU, India, Russia and Japan should be covered.

The US and the EU are also of interest because they have a similar standard of living socio-economic background to Australia. In this regard, other countries such as Canada would also provide a useful point of comparison from Australia's perspective as Canada has a similar resource based economy to Australia's.

5.5 **Distribution of global emissions**



Data source: UN Statistical Division

Policy variety

Another principle for selecting countries and commodities for comparison is that of policy variety. As already noted, different policies have a range of different implications for both abatement effort and competitiveness. It will be important that any comparison captures a variety of policy mechanisms in order to fully understand the differences between countries.

From this perspective, the EU provides an important benchmark for comparison as it has in place an explicit carbon price (through an emissions trading scheme).

Australian competitors

From the perspective of competitiveness, it will clearly be important to include key Australian trade competitors in the overall comparisons. In this case, the countries chosen for comparison depend very much on the particular industries that are also being considered. Key competitor countries vary considerably depending on the industry concerned, but would include a number of large emitters such as Indonesia and Brazil.

6 Using economic models

Ultimately, many of the intricacies of comparative carbon polices can only be captured with explicit economic modelling. There are a variety of models and studies that have already been used to examine the effects of a range of carbon policies. These could form a basis on which to build.

Because of the large number of interactions involved in mitigation policy, there is a strong case for using economywide simulation models to assist in untangling the various direct and indirect effects of carbon policies. This is particularly the case in trying to estimate effective carbon prices where effects up and down the production chain, as well as on consumption, is essential.

Models are also likely to be useful in creating a benchmark against which to compare inefficient climate polices. Properly specified CGE models can be used to provide an indication of the economywide marginal cost of abatement. This already has precedent in Australia of course, where models have been used by research agencies and the Commonwealth Treasury to examine the economywide costs of abatement.

There are a number of existing single and multi country models that could be used for this purpose, and model based analyses of carbon policies have already been undertaken for a number of countries. In addition, a number of studies have used models to examine comparable effort implied by different mitigation targets.

For model based comparisons to be successful, however, it would be important to observe a number of principles of modelling transparency to ensure that the implications of models are understood and accepted. These include:

- using a variety of models so as to capture a range of possible assumptions and different modelling strategies;
- undertaking sensitivity analysis within any particular model in order to understand the key drivers of the model results;
- ensuring model transparency by making models available to a variety of researchers if possible.

A model for this form of transparency again has an analogy in protection policy where the development of economywide models in Australia was an important part of the development of policy responses during the protection debate.

Finally, for carbon price analyses, it is likely that a number of different types of models will be needed. Economywide models will provide essential insights into the

broad flow on effects of policies, however for some purposes (particularly trade competitiveness issues) more details commodity specific models are also likely to be needed.