Carbon Trading: Theory and Practice

As governments grapple with an appropriate response to climate change, we look at the existing carbon trading schemes and the economic arguments supporting them. In our view, a general approach that combines elements of pure tax and permits systems would allow governments to implement an efficient

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CLIMATE CHANGE REPRESENTS a considerable policy challenge. In its latest report on climate change the Intergovernmental Panel on Climate Change (IPCC) stated that 'warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level' (IPCC, 2007, p. 4). The authors of the report also argued that 'most of the observed increase in globally averaged temperatures since the mid-20th century is very likely [with greater than 90 per cent probability] due to the observed increase in anthropogenic greenhouse gas concentrations' (p. 8).

Extensive media coverage of climate issues around the world suggests that governments and the people they represent are ready for action and yet progress towards a truly global, efficient and effective response has been slow. In an attempt to slow down and stabilise the pace of climate change most countries have signed and ratified the Kyoto Protocol (UNFCC, 1998) to the UN Framework Convention on Climate Change (UNFCCC). The Kyoto Protocol is a system based on a 'cap and trade' approach that sets targets for the reduction of greenhouse gases (GHG) and facilitates the trading of permits to emit GHGs between countries and individual entities. The existence of a trading mechanism allows most GHG abatement to occur in those sectors of the economy or in those countries in which it is cheapest. Although the Kyoto Protocol represents a major step towards a global policy on greenhouse gas emissions, the protocol has not been ratified by the world's largest emitter of GHGs: the United States.

The refusal by the United States and Australia to ratify the protocol has been viewed by many as an indication that neither government is serious about climate issues. However, economic theory suggests that quantity-based permit systems like the Kyoto Protocol are the most efficient way to achieve the cap on GHG emissions only under certain conditions. Conversely, the theory implies that under a different set of conditions and under uncertainty there may be more efficient approaches to GHG emissions policy. Using these and other economic arguments the United States and Australia have criticised the Kyoto Protocol on the following grounds:

- There is a high degree of uncertainty associated with the nature and consequences of climate change.
- There is a high degree of uncertainty associated with the relative size of costs and benefits associated with emission reductions.
- Existing policy proposals fail to adequately account for these uncertainties.
- Under the current form of the Kyoto Protocol large developing countries such as China and India need not cut their GHG emissions in the near future, which can further damage already fragile competitive positions of the developed countries.

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In this paper, we survey some current carbon emissions trading schemes and markets, briefly consider the economic theory behind emissions abatement and discuss an alternative approach to emissions policy. We begin by providing a brief summary of current carbon policy and several existing carbon markets.

Current emissions trading schemes

The Kyoto Protocol to the United Nations Framework Convention on Climate Change has been extensively debated in both the academic literature and the public media. As of June 2007, 174 countries and one regional economic integration organisation (the European Economic Community) had ratified the Protocol. Australia and the United States are notable exceptions. The Protocol is based on a cap and trade system that targets the quantity of GHG emissions and promotes trading of carbon allowances between countries and individual entities. In general, the provisions of the Protocol apply to developed countries and currently only 35 countries and the EEC are required to reduce GHG emissions compared with their historical levels. China and India are excluded.

Under the Protocol, national emission limit setting is performed by a government agency that decides on a cap of GHGs that can be emitted consistent with its Kyoto target and allocates this quantity, via permits, to major carbon-emitting industries. Individual organisations may then choose to either use their carbon allowances to validate their own GHG production, or to implement new technologies to reduce their GHG emissions and sell the permits. Thus, carbon trading occurs between firms that over-emit and under-emit relative to their allocations; firms that are able to control their emissions most easily do so and sell their surplus allowances at a profit to firms that face higher costs of controlling emissions. The trading mechanism allows most GHG abatement to occur in those sectors of the economy in which it is cheapest.

International carbon markets

The international carbon market grew from US$10 billion in 2005 to US$30 billion in 2006.[1] Briefly, carbon trading occurs both within and outside the framework set up by the Kyoto Protocol through two types of carbon permits. GHG emission allowances are permits created and distributed under cap and trade regimes such as the European Union Emissions Trading Scheme (EU ETS) which operates under the Kyoto Protocol. European Union Allowances (EUAs) are permits to emit carbon dioxide issued by regulatory bodies, usually EU state governments, whose total quantity is fixed under a trading scheme. Project-based permits, on the other hand, are emission credits generated from projects that reduce GHG emissions compared with a no-project scenario. Project-based permits are derived from two main sources: the Clean Development Mechanism (CDM) and the Joint Implementation (JI) initiative. CDM is an arrangement within the Kyoto Protocol allowing industrialised countries with a GHG commitment to invest in emission reducing projects in developing countries. China, India and Brazil provided most of the CDM carbon credits in 2006.[2] Although the JI credits are also project-based credits, they are projects based in industrialised countries. Japanese buyers participated in about 7 per cent and European entities in about 86 per cent of the total of all project-based transactions.[3]

So far a number of organised international markets for carbon permits have emerged, with the European Union Emissions Trading Scheme being at the forefront in terms of its size and regulatory organisation. The other two notable carbon allowance trading schemes are the NSW Greenhouse Gas Abatement Scheme (GGAS) and the Chicago Climate Exchange (CCX) project. We summarise each of these schemes below.

European Union Emissions Trading Scheme (EU ETS)

The EU ETS is the world's largest mandatory carbon trading program. Although a relatively new market (launched on 1 January 2005), it has grown at an unprecedented rate. The total value[4] of transactions conducted in 2006 exceeded US$24 billion, compared with US$8 billion traded in 2005. The EU ETS was designed to operate in two phases. During the first phase (2005–07) the EU ETS covers over 12,000 emitting installations and about 40 per cent of the total EU carbon dioxide emissions. The first phase is a pilot program that will aid the EU in its preparation for full compliance with the Kyoto Protocol. The second phase (2008–12) will broaden the coverage of the EU ETS to more industries as well as greenhouse gases and will reach compliance with the Kyoto protocol.

European Union Emissions Allowances are allocated to carbon emitting installations by member state governments in predetermined quantities through National Allocation Plans (NAPs). Although the member states formulate their NAPs, they must be approved by the European Commission. The total number of permits issued by each member state is constrained to be consistent with the path undertaken by the EU towards achieving its overall Kyoto commitment of reducing greenhouse gas emissions (8 per cent below its 1990 level by 2012). The EUAs are legally binding and each affected installation is required to hold permits in the amount equal to its carbon

emission. There is a well-developed secondary market for EUAs and spot and futures contracts trade on the over-the-counter market as well as organised exchanges such as Powernext, European Climate Exchange and Nordpool.

Chicago Climate Exchange (CCX)

CCX is another quantity-based trading scheme. CCX is a self-regulated exchange that operates on the basis of voluntary participation where carbon emitting organisations, institutions or government bodies voluntarily sign up to its program which then becomes legally binding. CCX members that sign up to the abatement scheme are required to reduce their greenhouse gas emissions at a rate of 1 per cent per year relative to a predetermined benchmark. Those members that reduce their emissions below the required level are then able to sell surplus emission allowances on the exchange or bank them for later use. Exchange members that are unable to achieve the reduction targets internally can meet their compliance by purchasing emission allowances through CCX's electronic trading platform from other CCX members. Alternatively, they may purchase project-based offsets. Currently, CCX members include a growing group of companies, including DuPont, Rolls-Royce, IBM, Ford, Bayer and numerous local governments. Although it is a relatively small market compared to EU ETS and NSW GGAS, CCX increased the value of traded allowances tenfold[5] in 2006 to US$38 million compared to only US$3 million traded in 2005.

Australian mandatory environmental trading schemes

The current Australian Government has decided not to ratify the Kyoto Protocol. In Australia, the issue of climate policy has become heavily politicised with the federal Australian Labor Party publicly criticising the Liberal Government's refusal to ratify the Protocol and commit to an emissions target. In January 2004, a National Emissions Trading Taskforce (NETT) was set up by the state and territory Labor governments to develop a National Emissions Trading Scheme (NETS). In August 2006, the NETT released a discussion paper[6] outlining the possible design for a national greenhouse gas emissions trading scheme. The discussion paper suggested a cap and trade system to reduce emissions by around 60 per cent compared with 2000 levels by the middle of the century. In February 2007 the Prime Minister established a separate task group on emissions trading, which argued that 'market mechanisms, including carbon pricing will be integral to any long-term response to climate change' (Howard, J. (PM), 2007). The report, which was released in May 2007, proposed that a cap and trade model be adopted with an overall emissions reduction trajectory which starts moderately and progresses to greater emissions reductions over time. It has a broader coverage than the currently proposed design by the NETT including most sectors other than agriculture. The Prime Minister has approved the scheme and work has already commenced on its structure with commencement planned for 2011. The actual targets and permit allocation details have not yet been determined, which makes it difficult to assess in relation to the existing schemes. There is no plan to scrap the existing schemes, however, it is felt that they will simply run out over time and as the Federal Scheme is introduced.

It would appear then that both the federal Liberal Government and the state and territory Labor governments acknowledge the need for a national response to climate change based on market mechanisms and carbon pricing. It is unclear, however, how any national scheme will be implemented and coordinated across the nation and how it will fuse with the existing schemes that are operating on a state-by-state basis. Currently Australia has a number of environmental trading schemes operating somewhat independently of each other in Victoria, New South Wales, Queensland and the Australian Capital Territory of which the NSW greenhouse gas abatement scheme is by far the largest and most established. Total value of carbon allowance traded on NSW GGAS increased to US$225 million in 2006[7] from US$59 million traded in 2005. The details of these trading schemes are summarised in Table 1.

TABLE 1. RENEWABLE ENERGY, ENVIRONMENTAL AND CARBON TRADING SCHEMES

State/ region	Scheme	Commencement date	Aims/specifications
NSW	NSW greenhouse gas abatement scheme (GGAS)	2003	The GGAS aims to reduce GHG emissions associated with the production and use of electricity. It establishes annual state-wide GHG reduction targets, and requires electricity retailers and certain large users of electricity in NSW to meet the targets based on their share of the electricity market. Monitoring the performance of benchmark participants is undertaken by the Independent Pricing and Regulatory Tribunal of NSW (IPART). The amount of the greenhouse penalty per tonne of carbon dioxide for any shortfall in certificates surrendered is $11.50 up until 2010, rising to $12.50 in 2010, $13.50 in 2011, $14.50 in 2012 and $15.50 for 2013 and subsequent years. Financial instrument traded: GAC = 1MWh.
	NSW Renewable Energy Target (NRET)	2007	The target for the NRET is to increase the percentage of renewable energy purchased to 10% by 2010 and 15% by 2020. NSW Renewable Energy Certificates (NRECs) are created by the generation of electricity from renewable sources above the baseline. The decision as to whether this scheme will run in conjunction with the Victorian Scheme has not yet been determined. Shortfall charges and other details are also yet to be finalised. Financial instrument traded: NREC = 1MWh.
ACT	ACT Greenhouse Gas Abatement Scheme (GGAS)	2005	The same aims as NSW GGAS, however, the responsibility for the operation of the GAS in the ACT rests with ACT's Independent Competition and Regulatory Commission and NSW's Independent Pricing and Regulatory Tribunal. Financial instrument traded GAC = 1MWh.
VIC	Victorian Renewable Energy Target (VRET) Scheme	2007	The Victoria renewable energy target aims to increase the percentage of renewable energy purchased to 10% by 2012. The scheme will continue until 2031 and is predominantly relevant for electricity retailers and large energy users. From 2007 the penalty for shortfalls is $43/MWh. This will then increase annually in line with the CPI. Certificates are created by the generation of electricity from renewable sources. Administered by the Victorian Essential Services Commission. Financial instrument traded VREC = 1 MWh.
QLD	13% Gas Scheme	2005	Aims to encourage more electricity to be sourced from gas with 13% of electricity to be sourced from gas from 2006 onwards. Penalty for shortfalls per MWh is $11.60 to be increased by the CPI annually. Accredited generators for accredited power stations may create GECs that may be traded or surrendered to meet their liability. The Chief Executive of the Department that administers the *Electricity Act 1994* is the Regulator with assistance from The Department of Mines and Energy. Financial instrument traded: GEC = 1MW.
Australia-wide	Mandatory Renewable Energy Target Scheme (MRET)	2001	The Scheme requires the generation of 9,500 gigawatt hours of extra renewable electricity per year by 2010. Renewable energy certificates (RECs) can be created when solar heaters are installed and renewable energy is produced by small generation units or power stations. The penalty for shortfalls is $40 per MWh and the scheme is administered by The Office of the Renewable Energy Regulator who is a statutory authority established specifically to oversee the Scheme. Financial instrument traded: REC = 1MWh.

A critique of the current state of the Australian trading schemes

In finance we require markets to be liquid in order for trading to take place in an efficient manner as this allows investors to readily sell their securities at the current price (Hunt and Terry, 2005, p. 479). Thus, liquid markets form the cornerstone of any belief that the markets are efficiently pricing the securities being traded. Another important issue we are concerned with in finance is the relationship between risk and return — the greater the level of risk we are prepared to accept, the higher the level of return we require in order to be compensated for that risk.

What risks are associated with the current state of carbon trading in Australia? As has already been discussed, the actual consequences of climate change are highly uncertain. However, for the sake of this analysis, let us assume the level of risk as used by Stern in 'The Stern Review on the Economics of Climate Change' presented to the Prime Minister and Chancellor of Britain in August 2006. Leaving aside the economic risks of climate change, the dominant risk for those trading in the carbon markets seems to be the uncertainty and variability of the steps which the various governments are taking to combat global warming. Given the wide disparity in the approaches taken in Europe and the United States, it is unclear if Australia will follow either one of those schemes, or introduce a completely different national carbon trading system. This raises the important questions of *if* and *how* the current schemes will be integrated into the new national program which the Australian Government plans to introduce no later than 2012. Until these issues are resolved, firms may be reluctant to engage in carbon trades or invest in carbon financial instruments in Australia for fear that

their carbon allowances written under one of the several existing programs may become worthless once the new national scheme is established.

With respect to liquidity, Australia's relatively small population compared with Europe raises liquidity issues which are exacerbated by the increasing number of different schemes and markets currently under operation. The NSW Greenhouse Gas Abatement Scheme Registry shows 17,857,364 NSW GGACs were traded in 2006, however, this was in only 669 trades. This is improving with 9,571,902 GGACs traded in 592 trades in the first four months of 2007. Johnson, Winter and Slattery note that there were only 42 trades in the Queensland Scheme for the year until October 2006. In contrast, Europe has seen a recent rationalisation in their marketplace commencing with the amalgamation of the European Climate Exchange and Powernext Carbon to become the largest futures and spot market exchange (Morrison).

Another component aiding liquidity in Europe is the availability of cash and derivative carbon contracts traded through organised exchanges. Such standardised contracts, in terms of size and maturity, provide the opportunity for market participants to trade and hedge their positions with relative ease and with low transaction costs. Equally as important, lower transaction costs found on organised exchanges allow trading by speculators who provide liquidity and improve price discovery. In Australia, carbon trading is implemented in the over-the-counter (OTC) markets which are less transparent than their European and American counterparts and, as a result, more difficult to assess in terms of market efficiency and efficacy. We believe it is likely that the Australian carbon markets would benefit from the introduction of a standardised carbon instrument. However, at this point in time, there is an even greater need for a single set of overriding national regulations, targets, rules and penalties.

The economics of climate policy

The greenhouse gas emissions policies discussed above are permit or quantity-based systems. Tradeable permit systems are an attractive mechanism for climate policy because they allocate emissions to their most valuable use and encourage long-term investments that are critical to the reduction of emissions. Importantly, permit systems can act to strengthen the policy itself because they encourage support from the owners of valuable permits. In the case of GHG emissions, however, economic theory suggests that quantity-based instruments are likely to be inefficient when compared with price instruments.

If the costs and benefits of emissions abatement were perfectly known, then intervention could take the form of a price (tax) or a quantity (permit) instrument with either policy approach capable of achieving an efficient level of emissions abatement — the amount of reduction in emissions at which the marginal benefit of abatement (lower environmental damage) equals the marginal cost of abatement (higher costs of production). There is, however, a great deal of uncertainty about the costs and benefits of abatement and this poses an important additional cost to society from emissions policy, namely the risks associated with incorrectly estimating costs and benefits and thus implementing an inappropriate level of policy.

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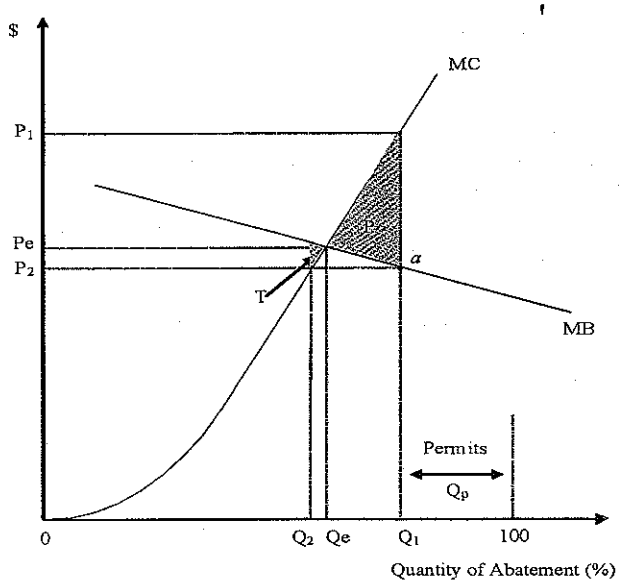
Greenhouse gases are a 'stock' pollutant — it is the build-up of carbon dioxide (and other GHGs) in the atmosphere over long periods of time that matters for the climate. It is unclear if the reduction of GHG in the short run will result in substantial changes in benefits at the margin. On the other hand, the effects of costs to consumers and producers of changes in the abatement effort are likely to be relatively significant as they involve shifting to more expensive technologies. Under these conditions, a tax or price-based system is more efficient because differences between expected and realised costs and benefits are less damaging to welfare if the policy sets the tax (the price of emissions) and allows the quantity of abatement to be market driven rather than setting the quantity (the number of permits) and allowing the price to adjust (McKibbin and Wilcoxen, 2002). In the context of carbon markets, the damage to society created by an inappropriate tax level, with the resulting amount of abatement being either more than or less than optimal, will be smaller than the damage of setting an inappropriate level of abatement and having to bear unexpectedly large costs. This argument, based on a seminal paper by Weitzman (1974) is presented

FIGURE 1. CLIMATE POLICY UNDER THE ASSUMPTION OF CERTAINTY



Despite the efficiency argument, tax-based systems are unlikely to be politically popular. Significant levels of taxation may be required in order for there to be any significant effect on emissions levels.

by McKibbin and Wilcoxen (2002, p. 65) using a simple diagram (see Figure 1).

In Figure 1, the MC curve represents marginal abatement costs and the *MB* curve represents the marginal benefits of emissions abatement. As described above, the *MB* curve is drawn relatively flat compared with the MC curve because we hypothesise that the marginal benefit of GHG abatements is smaller than its marginal cost. The efficient level of abatement exists where marginal benefits equal marginal costs. If the nature of the MB and MC curves were known with certainty, this could be achieved by either a tax on emissions at the rate P_e or a permit policy where the quantity of required reduction would be Q_e per cent of the total amount of emissions. However, the nature of these curves is highly uncertain.

Suppose, for example, that marginal costs are believed to be lower than those depicted in Figure 1 and that the MC and *MB* curves are (incorrectly) assumed to intersect at point *a*. Under a permit system, the quantity of permits (Q_p=*100* – Q_1) would be less than the efficient level, the difference given by $Q_1 - Q_e$ and firms would be forced to undertake the additional abatement. The price of a permit would rise to P_1 and the cost of the additional abatement would exceed the benefits by the shaded area *P*. Under a tax system, the same intersection point *a* would result in a tax level set at P_2 but firms would soon realise the higher than expected marginal cost curve and would, in response, reduce their level of abatement to Q_2. This level of abatement is too low but the welfare loss associated with the tax system (shaded area *T*) is much smaller than the welfare loss associated with the permit system.

It is important to understand that the relative slopes of the marginal cost and marginal benefit curves are crucial to this argument. While the nature of stock pollutants suggests that the marginal benefit curve will be relatively flat compared with the marginal cost curve (Newell and Pizer, 2003), the properties of these curves are highly uncertain. Despite the efficiency argument, tax-based systems are unlikely to be politically popular. Significant levels of taxation may be required in order for there to be any significant effect on emissions levels. This would be difficult to 'sell' politically as it would disadvantage consumers and energy intensive producers.

In the case of GHG emissions, both *pure* approaches are unlikely to be politically sustainable. The pure permit system requires the achievement of rigid targets regardless of the cost of doing so (the high degree of uncertainty associated with climate change requires governments to commit to targets that are associated with unknown and possibly excessive costs). Whereas permit systems create vested interests in the continuation of climate policy, pure tax systems create vested interests in its removal. One way to overcome the problems associated with the pure permit and tax-based approaches to climate policy is a hybrid approach that combines the best elements of both mechanisms and avoids most, if not all, of the shortcomings. Hybrid approaches to emissions policy are now receiving considerable attention in the academic literature (see, for example, Newell and Pizer, 2003; McKibbin and Wilcoxen, 2006).

A hybrid approach

For over a decade, economists Warwick McKibbin and Peter Wilcoxen have been promoting their hybrid approach to emissions policy – the McKibbin-Wilcoxen Blueprint. It is only recently that they have managed to generate serious interest from governments and key private sector players.

Under the McKibbin-Wilcoxen Blueprint (see McKibbin and Wilcoxen, 2006), the government supplies short-term permits at a fixed price which act like a 'tax' on emissions, but also issues (to those deserving of welfare compensation) a government-determined amount of valuable long-term or perpetual emission permits. The valuable perpetual permits (that 'could be traded among firms, or bought and retired by environmental groups' (p. 7)) provide long-term credibility by creating 'a private sector constituency with a clear financial interest in the seeing the policy maintained and enforced' (p. 7). The annual permits provide the advantages of an emissions tax: 'they provide clear financial incentives for emissions reductions but do not require governments to agree to achieving any particular emissions target regardless of cost' (p. 8). Other key aspects of the proposal are detailed in McKibbin and Wilcoxen (2002, 2006). While the Blueprint has a potential of achieving GHG abatement at lower costs than the more rigid price-only or quantity-only policies, under uncertainty, it should be noted that the EU has very large interests vested in its existing multi-billion dollar EU ETS system.

Conclusion

The Kyoto Protocol continues to receive both public and political support, but economic theory suggests that under certain conditions and uncertainty, permit systems may be a relatively inefficient approach to policy. An alternative hybrid approach to emissions policy is now being widely debated. Although global warming is an issue that requires a coordinated international response, the process of international agreement is complex and countries should be encouraged to undertake meaningful steps to reduce emissions now, even in the absence of an effective international agreement.

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Notes

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